DISSERTATION

STUDY ON RISK MANAGEMENT IN OIL AND GAS CONSTRUCTION PROJECTS

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STUDENT DECLARATION

I, **Bijendralal Kunhi Mangalavan**, Student of **MBA (Oil and Gas)**, studying at **University of Petroleum and Energy Studies**, declare that the project work entitled **'Study on Risk Management in Oil and Gas Construction Projects'** was carried by me in the partial fulfillment of MBA (Oil and Gas) programme under the University of Petroleum and Energy Studies. This project was undertaken according to the university rules and norms as part of academic curriculum. It is my original work and It has no commercial interest. It is not submitted to any other organization for any other purpose.

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Declaration by the Guide

This is to certify that Mr. **Bijendralal Kunhi Mangalavan,** a student of **MBA (Oil and Gas)**, SAP ID 500065992 of **University of Petroleum & Energy Studies** has successfully completed this dissertation report on **'Study on Risk Management in Oil and Gas Construction Projects'** under my supervision.

Further, I certify that the work is based on the investigation made, data collected and analyzed by him and it has not been submitted in any other University or Institution for award of any degree. In my opinion it is fully adequate, in scope and utility, as a dissertation towards partial fulfillment for the award of degree of MBA.

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ABSTRACT

Oil and gas construction projects are complex and risky because of their dynamic environment. Furthermore, rising global energy demand has increased the need for trustworthy risk assessment models for such projects that can provide adequate and precise policy planning. Traditional risk assessments in oil and gas construction projects do not consider the interrelationships of factors in the best-fit models.

The purpose of the paper is to the identify risk factors, which affect oil and gas construction projects and derive risk responses. Questionnaire survey was conducted with the involvement of project executives working in oil and gas construction projects and statistical analysis was carried out in order to identify the major project risks. Subsequently, mitigating measures were derived using informal interviews with the various levels of management personnel from oil and gas construction projects. This study is to determine the suitable risk response, mitigation plan and find out the difference between approaches of project risk awareness. Two approaches used for this study are 1) detailed risk analysis approach and 2) less detailed general idealistic approach. This report explain risk management methodology, risk analysis, risk mitigation action and contingency reserve requirement for the major oil and gas construction projects.

Long project approval procedures, poor engineering, poor expediting practices in procurement, incompetence of project team, lack of experience in fabrication, inadequate tendering practices, non-availability of right resources and late internal approval processes from the client were identified as major risks. The project team suggested various strategies to mitigate the identified risks. Effective communication with functional managers, implementing sub-contractor evaluation using multiple criteria decision-making technique, and providing training to project people were suggested as viable approaches.

The improvement measures as derived in this study would improve chances of project success in the oil and gas industry. There are several risk management studies carried out in oil and gas construction. However, as risk factors vary considerably across industry and countries, the study of risk management for successful projects in the oil and gas industry is unique and has tremendous importance for effective project management.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Risk management is a decision-making process used for the successful completion of projects. Risk management mentions to a planned set of activities and techniques that are utilized to guide an organization and to control the numerous risks that can affect its capacity to accomplish certain objectives. Risk management needs to provide an action plan on how it going to manage such risks by applying management policies, company procedures, management tools, methodologies and resources that will be utilized.

The reason for this research is to distinguish the real risks management methodologies influencing oil and gas construction projects from the preparation stage through until the execution stage. Research presents effective use of the contingency reserves (additional money, labour or time) by various risk reduction choices where a methodology was taken for the lower possibility and higher possibility saves. Case study of ongoing two major oil and gas offshore construction projects in Middle East by a construction organization was carried out to recognize the real risks that exude on oil and gas ventures by means of risk management analysis. Two comparative projects of same scope of works were picked for the correlation between the risk appraisal methodology.

The research need to find answer for when two different risk analysis methodologies (less detailed general idealistic methodology and detailed analysis approach) were used, how that will manage project threat and opportunities in a way decreases usage of contingency reserves.

Risk analysis extent of the two selected projects focuses basically on the project risks during various project phases like project scope review, constructability review during engineering, bill of material preparation, manpower estimation, project schedule preparation, fabrication of components at shops, assembly of structures at site, equipment and process installation, mechanical completion, pre-commissioning and closeout of project. Risk is associated in each stages of the project. Failure in early identification of risks and action taking to mitigate the same may lead to operating loss and decrease in available cash.

1.2 PROBLEM STATEMENT

Risk management can be characterized as a vital business process, whereby management need to survey whether the business exercises are reliable with its expressed key objectives and how risk management is connected to project success.

Risk management in major oil and gas construction projects still have inefficiencies and the main cause for this situation is lack of early identification of risks, prioritization of risks and proper management approach for risk mitigation. Most risk management is concentrated towards counteractive action of disappointments and comprehension on the reasons for the disappointments. Not identifying potential risk at early stage has large negativity to project. Assessing identified risks using qualitative techniques helps to prioritize risk for better controlling of risk. Improper alignment of risk management with project schedule, budget and resource estimates will negatively impact organization. The operation of the organization may be in trouble due to shortage of cash and in long term reputation of the company will be affected. By applying proper risk management and analysis methodologies utilization of contingency reserves can be minimized.

1.3 NEED FOR THE RESEARCH

The cost is utilized as a pointer whether the project is ready to meet quality requirements or ready to finish on schedule in oil and gas construction projects. A cost of non-quality (CONQ) is associated with any re-work, delay or damages in construction. Furthermore, cost of construction escalates in oil and gas industry due to various reasons like incorrect cost estimate, incorrect sequence of activities, delay in material supply by suppliers, shortage of labour, capacity constraints in fabrication shops and unforeseen conditions. Contingency cost can be kept as minimum by taking comprehensive approach in risk management at each stages of project with timely mitigation of risks.

Major oil and gas construction companies are providing a comprehensive modular solution for large projects. Process units are fabricated as modules in the fabrication yards then moving the modules to construction site for installation. Oil and gas construction projects now involves set of tasks organized in a repeated way. A comprehensive risk management approach identified can be used for all similar construction projects.

1.4 OBJECTIVES OF THE STUDY

- To identify the main risks and suitable risk mitigation plan in oil and gas construction projects.
- To find out the best risk assessment approach to minimize utilization of contingency reserve.
- To prepare risk register considering major risks that affects the construction project in oil and gas industry.
- To analyze how to overcome the risks in construction project from internal and external factors.

1.5 RISK MANAGEMENT

Risk management is the process of recognizing, assessing and controlling threats to the company's capital and earnings. These threats, or risks, could stem from a wide assortment of sources, including budgetary vulnerability, legitimate liabilities, strategic management errors, accidents and catastrophic events. IT security threats and information related risks, and the risk management strategies to reduce them, have turned into a top need for digitized companies. As a result, a risk management plan increasingly includes companies' processes for recognizing and controlling threats to its computerized assets, including exclusive corporate information, a customer's personally recognizable data (PII) and licensed innovation.

Each business and association face the risk of unforeseen, unsafe events that can cost the organization money or cause it to for all time close. Risk management allows organizations to endeavor to get ready for the negative impact by limiting risks and reserving additional costs (contingency and management reserve) before they occur.

In the realm of finance, risk management refers to the act of recognizing potential risks ahead of time, dissecting them and finding a way to diminish/check the risk. At the point when a company makes an investment decision, it exposes itself to various money related risks. The quantum of such risks depends on the sort of budgetary instrument. So, to limit and control the exposure of project to such risks, project managers and investors practice risk management. Not giving due significance to risk management while settling on project decisions may unleash devastation on investment. Various levels of risk come connected with various categories of functional areas.

Significance

By executing a risk management plan and considering the various potential risks or events before they happen, organization can save money and secure their future. This is because a robust risk management plan will enable an organization to establish procedures to dodge potential threats and limit their effect. This capacity to understand and control risk will enable organizations to feel increasingly sure about their business decisions. Moreover, strong corporate administration principles that focus specifically on risk management can enable an organization to arrive at their goals.

Other significant benefits of risk management include:

- Creates a safe and secure workplace for all staff and customers.
- Increases the stability of business operations while also decreasing risk.
- Provides insurance from events that are hindering to both the organization and the earth.
- Helps establish the company's insurance needs to save on unnecessary premiums.

1.6 RISK MANAGEMENT STRATEGIES AND PROCESSES

All risk management plans pursue the same steps that join to make up the general risk management process:

Establish setting: Understand the circumstances wherein the rest of the process will happen. The criteria that will be used to assess risk should also be established and the structure of the analysis should be characterized.

Risk identification: The organization identifies and defines potential risks that may adversely impact a specific organization process or task.

Risk analysis: When specific types of risk are recognized, the organization at that point determines its odds happening, as well as its consequences. The objective of risk analysis is to further understand every specific instance of risk, and how it could impact the organization's projects and objectives.

Risk assessment: The risk is then additionally assessed in the wake of deciding the risk's general probability of event joined with its general consequence. The organization would then be able to settle on decisions on whether the risk is satisfactory and whether the organization will take it on based on its risk craving.

Risk alleviation: During this step, companies assess their highest-positioned risks and build up an arrangement to mitigate them using specific risk controls. These plans incorporate risk relief processes, risk avoidance tactics and emergency courses of action in the occasion the risk comes to fulfillment.

Risk monitoring: Some portion of the moderation plan includes following up on both the risks and the general arrangement to continuously screen and track new and existing risks. The general risk management process should also be surveyed and refreshed as needs be.

Convey and consult: Inside and outside shareholders should be incorporated into correspondence and consultation at each fitting step of the risk management process and in regard to the process all in all.

Risk management strategies should also endeavor to answer the accompanying questions:

What can turn out badly? In what capacity will it influence the project? Consider the likelihood of the occasion and whether it will have an enormous or small effect.

What should be possible? What steps can be assumed to anticipate the loss? What should be possible recuperate if a loss does happen?

In the case of something happens, by what means will the company pay for it?

1.7 RISK MANAGEMENT APPROACHES

After the organization's specific risks are distinguished and the risk management process has been executed, there are several unique strategies project team can take with respect to various types of risk:

Risk evasion. While the total disposal of all risk is seldom possible, a risk evasion strategy is designed to redirect as numerous threats as possible as to keep away from the costly and disruptive consequences of a harming occasion.

Risk decrease. Companies are sometimes ready to lessen the measure of impact certain risks can have on organization processes. This is accomplished by adjusting certain aspects of a general task plan or organization process, or by decreasing its scope.

Risk sharing. Sometimes, the consequences of a risk are shared, or distributed among several of the undertaking's participants or business departments. The risk could also be shared with an outsider, such as a vendor or sub-contractor.

Risk holding. Sometimes, companies choose a risk is justified, despite all the trouble from a business standpoint, and choose to keep the risk and manage any potential aftermath. Companies will frequently hold a specific degree of risk if an undertaking's foreseen benefit is more noteworthy than the costs of its potential risk.

Limitations

While risk management can be an incredibly advantageous practice for organizations, its limitations should also be considered. Many risk analysis techniques such as making a model or simulation require assembling a lot of information. This extensive information gathering can be expensive and is not destined to be solid.

Besides, the use of information in decision making processes may have poor outcomes if simple indicators are used to mirror the significantly more mind-boggling realities of the situation. Similarly, embracing a decision all through the entire venture that was planned for one small aspect can prompt unforeseen results.

Another impediment is the absence of analysis expertise and time. PC software programs have been created which simulate events that may negatively affect the organization. While cost successful, these mind-boggling programs require experienced personnel with comprehensive skills and learning so as to precisely understand the created results. Breaking down historical information to recognize risks also requires exceptionally skilled and experienced personnel. These individuals may not always be assigned to all projects when company is handling multiple projects at same time at different work locations. In this study risk assessment and mitigation plan of two identical projects of same construction organization handled by experienced / less experienced project management team is evaluated.

Different limitations include:

Risk models can give organizations the false conviction that they can measure and direct every potential risk. This is false because it is impossible to expect the unforeseen. Besides, there is no historical information for new products, so there's no understanding to base models on.

It's hard to see and understand the total picture of total risk.

Risk management is juvenile. There is still far to go before techniques and models are built up that really fit the risk management purpose.

1.8 RISK MANAGEMENT STANDARDS

Since the mid-2000s, several industry and government bodies have extended administrative consistence rules that scrutinize companies' risk management plans, policies and procedures. In an increasing number of industries, boards of directors are required to audit and provide details regarding the ampleness of enterprise risk management processes. As a result, risk analysis, inside audits and different means of risk assessment have turned out to be significant components of business strategy.

Risk management standards have been created by several organizations, including the National Institute of Standards and Technology (NIST) and the International Organization for Standardization (ISO). These standards are designed to enable organizations to recognize specific threats, assess exceptional vulnerabilities to decide their risk, distinguish ways to lessen these risks and after that actualize risk decrease efforts as per authoritative strategy.

The ISO 31000 principles, for instance, give frameworks to risk management process improvements that can be used by companies, regardless of the association's size or target sector. The ISO 31000 is designed to "increase the probability of accomplishing objectives, improve the identification of opportunities and threats, and successfully assign and use resources for risk treatment," as indicated by the ISO website. In spite of the fact that ISO 31000 can't be used for confirmation purposes, it can help give direction to inward or outer risk review, and it allows organizations to contrast their risk management practices and the universally perceived benchmarks.

The ISO prescribed the accompanying objective areas, or principles, should be a piece of the general risk management process:

The process should make an incentive for the association.

- It should be a fundamental piece of the general authoritative process.
- It should factor into the organization's general decision-production process.
- It must unequivocally address any vulnerability.
- It should be systematic and structured.
- It should be based on the best accessible data.
- It should be custom fitted to the venture.
- It must consider human factors, including potential errors.
- It should be transparent and comprehensive.
- It should be versatile to change.
- It should be continuously observed and enhanced.

The ISO standards and others like it have been created worldwide to help organizations systematically execute risk management best practices. A definitive objective for these standards is to establish basic frameworks and processes to successfully actualize risk management strategies.

These standards are regularly perceived by universal administrative bodies, or by objective industry groups. They are also consistently supplemented and refreshed to reflect quickly changing sources of business risk. Albeit keeping these standards is usually deliberate, adherence might be required by industry regulators or through business contracts.

1.9 STEPS IN RISK MANAGEMENT PROCESS

A typical meaning of risk is a dubious occasion that on the off chance that it occurs, can have a positive or negative impact on a project's goals. The potential for a risk to have a positive or negative impact is a significant idea. Why? Because it is normal to fall into the snare of reasoning that risks have inalienably negative effects. On the off chance that you are also open to those risks that make positive opportunities, you can make your project smarter, streamlined and increasingly productive. Think about the maxim – "Acknowledge the unavoidable and make it advantageous for you." That is your main thing when you mine project risks to make opportunities.

Vulnerability is at the core of risk. You might be unsure if an occasion is probably going to happen or not. Also, you might be dubious what its consequences would be on the off chance that it occurred. Probability – the likelihood of an occasion happening, and consequence – the effect or result of an occasion, are the two components that portray the extent of the risk.

All risk management processes pursue the same basic steps, albeit sometimes extraordinary language is used to describe these steps. Together these 5 risk management process steps join to convey a simple and successful risk management process.

Step 1: Identify the Risk. You and your group reveal, perceive and describe risks that may influence your project or its outcomes. There are various techniques you can use to discover project risks. During this step you start to set up your Project Risk Register.

Step 2: Analyze the risk. When risks are distinguished you decide the probability and consequence of each risk. You build up an understanding of the idea of the risk and its capability to influence project goals and objectives. This data is also contribution to your Project Risk Register.

Step 3: Evaluate or Rank the Risk. You assess or rank the risk by deciding the risk greatness, which is the mix of probability and consequence. You settle on decisions about whether the risk is adequate or whether it is serious enough to warrant treatment. These risk rankings are also added to your Project Risk Register.

Step 4: Treat the Risk. This is also alluded to as Risk Response Planning. During this step you assess your highest positioned risks and set out an arrangement to treat or adjust these risks to accomplish satisfactory risk levels. How might you limit the likelihood of the negative risks as well as upgrading the opportunities? You make risk moderation strategies, preventive plans and emergency courses of action in this step. Also, you include the risk treatment measures for the highest positioning or most serious risks to your Project Risk Register.

Step 5: Monitor and Review the risk. This is where you go out on a limb Register and use it to screen, track and survey risks.

Risk is about vulnerability. On the off chance that you put a system around that vulnerability, at that point you successfully de-risk your project. What's more, that means you can move significantly more unhesitatingly to accomplish your project goals. By recognizing and dealing with a comprehensive list of project risks, unpleasant surprises and barriers can be decreased and brilliant opportunities discovered. The risk management process also helps to resolve problems when they happen, because those problems have been envisaged, and plans to treat them have just been created and concurred. You keep away from impulsive reactions and going into "putting out fires" mode to correct problems that could have been envisioned. This makes for more joyful, less stressed project teams and stakeholders. The final product is that you limit the impacts of project threats and catch the opportunities that happen.

CHAPTER 2

INDUSTRY PROFILE

2.1 OIL AND GAS OPERATIONS

Oil and gas operations usually divided into three sectors; up-stream, mid-stream and down-stream.

Up-stream, mid-stream and Down-stream Activities in Oil and Gas Industry

Upstream section also known as exploration and production (E&P) involve finding, lifting and processing oil and gas from subsurface into surface and ready for transportation. Upstream activities that occurred before processing and refining of hydrocarbon. Those activities are exploration to find oil reserves and production.

Mid-stream section involves transportation and storage of crude oil and natural gas from E&P location (offshore / Onshore) for further processing by pipeline, railways, road, or marine tankers.

Down-stream section also known as refining and marketing (R&M) involves further processing of crude oil and natural gas into useful final product or row material for other fertilizer or petrochemical industry. Downstream activities involve processing and refining of the crude, petrochemical plants, logistic and retail transactions. Ordinarily downstream activities require industrial plants, pipelines, and storage services.

Two projects selected for case studies in this research are from upstream section. These projects are offshore oil filed development projects to increase the production capacity of major oil company in middle east. Scope of work include engineering, procurement, construction and installation (EPCI) of new sub-sea jackets , topside platforms, connecting bridges and sub-sea crude export lines to onshore processing plant.

Risks

Characterized risk as an issue that may cause losses or might undermine the success of a project. Ordinarily in a project, "risk" is a potential issue that will affect cost, schedule or success of the project. Risk can be isolated into two which are 'stake' and 'vulnerability', whereby as for 'stake' it will be assessed whether it may prompt monetary benefit or loss, and for vulnerability it is exceptionally subject to time and situation.

Risk Management

Risk management can be characterized as a strategic business process, whereby management need to assess whether the business activities are consistent with its stated strategic objectives and how risk management is connected to investment and development decisions. Most risk management studies concentrated towards counteractive action of failures and understanding on the causes of the failures and the reasons for the failures to happen. Risk management allows for unwavering quality of project design because of formal strategy or procedures to favor any important project, and included worth because it allows for superior, effective cost management, and complying with project time constraints.

2.2 PROJECT MANAGEMENT

Project management involves activities such as project arranging, project execution and project monitoring. As indicated by, 'The Iron Triangle' (cost, quality, and time) (Refer to Figure 2.2.1) for project management was created by Oisen during 1950s, and it was used by the British Standard for project management definition.

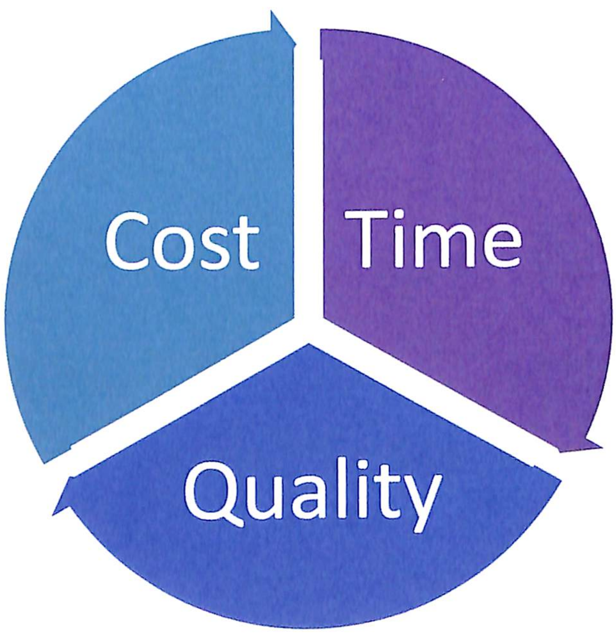


Figure 2.2.1: The Iron Triangle

Project management characterize by British Standard for project management as the arranging, monitoring and control of all aspects of a project and the inspiration of every one of those associated with it to accomplish the project objectives on time at specified cost, quality, and execution.

Further, had posited that criteria for success comprised of the conveyance stage (the process), and post-conveyance stage (systems and benefits). Table 2.2.2, beneath depicts the components to understanding success criteria.

Table 2.2.2: Square Route to Understanding Success Criteria

Iron Triangle	**The Information System**	**Benefits Organization**	**Benefits Stakeholder/ Community**
Cost Quality Time	Maintainability Reliability Validity Information quality use	Improved efficiency Improved effectiveness Increased profits Strategic goals Organizational Learning Reduced waste	Satisfied user Social and environmental input Professional learning, contractor's profits Capital suppliers, content project team, economic impact to surrounding community

2.3 PROJECT MANAGEMENT TRIANGLE

A survey on project scope, costs, quality and scheduling sent for project management triangle.

Project Scope

In a study, project scope is distinguished as one of the criteria for the greatest issue under project definition. Further, on an oil and gas project failure showed that multifaceted nature/size factors as one of the factors added to project deferral or failures.

Project Cost

The cost is used as a pointer whether the project ready to meet the schedule or ready to finish on time proposed an earned readiness management (ERM) in scheduling, monitoring and assessing a project so as to ensure success had coordinated the estimation of expected culmination likelihood by using the Line of Balance Technique (LOB) with Program Evaluation and Review Technique (PERT), and Repetitive Project Evaluation and Review Technique (RPERT) to create software for monotonous construction project with indistinguishable activities. Cost variety subject to lowest offering acquisition strategy, extra work, wrong technique for cost estimation and under estimating the gravity of issues are the most basic factors for cost variety. More different factors that lead to cost overwhelm includes off base cost estimation, method of installment and financing, unforeseen ground conditions, swelling and fluctuation in prices of crude materials.

Project Quality

To limit failures, designers or project managers must have amazing learning on the causes of project failures that may be because of poor project design, process or outside of the system (users, condition) like poor vendor or sub-contractor selection.

Project Scheduling

In a study led by, project delay can be arranged by seven principle factors which are consultants related factors, contractual worker related factors, design related factors, equipment related factors, outside related factors, labors related factors, and materials related factors. In another study on project scheduling directed by the study applied project cards that incorporate unique scheduling that comprise of baseline schedule, risk analysis and project control with new two components distinguished which is project genuineness and following credibility.

As indicated by, project management methodologies require software support systems, until late 1980s most project management tools were software packages designed for project scheduling such as PERT (Program assessment and audit strategy), ADM (Arrow charting technique) and PDM (Precedence graphing strategy). Those three software ready to framed the basis for arranging and foreseeing, visibility and empowered management to control the program, assisted management to deal with the uncertainties, gave facts to decision making, capacity to decide labor, material and capital requirements, and capacity to give structure to data detailing.

Be that as it may, project leadership couldn't be supplanted with PC software packages, yet it very well may be used as a source of perspective for decision making purposes. Furthermore, 95% of the project management software focuses on arranging, scheduling, and controlling project should be made for the inception of a project and furthermore the closure of a project.

Further, in most project management researches nowadays, the used of 'soft' and 'hard' have been used extensively. Usually, 'soft' is alluding to human factor, whereas 'hard' is alluding to specialized execution and effectiveness. The 'soft' part in project management is very clear as it usually involves human conduct. Nonetheless, it is very hard to make speculation for the 'difficult' issues in project management.

Table 2.3.1 Hard Vs. Soft in Project Management

Hard	**Soft**
Hard end project: specialized execution and proficiency (to decrease vulnerability)(Closed system approach such as Systems Engineering, System Analysis and System Dynamics)	Soft end project: goals that worth relationships, culture and importance (to diminish equivocalness)
Hard Skills: contracting, business finance, coordinated cost and schedule control, measuring of work execution, monitoring of quality, and conduction of risk analysis.	Soft Skills: arrangement, change management, understanding and managing needs of peers, staffs and managers.
Hard Issues: time, cost, quality to measure project success	Soft Issues: people group observation, safety, ecological impacts, lawful agreeableness, political, and social effect

Project Risk Management

Project risk management included identification, assessment, and prioritization of risks through coordination and financial utilization of resources in limiting, monitoring and controlling the likelihood consequences of deplorable events that will boost the success of a project. In project risk management there are five basic factors to be considered which are arranging risks, risks identification, subjective risk analysis, quantitative risk analysis, and monitoring risks.

2.4 POTENTIAL RISKS IN OIL AND GAS PROJECTS

Reasons for Poor Project Results

In a study, it was discovered that huge oil and gas construction project cost overruns and losses on work efficiency in Canada were because of management insufficiency in overseeing scope, time, cost, quality, profitability, procedures, equipment, materials, and absence of leadership. In another study by, there are 20 reasons that may prompt poor project results, schedule and cost overruns for Canadian oil sand projects, as listed underneath:

1. Lack of experienced proprietor and temporary worker sources.
2. Overall quality of proprietor and temporary worker management capabilities.
3. Ineffective hierarchical and coalition structures for super projects.
4. Inappropriate designation of proprietor responsibilities to contractors.
5. Lack of clear meaning of lines of power and management responsibilities.
6. Lack of discipline and inadequate control of project scope.
7. Complexities of significant expansions to existing working plants.
8. Customization of proprietor specification requirements,
9. Level of project definition and closeness not surely knew.
10. Lack of recognition with the atmosphere, safety requirements, ecological constraints, administrative regulations, construction practices.
11. Scarcity of qualified art workers, high work costs, inconsistent profitability.
12. Many finishing super projects influencing resources and work accessibility.
13. Ineffective authoritative arrangements and rewarding contracting condition.
14. Ineffective material management plans and untimely field activation.

15. Inappropriate management impact of cost estimates to meet financial hurdles and overlooking project reality.
16. Ineffective project control systems and project advancement practices.
17. Lack of discipline and consistent use of project code of accounts to permit compelling control and accumulation of genuine costs.
18. Lack of proprietor front-end estimating ability and project control personnel.
19. Lack of proper risk analysis expertise.
20. Lack of proprietor historical project systems and databases on the area of the project conditions.

Possible Sources for Uncertainty

Agreeing for possible sources of vulnerability for oil and gas industry may be because of several sources as listed beneath:

1. Poor estimates of time and cost.
2. Lack of a reasonable specification of project requirements.
3. Ambiguous guidelines about administrative processes.
4. Lack of information of the number and types of factors affecting the project.
5. Lack of information about the interdependencies among activities in the project.
6. Unknown events inside the project condition.
7. Variability in project design and logistics.
8. Project scope changes.
9. Varying bearing of objectives and priorities.

Potential Risks

For oil and gas operations in either Middle East or other countries the potential risks as shown on below.

Potential Risk	Items
Exploration	1. Subsidence. 2. Wave loading. 3. Loss of surface water access. 4. Delays due to species migration.

Production	1. Early season delays. 2. Pad damage. 3. Loss of surface water access. 4. Production interruption. 5. Ice road decreased trader's travels.
Transport and terminals	1. Ice load variation. 2. Damage to coastal facilities. 3. Shipment interruptions. 4. Improved for reduced shipping lanes or seasons.
Pipelines	1. Thaw subsidence and frost jacking. 2. Wildfires.
Refining and processes	1. Loss of access of water. 2. Flooding. 3.Loss of peak cooling capacity
Neighboring communities	1. Loss of species and habitat. 2. Water. 3. Storm impacts on key infrastructures.

2.5 RISKS PROJECT MANAGERS FACE IN THE OIL AND GAS INDUSTRY

The energy industry faces various risks and challenges from almost every point. These range from Engineering to commissioning stage of the project. Different risks incorporate strict budgets and schedules, safety issues, natural concerns, dubious operations, regulations and other unforeseen factors that effect on the processes.

The oil platforms at offshore, specifically, are dangerous and companies must invest vigorously to ensure the assurance of their employees, marine life, and the sea. They must, hence, agree to safety and natural regulations which may keep their operations to specific limits. For instance, they need to avert contamination and have alternate courses of action for clearing or crisis services in case of a mishap. The numerous risks make the oil and gas industry unpredictable and aggressive.

The project managers need, in this manner, understand every one of the challenges and after that put alleviation measures to address them. While it is impractical to dispense with the risks totally, the project managers can use new technologies to limit them. This streamlines the operations at a lower cost while ensuring safety, less personal time and costs savings.

2.6 MAJOR RISKS IN THE OIL AND GAS INDUSTRY

Despite the fact that there are numerous challenges in the industry, the number influencing a specific organization fluctuates as per the area, geography, government and different factors. Following are the significant 5 risks project managers face in the oil and gas industry.

Operational and cost risks

Operational costs vacillate as per regulations, condition, and different factors. Strict safety procedures require extra costs to operate equipment and other administrative conditions subsequently making the project increasingly expensive.

The prices in the oil and gas industry are so unstable because of the uneven idea of delivering the products. Further, shocks in the supply and request, as well as dubious universal prices because of overproduction by different companies increase the operational risks, and these are usually past the organization's control. Geographical barriers frequently increase the cost risks since they regularly require flighty extraction methods that are all the more costly.

Furthermore, finding and holding qualified workers is another test, especially during the blast time, and this may increase the finance significantly. Other operational risks incorporate damage to workers, accidents, as well as violations that could prompt penalties.

Planning and costs

Planning risks arise because of uncertainties in the extraction processes such as penetrating in new or troublesome terrains. Indeed, even after an oil and gas organization invests intensely, fluctuations in the worldwide oil and gas request and prices may affect adversely on the revenues. Lacking or unstable oil production in the wells is another risk that can place constraints in the working spending plan especially with regards to valuing the products.

2.7 REGULATION RISKS IN THE OIL AND GAS INDUSTRY

The regulations risks may shift from one locale and government to the next. This usually happens because of an adjustment in policies, taxes, and mining quotas, send out limits, network engagements and then some. Shifts in the political winds that regularly lead to changes in the regulations may influence the cost of production or revenues and affect the companies negatively.

Government regulations with respect to where and oil and gas companies concentrate and process the products shift from area and politics of the day. Indeed, even in the wake of starting off on an ideal arrangement, things may change for the worst when a when there is a difference in government or approach, especially if this comes after gigantic investments by the oil organization.

Eco-accommodating groups and politicians may also impact the heading the organization takes especially on the off chance that they need to hold fast to strict guidelines to preserve the earth. What's more, the politics may make demands for the oil organization to start network projects in areas surrounding the oil wells or facilities.

Technology Risk that oil and gas companies face

The technology in the oil and gas industry keeps on advancing as the players attempt to decrease risk, increase effectiveness and revenues. Despite their numerous benefits, investing in the new technologies may risk the project stream in terms of spending plan, projections, and profits.

Moreover, disappointment in the new technology or failure to accomplish proposed goal may prompt extra costs and losses, unforeseen repairs, upgrades, and so forth. Therefore, the project managers must consider the benefits and limitations of updating the existing technologies.

2.8 CONSTRUCTION RISKS IN OIL AND GAS INDUSTRY

There are several risks that are probably going to arise during the construction of the oil and gas facilities. Failure of structures, accidents and delays are some of the challenges during the construction processes.

Factors such as workmanship or material defects, changes in the climate patterns, cataclysmic events, meeting safety requirements, issues with workers and transportation of materials affects the finish time and spending plan of the project. Further, construction risks are higher when there are risky processes such as installation of offshore platforms in deep water.

The conventional methods of doing surveys, inspections, recognizing and area defects such as leaks in pipeline, tough oil and gas locations are dangerous as well as costly and wasteful. What's more, these may require shutting down the facilities over observing strict safety procedures.

2.9 AVOID PROJECT FAILURES

There are not many methods that can be used to maintain a strategic distance from project failures which are Failure Mode and Effect Analysis (FMEA), for base up analysis, and Hazard and Operability Analysis (HAZAOP) and What if checklist for top base analysis.

In designing an item or project, couple of methods can be used to limit the failures of an item or project design by performing Fault Tree Analysis (FTA) for top down analysis, and Failure Mode and Effect Analysis (FMEA) for base up analysis. Moreover, Hazard and Operability analysis (HAZOP) and What if checklist, also expected to lessen or limit the causes of failures. Nonetheless, new strategy TRIZ is acquainted that forces users with adopt substantially more proactive strategy in recognizing causes of problems, so as to permit to 'design the disappointment' and after that to re-transform the imagined disappointment into a means of anticipating the failures later on.

Coordinated computation with expected fruition likelihood by using the Line of Balance Technique (LOB) with Program Evaluation and Review Technique (PERT), and Repetitive Project Evaluation and Review Technique (RPERT) to create software for monotonous construction project with indistinguishable activities.

2.10 THEORIES RELATED TO PROJECT RISK MANAGEMENT

As per Resource Based View or Resource Based Theory began from monetary disciplines, anyway the use of the theories has reached out towards management, sociological, data management and learning management. From the analyses led by them from aggregation of various literatures on Resource Based Theory, about 73.8 percent in the territory of general management and strategy from 1992 to 1994, and 57.7 percent in year 1998 to 2000. The latest analyses of theories showed that it had advanced from monetary towards management fields such as promoting, hierarchical studies, production activity and management. Other than that, as per resource-based hypothesis focuses on:

- performance differences between firms profoundly reliant on the measure whether the firm owns exceptional inputs and capabilities,
- the level of the resources whether at notoriety level or seller steadfastness,
- Acceptable proxies for firm resources (R&D capabilities or management proclivities), and
- New IO game hypothetical methodology (3 forces: 1. Claim assets, 2. Competitors assets, 3. Constraints from more extensive industry and open arrangement condition).

Further, as indicated by resource Based View is really a strategic management hypothesis that has been used extensively by managers in project management. It is used to analyze how resources can increase upper hand by having the option to make included an incentive than rivals and simultaneously increased better yield from investments According to project management is identical to brief association.

From the research, they proposed that 'activity' is not necessarily the consequence of decision, whereby a decision can be made after the activity so as to genuine the previous activity.

Activity may supersede decision when 1. Time is significant; 2. Task, 3. Group and 4. Transition.

Discussed incorporated dependability hypothesis towards logistics park construction project risk control so as to maintain a strategic distance from risk and increase the unwavering quality of the project with a base absolute investment. At decision stage the factors recognized are work direction, area and investment decision. As for construction arrangement, the factors that considered as significant risk will be land acquisition, survey and design, offering and offering, and financing and readiness. For construction phase the factors distinguished are construction, facilities installation and commissions, contract management, hardware and material management, security management, and supervision. Last phase, which is the gift and activity, consisted of acknowledgment and handover, dealer and activity management.

2.11 MANAGE RISKS IN OIL AND GAS CONSTRUCTION PROJECTS

In the oil and gas construction industry, contractors are required to acknowledge and deal with a specific level of risk; that is, they must attempt a proactive way to deal with arrangement with threats and recognize opportunities.

In spite of the fact that risk management is acknowledged as one of the basic success factors for construction projects, construction risk management is one of the most ineffectively understood areas of Project Management. Truth be told, numerous surveys demonstrate that unmanaged risk is one of the essential drivers of project disappointment.

Customarily, risk management has focused on cost during the arranging phase of construction. However, the history of the construction industry is brimming with projects that were finished with significant cost and schedule overruns. That is because conventional approaches come up short on a comprehensive and formal risk management system to recognize, assess, moderate and viably impart risks all through the construction phase.

An Integrated Approach

A viable risk management system includes the identification, capability, evaluation, relief and execution of activity plans for all risks affecting all project objectives. Also, these risks must be overseen all through the project life cycle and by all the concerned parties. Thus, risk management is not a one-time-just process, however an incorporated, iterative process rehashed for the duration of the life of the construction project.

For risk management efforts to have the greatest effect on project result and related events, the process should be started as right on time as possible in the project lifecycle. During the offering phase, the proposal supervisor begins to oversee risk as a formal and continuous process from the project GO/NO-GO decision until the project grant date. The project manager continues the process from the hour of agreement grant through the execution phases and up to project closeout.

CHAPTER 3

LITERATURE REVIEW

3.1 RISK MANAGEMENT IN OIL AND GAS CONSTRUCTION PROJECTS

Projects are exposed to both inner risks (money related, design, authoritative, construction, personal, included parties and operational risks) and outside risks (practical, social, political, lawful, open, logistical and ecological risks). Every one of the risks may impact cost, schedule or quality of the project in negative ways (Charoenngam and Yeh, 1999). Along these lines, risk management should be very much perceived and taken care of as an incorporated capacity of project management.

Vietnam is a rising economy with increasing gross domestic item (GDP) (World Bank, 2001). The construction industry is the fundamental supporter of the development with genuine expansion of 7.2 percent in 2001 and 14 percent in the first quarter of the year 2002. Nonetheless, Vietnam's construction industry has as of late experienced numerous issues that cause negative impacts on construction projects, one of which is the absence of systematic and successful risk management system.

Risks in construction frequently cause time and cost overruns. Numerous projects have been deferred or surpassed their arranged budgets, as project managers couldn't oversee risk adequately. These problems seem to happen all the more regularly these days, because of the rising idea of the economy. Projects today are exposed to considerably more risks and uncertainties because of factors such as arranging and design intricacy, presence of various interest groups (project proprietor, consultants, contractors, vendors, and so forth.), resource accessibility (material, hardware, funds, and so on.), climatic condition, social concerns as well as monetary and political statutory regulations.

The oil and gas industry in Vietnam contributed 10 percent of the GDP in 2001 (Statistical Publisher, 2001). Today, the industry continues to develop strongly inferring demands for construction of new oil and gas facilities. Oil and gas construction projects are frequently capital intensive. Thus, their successful usage is strategically significant. In any case, oil and gas construction projects are exposed to risks because of enormous capital investment, contribution of numerous stakeholders, use of complex technology, high ecological and social effect.

Oil and gas projects in Vietnam are actualized through joint ventures partnerships including global companies like British Petroleum, Petronas, Total, Chevron, Conoco, and so forth. Such partners supply capital and high technologies required for oil and gas projects which Vietnamese partners are still inadequate. The investment of outside partners makes the projects suffer from risks such as differences in practices among domestic and remote partners, approach and political risks, monetary risks, lawful and political risks. The swelling rate in Vietnam is very high; while the national cash is moderately frail. Vietnam is situated in South East Asia, a district considered the most powerful and testing on the planet. The quality of management in Vietnam is still underneath world standard as the nation is rising up out of an arranged economy. In perspective on the abovementioned, oil and gas construction projects in Vietnam pose lots of risks that can cause adverse impacts on project usage. Hence, there is earnest requirement for good risk management in oil and gas project management.

As needs be, the objectives of the study are to decide the significant risks influencing oil and gas construction projects in and propose suitable strategies to successfully moderate the significant risks.

3.2 RISK MANAGEMENT TECHNIQUES IN THE CONSTRUCTION FIELD

No construction project is without risk. Risk is sensible diminishable, transferable or worthy however not unimportant (Latham, 1994).

Rahman and Kumaraswamy, (2002) recognized 41 risks in construction projects. Risk management is thus a significant device to adapt to such substantial risks in construction industry as per

(Edwards, 1998) by the accompanying steps:

a) Assessing and ascertaining project practicality.

b) Analyzing and controlling the risks so as to limit loss.

c) Alleviating risks by appropriate arranging.

d) Avoiding dissatisfactory projects and thus improving overall revenues.

Thompson and Perry (1992) The construction industry is subject to more risk and vulnerability than numerous different industries it has a poor notoriety for adapting to risks, numerous projects neglecting to comply with time constraints and cost targets. Clients, contractors, general society and others have suffered as a result.

The process of taking a project from beginning investment appraisal to finish and into use is intricate, for the most part bespoke, and entails tedious design and production processes. It requires a large number of individuals with various skills and interests and the co-appointment of a wide scope of disparate, yet interrelated activities. Such multifaceted nature besides, is aggravated by numerous outer, wild factors Flanagan and Norman (1993).

In 1992 overall survey announced that most of construction projects neglect to accomplish the objectives of the schedule (cooper K. G. 1994) even in 2001 one of the industry's longest, oldest and most respected brands was a casualty of poor risk management , another survey was directed by Laufer and Stukhart (1992) of 40 U.S. construction managers and owners demonstrated that for scope and design objectives just 35% of the projects considered had low vulnerability and the staying 65% had medium to high vulnerability toward the start of construction. The costs of the projects found the middle value of $5,000,000. This finding was affirmed in a later report by Laufer and Howell (1993). They inferred that roughly 80% of projects toward the start of construction possessed a significant level of vulnerability. The measure of vulnerability in the inward and outside environments of a project is a significant factor in deciding if there will be a schedule overwhelmed or cost invades.

As per Carr and Tah (2001) construction projects have formed into being progressively confused and dynamic, which results in a more risky industry than others .It is famous for its extraordinary measure of uncertainties Ng Hwee and Robert Tiong (2002) suggest that all projects are exposed to numerous uncertainties (risks) through their life cycle, yet especially during their construction phase Jaafari (2001). Believes that risks my result from outer factors (business and aggressive pressure, social and political factors, ethics, norms and shifting requirements of the clients) concerning previously mentioned factors interest in risk assessment is developing. With an increasingly unpredictable and quickly changing business condition, owners and their contractors are being tested to oversee risk while keeping up control and improving execution.

In any case, some owners are inexperienced with the concepts of risk assessment where there is an absence of an acknowledged technique for risk assessment and management among professionals in the construction industry contrasted and the money related and wellbeing professionals. Thusly, the onus must fall on the construction industry to advertise the concepts of risk assessment.

Risk management is not a discrete movement, however a basic central of the project management. In the worldwide sense, risk management is the process that, when completed, ensures that everything that could possibly be done can't avoid being done to accomplish the objectives of the project inside the constraints of project (Clark, Pledger and Needier 1990).

In the limited specialized sense, risk management is a piece of the general process. When a risk is distinguished and characterized, it ceases to be a risk and becomes a management issue. It very well may be summarized that:

- Risk management needs to be a continuous capacity of project management.
- Risk management needs to give a target perspective on the project from the minute the project starts to the minute it ends.
- Risk management processes the accessible data into a proper model which supports the decisions.
- Risk management breeds responsive, adaptable and arranged project management

A risk management process commonly comprises establishment of setting, risk identification, risk analysis, risk assessment and risk response (Lyons, 2003).

A risk can be portrayed by the risk occasion, its likelihood of event and the measure of potential loss or addition. All factors comprising a risk are to be recognized, broke down and assessed so that response would then be able to be given. Risk response is a process of detailing of a management strategy prompting distinguishing activity owners and the risk management plan

Risk designation, the definition and division of responsibility associated with a possible future loss or increase, seeks to assign responsibility for an assortment of speculative circumstances should a project not continue as arranged (Uff J., 1995).

Usually, a delicate archive of a construction project is set up by the contracting party, for example the proprietor, who initiates the project.

Usually the proprietor tends to legally pass the responsibility for most of the risks to the contractual worker under conventional obtainment processes (Rutgers and Haley 1996). An agreement would thus be able to be considered as an exchange off between the contractual worker's prices for undertaking the work and his willingness to acknowledge both the controllable and wild risks (Flangan and Norman, 1993).

Regardless of whether the gathering is willing and mindful to hold up under the risk will influence its response to risk (Ward and Chapman, 1991). The cost of ill-advised risk allotment could be seen from the response from contractors such as including a high possibility (premium) to the offer cost or conveying low quality work. During the project, the proprietor may spend greater management resources for the increased work disputes. Endless supply of the works, prosecution of legally binding claims may come after.

The cost of inappropriate risk assignment could be seen from the response from contractors such as including a high possibility (premium) to the offer cost or conveying low quality work. During the project, the proprietor may spend greater management resources for the increased work disputes. Endless supply of the works, prosecution of Contractual claims may come after.

In the worst case, the proprietor pays for the risks twice incorporating one in offering contingencies and the other one in court (Fisk, 2000). The designation of risk is thus one of the significant decision-production processes prompting project success. Ideally, the objective of risk management should be to limit the complete cost of risk to a project, not necessarily the costs to each contracting gathering separately (CII, 1993). The most testing of the task is to choose what the evenhanded risk portion is such that the objective is adequately accomplished.

While model or standard sets of general conditions of agreement are accessible, it is contended that the principles behind the allocations in these documents have not been unmistakably stated (Thompson and Perry, 1992). Problems can arise using any of them If extra clauses influencing risk are concerned them.

In addition, the nature and degree of risks will in general be project-specific in the present high-risk scenarios and multiparty complex projects that appropriation of customized contract Strategies is progressively desirable (Rahman, Kumar aswamy, (2002).

Various risk designation principles had been suggested by various researchers such as (Casey, 1979), (Kussel, 1979), (Barnes, 1979), (Abrahamson, 1984) and (Thompson and Perry,1992). Receiving these principles as the basis for designating risks is useful in arriving at an impartial decision. It would be at last helpful to the two owners and contractors. Like most of the management doctrines, all these risk distribution principles generally use common language in the expression, which are nevertheless ambiguous in genuine application.

For instance, one of the principles referenced by (Abrahamson, 1984) states that 'a gathering should bear a construction risk where it is in his control'. The term "in his control" is hard to be precisely deciphered as the "control" by a contracting party on a genuine situation could be 'halfway'. The use of those principles to ultimate choice making thus vigorously relies on the subjective judgment and experiential learning of construction experts. The issue of this sort of decision making process is its implicitness. Again and again it is hard to be investigated and recovered by others.

Human factors such as the frame of mind of the parties (Barnes, 1983) and bias in personal judgments may impose significant minor departure from the decision result. (Rahman and Kumaraswamy, 2002) had shown that there was a difference of recognition on risk portion in construction contracts among various groups. It is not surprising that inappropriate risk allotment in construction contracts remains a worry in the construction industry in numerous countries (CIRC, 2001).

3.3 RISK MANAGEMENT IN PLANNING OIL AND GAS PROJECTS

Project management is a one-time deliberately arranged and sorted out exertion to accomplish a specific objective. Project management includes: Developing a project plan, which includes characterizing project goals and objectives, specifying tasks or how goals will be accomplished, what resources are required, and associating budgets and timelines for culmination, actualizing the project plan cautiously to ensure the arrangement is being executed by plan.

Project management usually includes the accompanying fundamental phases:

- Initiation.
- Design.
- Planning.
- Execution.
- Commissioning.
- Closeout

These phases might be characterized as follows:

- Initiation: It is where another project is officially approved; starting up the project. A project is started by characterizing its reason, business goals and scope. Also it is the phase when the primary chain of command is to be distinguished, as well as early milestones and early proposed spending plan. With the above data we can proceed onward and play out a finish of Phase study so as to get a GO No GO decision.

- Design: It is the phase of detailing of an arrangement to execute a project with a specified presentation objective. It is a multi-step process including the research, conceptualization, feasibility assessment, establishing design requirements, fundamental design, natty gritty design, and production arranging and device design, lastly production.

- Planning: Once the project is characterized and the project group is assembled, we are prepared to enter the top to bottom the Project arranging phase. This involves making Project Management Plan, so as to control the group during the project lifetime. We will characterize the necessary skills of improvement group, Non-work Resources, Risks plan, nitty gritty activity items and milestones.

- Execution: Includes the processes of organizing project parties and different resources to complete the arrangement so as to perform legitimate usage of the project ashore as designed and made arrangements for its expected use.

- Commissioning: The Commissioning process comprises the coordinated use of a set of designing techniques and procedures to check, inspect and test each operational part of the project, from individual functions, such as instruments and gear, up to complex amalgamations such as modules, subsystems and systems.

- Closeout: Project Closeout involves releasing the last project to the customer, giving over project documentation, As-constructed drawings, and Network layouts. Last outstanding step is to attempt a Post Implementation Review to recognize the degree of project success and note down any lessons learned.

Arranging was a basic phase in project management (Pinto and Slevin, 1987; Johnson et al., 2001; Turner, 1999). Project arranging specifies a set of decisions concerning the ways that things should be done later on, so as to execute the design for a desired item or service. The project chief is responsible for finishing the project to the satisfaction of every single applicable stakeholder. Along these lines, he/she must ensure not just that actions are executed by plan, yet in addition that the arrangement is solid and appropriately represents stakeholders' requirements.

Kerzner (2006) finds vulnerability decrease to be one of the basic reasons for arranging a project.

Meredith and Mantel (2003) distinguished six arranging sequences including:

- Preliminary coordination.
- Detailed description of tasks.
- Adhering to project spending plan.
- Adhering to project schedule.
- Precise description of all status reports
- Planning the project's end.

Russell and Taylor (2003) recognized seven arranging processes characterizing project objectives, distinguishing activities, establishing priority relationships, making time estimates, deciding project finishing time, looking at project schedule objectives and deciding resource requirements to meet objectives.

De Meyer et al. (2002) guarantee that choosing of the best method for arranging the project is affected by the degree of risk, regardless of whether it is a "variety", "foreseen vulnerability", "unforeseen vulnerability" or a "chaos" project. Since a project director has to manage high vulnerability levels, the subject of risk management has gotten a lot of consideration, being one of the nine learning areas of a project (PMI, 2004).

As indicated by Wideman (1992), risks can be partitioned into five groups:

- External, erratic and wild risks
- External, unsurprising and wild risks
- Internal, non-specialized and controllable risks
- Internal, specialized and controllable risks and
- Legal and controllable risks.

Shtub et al. (2005) and Couillard (1995) classified risk events into three groups:

- Risks connected to specialized execution,
- Risks connected to spending plan and
- Risk connected to schedule.

Risk management deals with recognizing and diminishing the project's risk level, including risk management arranging, monitoring and control processes (PMI, 2004).

Risk management arranging processes incorporate risk identification, subjective and quantitative risk analysis and risk response plans. Risk monitoring and control is the last risk management process, which is performed during the project's execution phase. So as to manage risks, project managers may choose to use several tools from the vast assortment of risk management software and tools accessible, both from finance and project management disciplines, such as arranging meetings, risk rating and risk control.

Arranging was seen as a basic phase in project management (Pinto and Selvin, 1987; Johnson et al., 2001; Turner, 1999 and others). Project arranging specifies a set of decisions concerning the ways that things should be done later on, so as to execute the design for a desired item or service. The project manager is responsible for finishing the project to the satisfaction everything being equal. In this manner, he/she must ensure not just that actions are executed by plan, yet in addition that the arrangement is solid and appropriately represents stakeholders' requirements. A hypothesis was raised by (Zwikael and Sadeh, 2007) that improving the project plan might be a compelling device so as to manage high-risk projects. This hypothesis which includes the improvement of all arranging processes (for example schedule arranging and quality arranging) may supplant the customary methodology which focuses just on the improvement of risk management processes. The model proposed is described in Fig. (3-1) beneath

Quantifying Schedule Risk in Construction Projects

Schedules are considered as a key factor to the successful execution of projects. Which, diverse activities of a construction project are hard to oversee (Gould, 2002). Because risk and vulnerability are inborn in all construction activities (CII, 1989), most schedules are created in a deterministic way (Nasir and Hartono, 2003). As a result, schedule delays are regular in various construction projects and cause considerable losses to project parties. A broadly acknowledged idea in the field of construction project management is that a construction project schedule plays a key job in project management because of its effect on project success. Along these lines, it is essential to measure probabilities of schedule delays when dealing with a construction project. A need has risen for the improvement of useful methods to assess the likelihood of construction time overruns.

3.4 SIGNIFICANT DELAY FACTORS IN CONSTRUCTION PROJECTS

Numerous scientific journals have evaluated and basically appraised the central point causing delays on construction projects. The most well-known postpone factors of a construction project can be gathered under nine categories embracing the classification in (Assaf, 2006) as follows:

- Project-related factors
- Owner-related factors

- Contractor-related factors
- Consultant-related factors
- Design-related factors
- Material-Related factors
- Workforce-related factors
- Equipment-related factors
- Environment-related factors

Condition related factors are outside factors such as nasty climate, changes in government regulations and laws, traffic control and restriction at jobsite and slow region permits. Project related factors will be factors getting from the project Characteristics and the project conveyance system. Unrealistic agreement term, ineffectual defers penalties, sort of project offering and grant, and kind of construction agreement is ordinary factors in this classification.

Bayesian conviction networks (BBNs), alluded to as conviction networks, was first created at Stanford University during the 1970s (McCabe B et al, 1998). BBNs describe cause-impact relationships among variables through graphical models. Conviction networks consist of nodes, representing variables of the space, and arcs, representing reliance relationships between the nodes. A simple conviction arranges in which the hub at the tail of the bolt, alluded to as the parent hub, straightforwardly affects the hub at the leader of the bolt, alluded to as the youngster hub. The cause-impact relationship between the parent hub and the kid hub is frequently represented by a bolt or a curve alluded to as edge. Youngster nodes are restrictively reliant upon their parent nodes. BBNs are based on contingent likelihood hypothesis which was created in the late 1700s by Thomas Bayes. He discovered a basic law of likelihood which was then called Bayes' hypothesis (Charles River Analytics, 2007).

3.5 RISK MANAGEMENT AND COST-ESTIMATING PROCESSES

From the get-go in the risk analysis process, the cost elements of a project are sorted out into a suitable structure. The goal of this step is to produce a structure that contains sufficient detail for satisfactory analysis, however is not all that definite that a lot of resources and time would be required (Dale Cooper and Stephen Gray, 2005).

The cost structure contained 24 base costs, representing the fundamental activities and hardware items in the project, as shown beneath:

- Preliminary Works
- Concrete Structures
- Fill Structures
- Electrical and Mechanical Equipment
- Indirect Costs
- Engineering, Management and Owner's Costs
- Reservoir Cleaning
- Reservoir Seepage Control
- Global Risks
- Escalation Risks

Risk Management and Procurement Activities

Project management in the construction industry involves coordination of numerous tasks and individuals, influenced by unpredictability and vulnerability, which increases the requirement for productive collaboration. Acquisition is vital since it sets the basis for participation among clients and contractors. This is genuine whether the project is neighborhood, local or worldwide in scope. Customarily, acquisition procedures are focused, resulting in conflicts, adversarial relationships and less desirable project results.

To oversee costs, increase quality and decrease risk, acquirement has turned into a key piece of the arranging and organizing process (Egan J, 1998). Because of increased vulnerability, multifaceted nature, time pressure and customization in construction projects, significant levels of coordination and collaboration among project participants are required (Olsen B, 2005).

The task of planning and dealing with the numerous suppliers and their activities is frequently performed by the fundamental contractual worker (or Construction Management Company). The customer at that point has just a single purpose of contact to ensure that promises and authoritative requirements are being met. Generally, customer contractual worker relationships have been portrayed as adversarial and keeping up arms-length distance, as a result of focused acquisition procedures.

As of late, clients and principle contractors are increasingly organizing their activities, and regularly grow close agreeable relationships (ordinarily alluded to as joining forces) with one another and share numerous experiences from project to project (Ngowi, 2007). Such banding together relationships improve coordination and adaptability, which is frequently advantageous in projects portrayed by multifaceted nature and vulnerability (Anvuur, Kumaraswamy, 2007). Banding together has gotten a lot of positive consideration in late research, however some researchers guarantee that undeniable joining forces is not always suitable (Bresnen, 2007). Indeed a suitable harmony among participation and rivalry frequently is most proper (Eriksson, 2008). Notwithstanding the potential shortcomings of collaborating most authors concur that increased participation is desirable in construction projects described by high multifaceted nature, customization, time pressures, and vulnerability (Lu S, Yan H, 2007).

Previous research confirms that agreeable relationships are not easily established (Chan An et al, 2003). Indeed, most clients understand the significance of agreeable relationships yet come up short on the understanding of how to establish those (Mcintosh G et al, 2000). The development toward increasingly helpful relationships is ruined by the conventional sort of acquirement that encourages rivalry as opposed to collaboration (Cheung and Suen, 2003). Henceforth, it is useful to recognize an elective kind of obtainment and increase the understanding of how clients can establish helpful relationships with contractors through agreeable acquisition procedures (Pesama and Eriksson, 2009).

An experimental elective obtainment model was proposed by (Pesama and Eriksson, 2009) and exactly tests an elective acquirement model based on agreeable acquisition procedures, which facilitates collaboration among clients and contractors in construction projects. The customary focused kind of acquisition in the construction industry involves welcoming numerous bidders to get ready singular amount contract proposals based on definite design documents arranged ex bet by the customer and their consultants. In the subsequent offer assessment the lowest single amount cost is regularly granted the agreement (Eriksson PE, 2008).

A foremost assumption in this neoclassical view is that value leads to a satisfying decision and that the decision maker(s) is fit for accomplishing an intensive positive result. A process such as this is frequently alluded to as a sane process. One downside of this kind of hypothetical reasoning, in any case, is the assumption that all through this sound process the decision creator is equipped to settle on the best decision with the greatest worth and maintain a strategic distance from subjective preferences. Most current, complex industrialized products contain attributes that settle on it hard for the decision producer to assess the quality of the item based distinctly on target factors and stay away from subjective characteristics. An essential reason for this is natural laws and related regulations cause difficulties in settling on totally target decisions. The sound process in such situations at that point becomes a process to distinguish alternatives based on previous experiences (e.g., nature), or on notoriety, authenticity, quality standards or some other passing element. The process also eliminates others because of their size, absence of relationships to key suppliers, unsure notoriety, or their general standards are not consistent with moral and natural regulations.

An ongoing pattern is these last factors seem to assume a progressively significant job in the method of reasoning of decision makers all through the acquisition process. As a result, focused obtainment processes increasingly leads to disputes, conflicts and adversarial relationships (Cheung, 2003) and the development is more toward customer contractual worker participation (Molenaar et al, 2000) because it is progressively viable and improved acquisition procedures are actualized (Briscoe et al, 2004).

3.6 MANAGING QUALITY RISKS IN CONSTRUCTION ACTIVITIES

Not all studies required an evaluation of construction quality. The authors of some studies didn't mean to establish the relationship between the informative variables and the needy variable (quality). Or maybe, they presumed the factors found would influence construction quality (Abdel Razek, 1998). In such cases, there was no compelling reason to measure quality.

Others used some statistical methods to establish the relationship between logical variables and ward variable (quality). The statistical methods commonly used were numerous regression, connection analysis, and mean comparison (Konchar M et al, 1998). Occasionally, a position connection approach called Spearman's rho was used. At the point when such statistical methods were used, there was a need to measure construction quality.

Just like the way that the questionnaire survey was the most normally used strategy for information gathering, the subjective assessment by experts met or surveyed was the most usually used technique for measuring construction quality. The essential reason was the absence of information. Almost all studies using statistical methods to distinguish factors influencing construction quality referenced above used this strategy, albeit one study, (Cooke-Davis, 2002) didn't specify the technique for measurement. The main outstanding special case was who used the Hong Kong Housing Authority's (HKHA) Performance Assessment Scoring System (PASS) scores.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 RESEARCH APPROACH

The research includes the steps which summarize in the points: -

For this research , conduct a questionnaire survey for identifying project risks in various functional areas of the company which involved in the oil and gas construction project. Conduct interviews and discussion with some accomplished project managers, consultants and engineers for gathering information worried about recognizing the risk factors confronting the construction contractors during the construction of oil and gas construction projects.

Plan information gathered to create and design a comprehensive risk register that covers the necessary information, the sources of risks and likelihood of risk event and their effect.

Conduct case study of two oil and gas offshore construction projects having identical scope of work of the same construction organization. These projects executed at same time at different fabrication locations and managed by different project management team.

Two different approaches of risk management and mitigation plan were used for these two projects. Develop risk impact matrix and risk category map for two projects based on different risk management and mitigation plan. The risk category map presents major functional areas of project and probability of occurrence of risk events in each functional area. The risk profile was categorized to functional areas. Risk workshops were used to identify risk, find out risk mitigation plan, decide probability of risk occurrence and impact of risk. A detailed risk register was generated using survey result and meeting with various stakeholders. The contingency reserve required to manage project successfully is calculated from risk register.

4.2 RESEARCH METHODOLOGY

With the end goal of this methodology, the research strategy was utilized where two projects were examined. Referenced the information gathering and analysis approach was taken uniquely for the preparation/execution stage of the projects. Contextual analyses were investigated in following 3 stages:

(1) Short prologue to the project was given,

(2) Methodology grid of the specific risk appraisal procedure was shown and

(3) A risk impact matrix and category map were made.

The methodology network apparatus is exhibiting two methodologies of risk management and moderation system utilized in an undertaking. Methodology grid is displaying the full methodology of the risk and analysis management while demonstrates the slight deviation methodology approach. The risk category map explaining about risk classifications with the likelihood framework portrayed from risk level and comprises of important risk classifications with the likelihood grid depicted from the low/medium/high risk level.

4.3 SOURCES OF DATA

This research of study on risk management in oil and gas construction projects for the oil and gas industry profoundly worked in a project-based condition, whereby every datum collected in very organized way from two comparable projects from a construction organization in Middle East.

The risk identification work and analysis were performed using publicly available information and data (primary data) from construction organization in Middle East. The risks were identified and categorized based on their description in the various data sources within the construction organization. The secondary data collected by survey and discussion with industry professionals to refine both risk prioritization and risk management methodology.

4.4 SURVEY QUESTIONS

Survey Questions is to identify risks that will impact the project and the level of threat they pose to the project's success. In the questionnaire functional areas are grouped in typical categories of project risk. Major project risks in each functional area are included in the survey. Probability of occurrence of risk and risk impact (low, most likely and high) is also surveyed.

The completed questionnaire will identify the project's risk factors. New risks identified in the survey is added to project risk register. The results from the completed questionnaire should be used as guidelines to develop project risk register. Other factors that will lower or raise the risk level is further discussed in risk review meetings. Risk impact scores may be reduced if an experienced project manager leads the project. Having many high-risk characteristics does not necessarily mean the project will fail. However, it does mean that a plan must be into place to address each potential high-risk factor.

Refer **Appendix-I** for Survey Questionnaire.

4.5 SAMPLING

Sampling is a process by which study a small part of a population to make decisions about the population. Approximately 100 samples of risk activities had taken for this research from each project used for case study.

4.6 CASE STUDY

Two oil and gas offshore field expansion projects having identical scope of work and period of execution in same time frame were taken for risk management case study. The projects taken for case study was executed by different project management team of same oil and gas construction company. Project -1 was executed by experienced team whereas project -2 was executed by less experienced team. The projects used for case study was for major oil producing company in the Middle East. Different risk management approach was taken for two different projects. Project-1 executed by more experienced team, took comprehensive risk identification and detailed mitigation plan. Project -2 executed by less experienced team took general idealistic risk identification and less detailed mitigation plan. Primavera was used for project scheduling. Risk review meetings with FAMs (functional Area Manager) were conducted for identifying risk, evaluating risk impact and for risk mitigation plan. Construction company's standard risk evaluation matrix (Table 4.6.1) were used in the risk management tool to identify probability/ likelihood and impact score. A risk register was prepared for each project which gives complete picture of risk management, contingency reserve requirement at each stage of the project execution and contingency spending.

Risk Evalutation Matrix								
Probability Assessment		Impact Score (Severity)						
Probability	Description							
> 70% (Very High)	Risk can reasonably be expected to occur during the life of the project.	Probability / Likelihood	5	5	10	15	20	25
50 - 70% (Med. / High)	Certain circumstances may permit the risk to occur during the project. The risk has occurred in similar projects within MDR.		4	4	8	12	16	20
25 - 50% (Low / Med.)	Reasonable to predict the risk will not occur during the project. The risk has occurred several times in the industry. Occurrence is a credible possibility during project.		3	3	6	9	12	15
5 - 25% (Low)	Occurrence is low possibility but credible during the project. Risk has been known to occur within the industry.		2	2	4	6	8	10
< 5% (Very Low)	Risk in not considered a credible threat throughout the project.		1	1	2	3	4	5
Impact Assessment based on Project Category				1 Very Low	2 Low	3 Low-Med	4 Med-High	5 High
				Impact / Consequence				
Project Category	Value: USD			< 50K	50K - 125K	125K - 250K	250K - 500K	> 500K

Table 4.6.1 Risk Evaluation Matrix

In risk analysis, risk is defined as a function of probability and impact. The probability is the likelihood of an event occurring and impact of risk are the consequences, to which extent the project is affected by an event. By combining the probability and impact, the level of risk can be determined. These are often referred to as Impact and Probability Matrix and can take both qualitative and numerical values.

Probability impact matrix is one of the commonly used qualitative methods for risk assessment. Risk calculation is very simple considering that likelihood and impact of an event. After awarding of the total (scores) for likelihood and impact of risk categories identified will proceed to multiplying the two variables. For this case study probability/ likelihood of risk is categorized in 1 to 5 scales according to the probability percentage given in below table.(4.6.2)

Category	Probability (%)
5	> 70% (Very High)
4	50 - 70% (Med. / High)
3	25 - 50% (Low / Med.)
2	5 - 25% (Low)
1	< 5% (Very Low)

Table 4.6.2 Probability Category

For this case study impact / consequences of risk is categorized in 1 to 5 scales according to the monetary value (in US dollar) of risk as given in below table (4.6.3).

Category	Impact / Consequence ($)
5	> 500K (Very High)
4	250 - 500K (Med. / High)
3	125 - 250K (Low / Med.)
2	50 - 125K (Low)
1	< 50K (Very Low)

Table 4.6.3 Impact Category

Risks occur in every project and it is project team's responsibility to manage them as they occur. A contingency plan is developed and a contingency reserve to manage these identified risks are defined during the risk management planning process. The contingency reserve is not random; it is an estimate reserve based on various risk management techniques. Project managers control this reserve; they have full authority to use it whenever an identified risk occurs.

Expected monetary value technique is used to calculate the contingency reserve in this case study. This technique is used in medium to high-cost projects, where the stakes are too high to risk the project failing. To find the expected monetary value, first calculated the probability and impact value of each event, then multiply them together to generate the EMV of each risk.

Expected Monetary Value (EMV) = Probability * Impact

Then add the calculated contingency reserve of all identified risks in the functional area to get total contingency reserve requirement for each functional area.

4.6.1 RISK MANGEMENT CASE STUDY PROJECT-1

Project -1 was executed by more experienced project team at construction company's main fabrication yard in Middle East. This fabrication yard was catering the oil and gas offshore construction requirements of all major oil companies operating in Middle East for more than 35 years. All functional departs in this fabrication yard works as a "well-oiled machine". Initial risk assessment for this project was conducted at early stage of the project with all functions. Risk management was very well carried out for this project. Risk management review meetings were conducted to carry out risk identification, risk evaluation and risk analysis. All project-related risks which prevent to achieve projects goals were analyzed and reduced impact by initiating timely mitigation actions

Detailed preparation of the mitigation strategy and contingency plan are applied to all project functional areas: (1) Engineering, (2) Procurement, (3) Subcontracts, (4) Fabrication, (5) HSE (Health, Safety and Environment), (6) QA/QC (Quality Assurance/ Quality Control), (7) Offshore Hook-up, (8) Marine, (9) PMT (Project Management Team) and (10) Contracts and Finance.

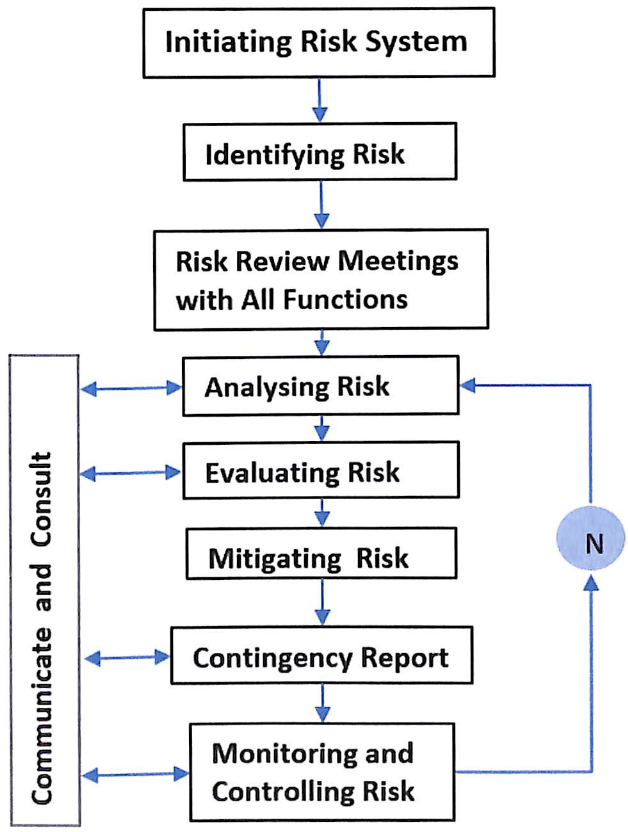


Figure 4.6.4 Flow Chart of Risk Management Process Case Study-1

Risk assessment process used for project-1 is shown in above flow chart (Figure 4.6.4). The order of risk assessment for project-1 was in the following sub-process levels: Initiating risk system, identifying risk, risk review meetings with all functions, analyzing the risk, evaluating risk, mitigating risk, preparing the contingency report and finally, controlling and monitoring risk related events. If there is deviation from the controlling measures, the risk has to go through the process as shown in the Figure (4.6.4). Each stage on this risk assessment process was communicated and consultant with relevant functional area managers. For identifying risks in various functional areas, survey was conducted with key players during initial stages of project using risk assessment survey questionnaire in **Appendix-1**. Experience and knowledge of senior management is used for designing an effective risk classification system for this construction project. The recommendations of senior managers for various functional departments were used identify risks based on their consequences and probability of risk occurrence. Communicating and consulting risk events during analyzing, evaluating and mitigation process with FAM helped the company to identify true perspective and exact nature of the risk. This also helped to identify origin of risks and risk dependency to other risks.

Project Specific risk register is generated using above mentioned detailed risk assessment system. This risk register is a comprehensive list of all risks has been identified in all departments with more than 100 potential risk events. The risk register focused to detailed approach to evaluate realistic risk with consultation of subject matter experts. By this approach achieved to prepare a critical risk register without any missing element in the process. If non-critical risks are listed and some most critical risks are missed out, the risk register can mislead project management team.

Project decision on the three critical impacting factors 1) cost 2) Schedule and 3) quality were made based on risk register prepared. Risk register for Project -1 is provided in **Appendix- II.** Functional area risk impact chart and risk category map are prepared before and after mitigation plan.

The main objective of risk analysis in case study-1 was to minimize all identified risks in project-1. Project team also want to ensure that identified risk associated cost of implementing those risks meeting the approved project budget and guarantee the cost of risk response strategy is not doubled through the contingency approach. In case that risk is monitored and cannot be mitigated, risk was returned to the assessment but without any impact on cost, schedule and quality. Contingency reserve map is generated from risk register after implementing mitigation strategy for case study-1.

4.6.2 RISK MANGEMENT CASE STUDY PROJECT-2

Scope of work for Project -2 used in case study-2 have same scope of Project-1 used in case study-1. Due to area and capacity constraint for executing project-2 scope in company's main fabrication yard, Project -2 construction work was moved to company's newly opened JV (Joint Venture) fabrication yard in another location in Middle East. Project team in this JV yard was less experienced. Coordination and communication between functional departs in this fabrication yard was poor. Initial risk assessment for this project was conducted partially. Risk management was very well carried out for this project. Risk management review meetings were not conducted to carry out risk identification, risk evaluation and risk analysis. Not all project-related risks which prevent to achieve projects goals were analyzed in project-2 due to less expertise of functional area managers and project team. Hence opportunity for reducing impact by initiating timely mitigation actions was diluted.

Similar to Project-1, Project -2 also prepared mitigation strategy and contingency plan are applied to all project functional areas: (1) Engineering, (2) Procurement, (3) Subcontracts, (4) Fabrication, (5) HSE (Health, Safety and Environment), (6) QA/QC (Quality Assurance/ Quality Control), (7) Offshore Hook-up, (8) Marine, (9) PMT (Project Management Team) and (10) Contracts and Finance.

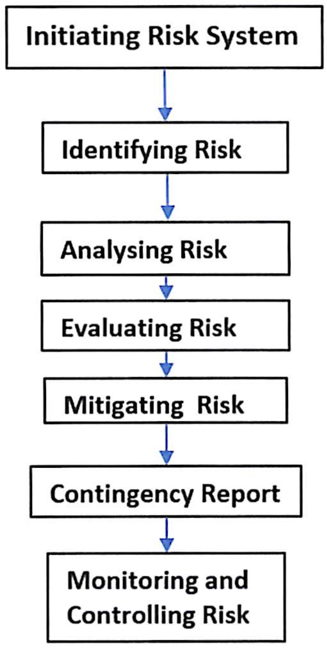


Figure 4.6.5 Flow Chart of Risk Management Process Case Study-2

Risk assessment process used for project-2 is shown in above flow chart (Figure 4.6.5). The order of risk assessment for project-2 was in the following sub-process levels: Initiating risk system, identifying risk, analyzing the risk, evaluating risk, mitigating risk, preparing the contingency report and finally, controlling and monitoring risk related events. Some risk assessment elements followed by Project -1 (Figure-4.6.4) was missing in the assessment process of project-2 as shown in Figure (4.6.5). This is due to generalist risk assessment approach applied by less experienced project team. Past experience and thumb rule were used to identify and evaluate risks in Project-2.

Risk review meeting with all functions on identified risks was missing in this approach. Communication and consultation with relevant functional area managers at each stages of risk assessment process like analyzing, evaluation, mitigation, monitoring and controlling is also missing in general risk assessment approach in Project-2. If there is deviation from the controlling measures, the risk has not gone through the process again. Response from various departments for risk assessment survey questionnaire (**Appendix-I**) was poor. Lack of experience of project team in handling major offshore oil and gas construction project was the challenge in designing an effective risk classification system for Project-2.

To reduce risk impact and probability of risk occurrence, most of the general risks should be allocated on risk categorization per the level of knowledge of project team. In the case study-2, risk model is constructed based on knowledgeable qualitative analysis, where the contingency was taken to compromise the unforeseeable types of risks that relates to imposed or planned changes which occur on projects due to external and internal factors.

Project Specific risk register was generated using above mentioned general risk assessment system. The risk register focused to general idealistic approach to evaluate risk with experience and general standards in industry. By this approach prepared a general risk register with missing of some critical risk events.

Project decision on the three critical impacting factors 1) cost 2) Schedule and 3) quality were made based on risk register prepared by low performing managers. Risk register for Project -2 is provided in Appendix- **III.** Functional area risk impact chart and risk category map are prepared before and after mitigation plan for Project-2 based on risk register. A comprehensive approach is missing in case study -2 risk assessment and project contingency reserve map was built on the standard available data.

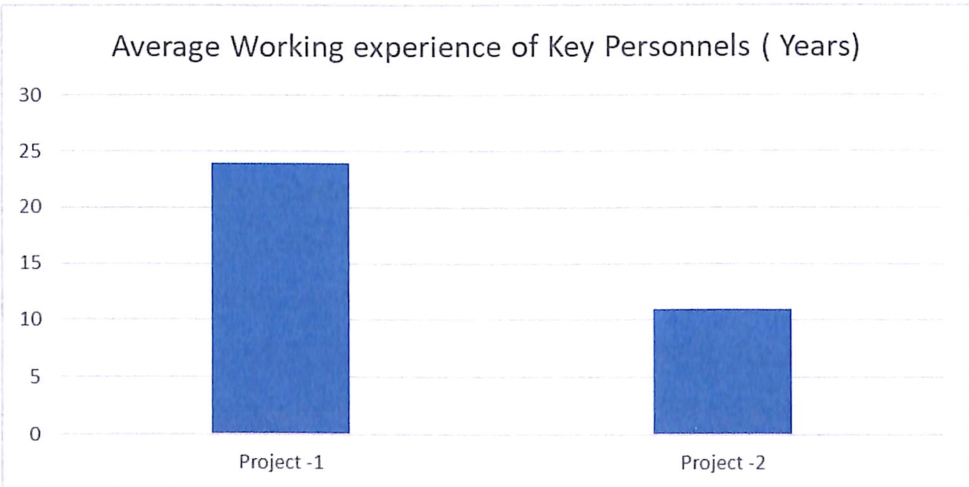
CHAPTER 5

DATA ANALYSIS AND INTERPRETATION

Table 5.1: Average working experience of Key Personnel on each project

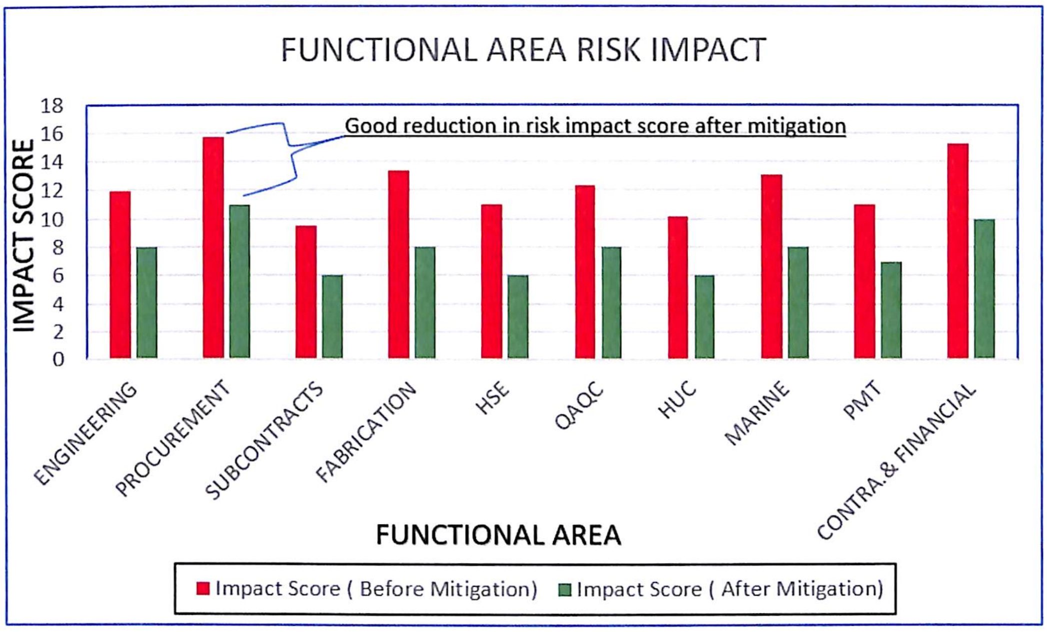
Project	Working experience in year
Project 1	24
Project 2	11

Chart 5.2: Average working experience Key Personnel on each project



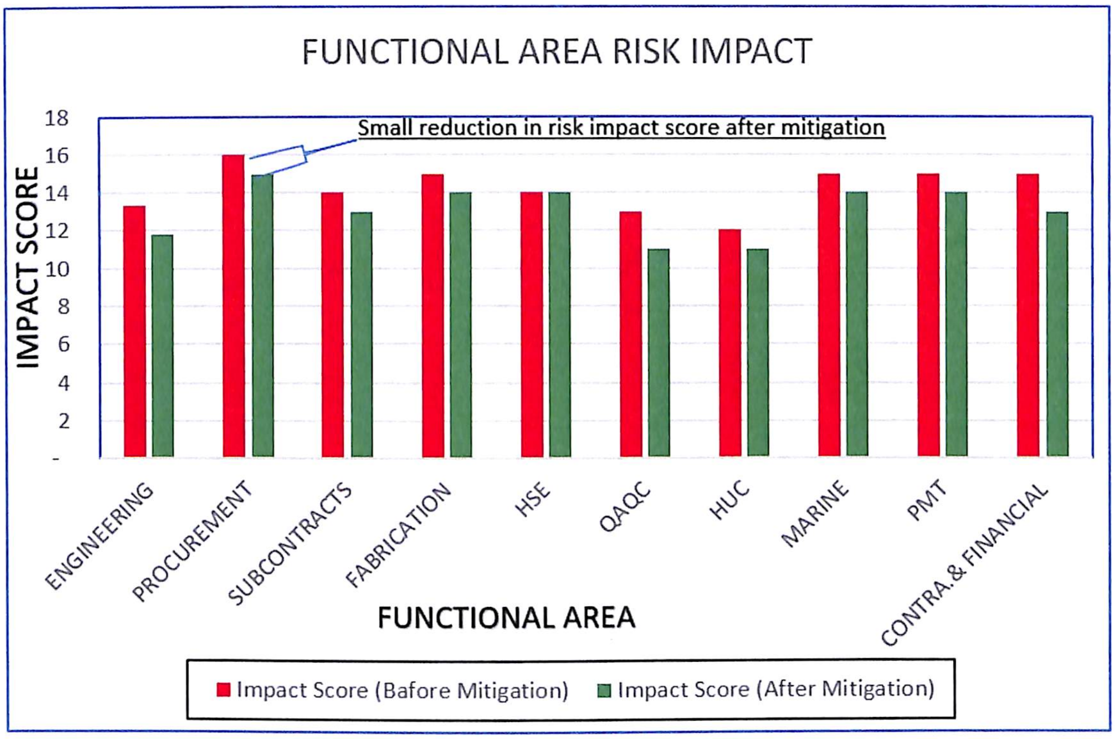
It is interpreted that key personnel worked in Project-1 had more experience in Oil and Gas offshore construction projects than the key personnel worked in Project-2.

Chart 5.3: Functional Area Risk Impact for Project-1 (Case Study-1)



There is good reduction in impact score after mitigation plan was implemented in Project-1 (case study-1). Detailed risk assessment approach used by Project team -1 helped them to take aggressive response and priority actions on risks identified as threat to the project objectives. In the detailed risk assessment approach by the Project team-1, the risks which receive high ratings are investigated further or an appropriate response was planned. Same time do not take immediate action on the low rated risks, but those risks are included in the Risk register for monitoring. By using detailed risk assessment approach, project -1 transformed high impact – high probability risks to next lower impact – lover probability level. Reduction in impact score means the reduction in the severity of risk, hence reduction in contingency cost to manage risks. Refer risk register for Project-1 provided in Appendix-II for functional area risk score.

Chart 5.4: Functional Area Risk Impact for Project-2 (Case Study-2)



There is very small reduction in impact score after mitigation plan was implemented in Project-2 (case study-2). General idealistic risk assessment approach used by Project team -2 missed to identify risks that threat to the project objectives and take response to mitigate risk. In the general risk assessment approach by the Project team-2, the risks which receive high ratings are not investigated further or an appropriate response was not planned. Project -2 used thumb rule and general industrial percentages to assess risks because of lack of experience in managing risks. By using general risk assessment approach, project -2 was unable to transform high impact – high probability risks to next lower impact – lover probability level. This in turn contribute for a higher contingency cost to manage risks for Projrct-2 (case study-2). Refer risk register for Project-2 provided in Appendix-III for functional area risk score.

Chart 5.5: Risk Category Map Project-1 (Case Study-1)

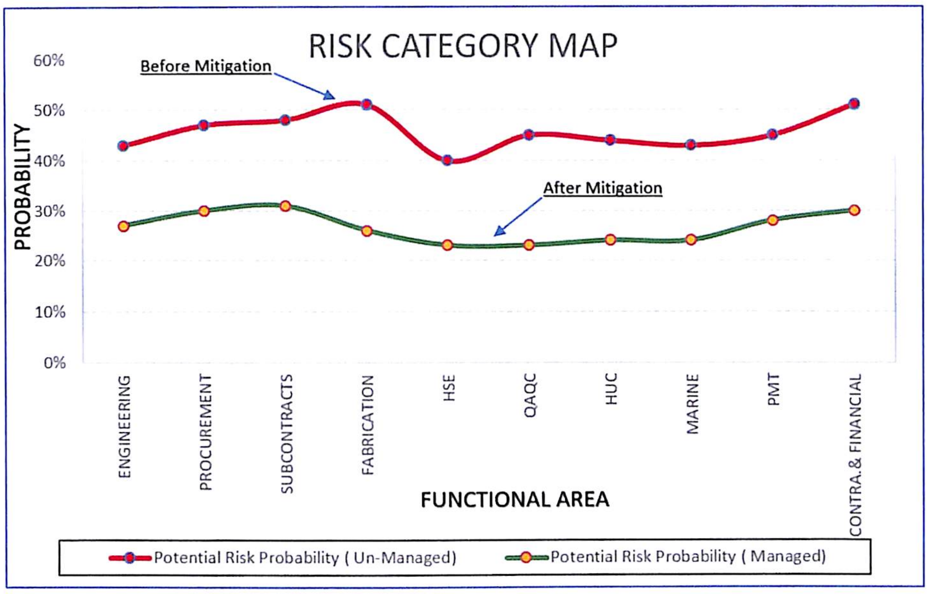


Chart 5.6: Cost-Risk Mitigation Map Project-1 (Case Study-1)

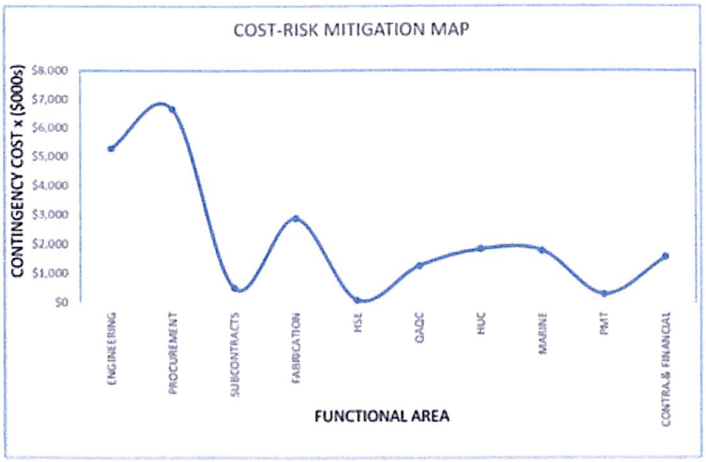


Chart 5.5 was based on selected risk response strategies by maximizing risk response effects of implementing the mitigation factors. After the risk assessment was carried out and mitigation plan was applied mitigation curve was moved to the lower level of the potential risks as shown in Chart-5.5. A wide gap between the two lines are clearly visible in above chart 5.5. The comprehensive approach was taken from the prospective of the risk management where the mitigation was done diligently and immediately showed progress in

the risk flow level. A contingency reserve was built on the level that minimum cost will be associated due to the good risk mitigation strategy applied in Project-1 (case study-1) as presented in Chart 5.6. Cost-Risk Mitigation map for Project-1. Refer risk register for Project-1 provided in Appendix-II for functional area risk probability and contingency reserve.

Chart 5.7: Risk Category Map Project-2 (Case Study-2)

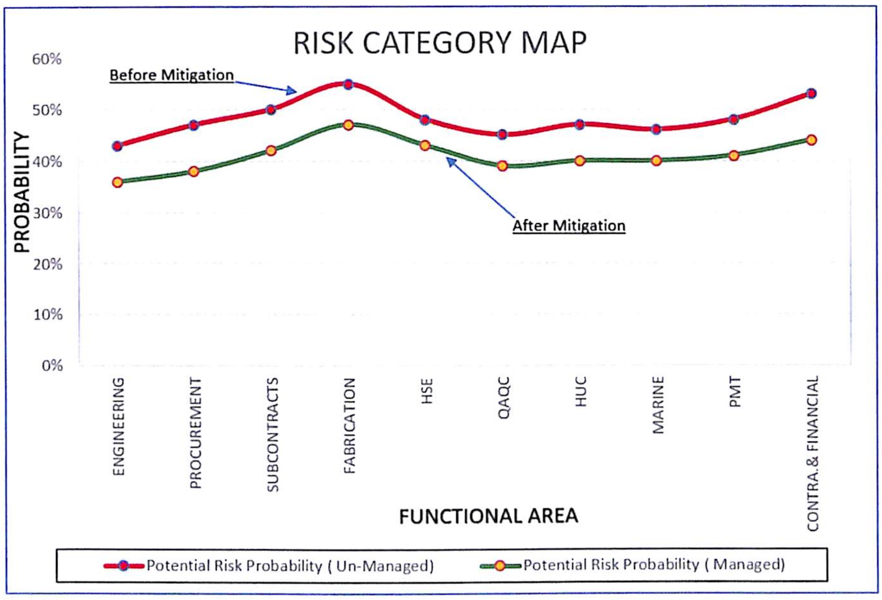


Chart 5.8: Cost-Risk Mitigation Map Project-2 (Case Study-2)

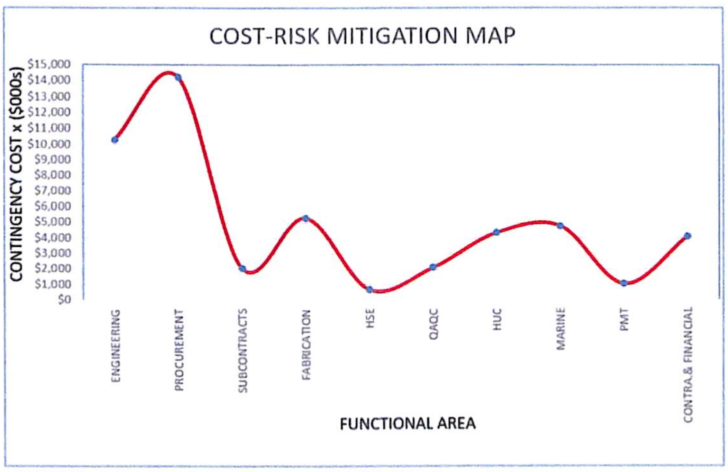


Chart 5.7 was based on general reduced risk assessment approach. In this approach mitigation curve was only slightly moved to the lower level after applying mitigation measures as shown in Chart-5.7. The narrow gap between the two lines are clearly visible in above chart 5.7.

Risk assessments for all the functional area were done on the best practice knowledge. In this general idealistic approach, detailed risk assessment is missing from the prospective and mitigation factors were not considered as a possible solution. Contingency reserve for all functional area was built on the standard data available in the company from past projects, as presented in Chart 5.8. Cost-Risk Mitigation map for Project-2 (case study-2). Refer risk register for Project-2 provided in Appendix-III for functional area risk probability and contingency reserve.

Chart 5.9: Cost-Risk Mitigation Map for Project-1&2

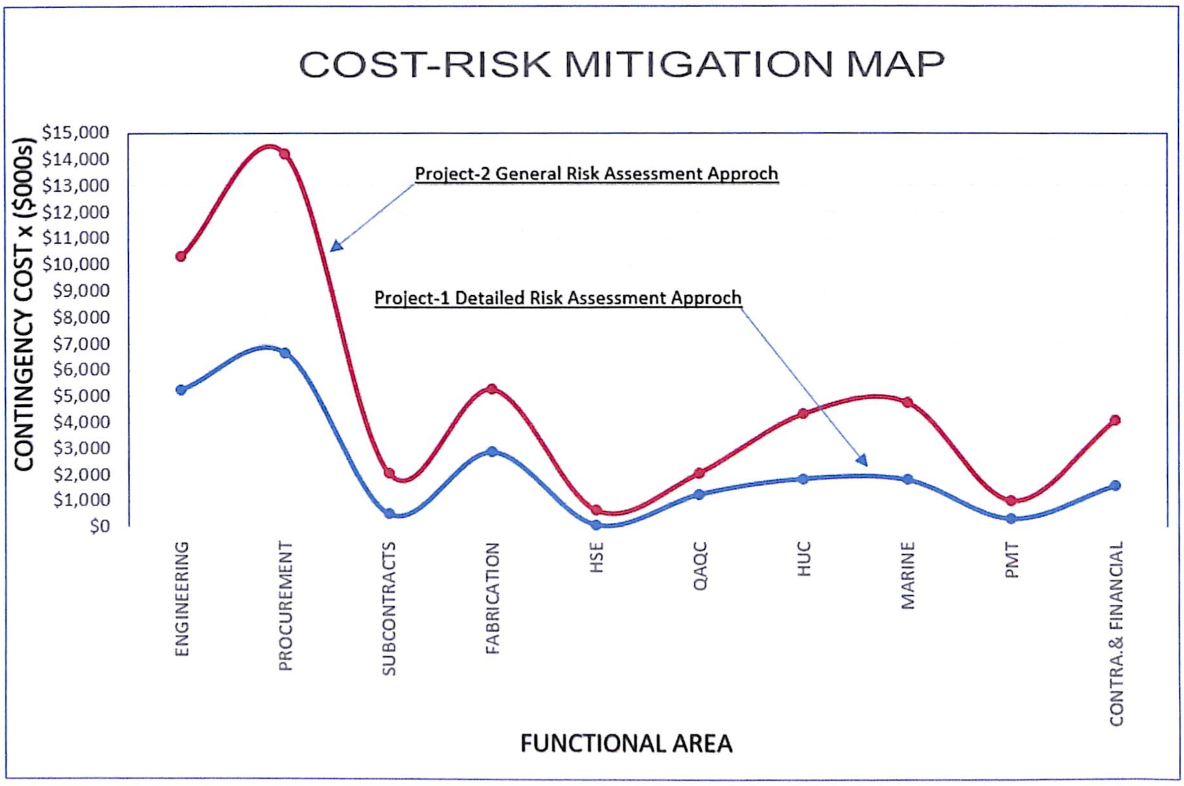


Chart 5.9 was shows the combined cost-risk mitigation map for Project-1 and Project -2 of identical scope of work executed by different project team using different risk assessment approach. The experienced Project-1 team adopted a detailed risk assessment approach whereas the less experienced Project-2 team adopted a general risk assessment approach. From the chart 5.9 it is evident that Project-2 needs more contingency reserve at each functional area than Project-1 to manage identified risks.

To manage risks in Project -2 required more contingency reserve. Contingency reserves are cushion against the risks and are part of project budget. There for Project -2 required higher project budget allocation than Project-1.

INTERPERTATION

By adopting a detailed risk assessment approach, contingency reserve required to manage identified risks can be reduced, this in turn helps management to reduce project budget. Contingency reserves are estimated figures part of project budget, which is also part of performance measurement cost baseline. Contingency reserve is the back bone of risk management as they provide means to manage risk. To complete project successfully, a proactive detailed risk management approach is essential. Successful project execution depends on a project group that has pertinent competences and can work together so as to solve project problems. Project team should apply their technical know-how and specialized skill where it is required to provide solutions for problems that happen. As a base, a project manager or potentially a PM group should have necessary experience and an ability to use resources and discover solutions to the challenges that happen during project execution phase.

CHAPTER 6

FINDINGS AND CONCLUSION

6.1 Findings

- It is found that average working experience of key personnel working in Project-1 is 24 years and Project-2 is 11 years and each project team got working experience.
- It is found that the risk impact score reduced, after applying mitigation plan from high impact – high probability risks to next lower impact – lover probability level by the detailed risk assessment approach used in Project-1 (Case Study-1).
- It is found only small reduction in risk impact score was achieved after applying mitigation plan by the general risk assessment approach used in Project-2 (Case Study-2).
- It is found that the probability of occurrence of potential risks reduced in all functional area after mitigation by the detailed risk assessment approach used in Project-1.
- After the detailed risk assessment and mitigation plan was applied mitigation curve was moved to the lower level of the potential risks in Project-1. Also observed wide gap between before / after mitigation curves in Project-1.
- It is found only small reduction in probability of occurrence of potential risks in all functional area after applying mitigation by the general risk assessment approach used in Project-2.
- It is found that mitigation curve was only slightly moved to the lower level after applying general mitigation measures in Project -2. Hence, only narrow gap between before / after mitigation curves in Project-2.
- It is found that minimum contingency cost was reserved in all functional area due to the good risk mitigation strategy applied in Project-1.
- It is found that maximum contingency cost was reserved in all functional area in Project-2 due to risk mitigation strategy was built on the standard data available in the company from past projects.
- It is found that contingency reserve required to manage identified risks are less in detailed risk assessment approach used in Project-1 compared to the contingency reserve required in Project-2 using general risk assessment approach.

- In case study-1, department's risk management and analysis are effectively performed. The project-1 has a structured method to identify risks, where identified risks are assessed jointly by the all department teams in risk review meetings.
- In case study-1 risks with substantial impact are recorded in a risk register. The unidentifiable risks as well as the risks with minor impact are covered with a contingency cost, which complements the risk register for Project-1.
- In case study-1, the contingency cost is assessed by expected monetary value technique. Al Major risk were covered during the assessment based on the detailed risk management approach.
- In case study-2 department's risk and analysis are not effectively performed. Risk review meeting and communication during each risk assessment process with departments were missing in the general risk assessment approach in Project-2. Inefficient communication between the functional areas in any stage of the project or risk assessment can leads to misunderstandings and errors.
- In case study-2, the contingency cost is assessed in an informal manner based on experiences and a gut feeling. Major risk was missed during the assessment based on the general risk management approach.

6.2: Conclusion

For projects to be successful, it is very important that the significant risks influencing projects be completely inspected. Their causes and characteristics must be deliberately broken down to propose the most suitable and effective strategies to relieve them. Typically, during project execution, numerous problems such as shortage of resources, complex conflicts with outer parties, legitimate problems, and so on harvest up. The project manager alone can't solve them. The relationship between the project manager and functional managers is extremely basic in this respect. The better the relationship, the faster is the resource distribution.

Taking into consideration the two risk management approaches for the mentioned case studies, it inferred that oil and gas construction companies uses a best practice risk management and analysis. Findings show that oil and gas construction companies risk management guidelines have some risks benchmarks and standard practice so that when a risk event occurs, company provides best solution by using existing analysis and mitigation plan. Missing to identify major risk and applying mitigation plan during the risk assessment based on the general risk management approach has increased the contingency reserve requirement, which has negative cost impact on projects. Adopting a thorough detailed approach by using the best knowledge, quality and full detailed risk management assessment, manages threats and opportunities in a way that decreases contingency resource utilization.

In today's changing economic conditions and fast track construction schedule, a risk flexible common structure will help deep understanding of project risk exposures. A continuous risk management approach can be carried out by construction companies by connecting the common risk register with the project specific risk register of new project.

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APPENDIX - I

SURVEY QUESTIONNAIRE

RISK ASSESSMENT SURVEY QUESTIONNAIRE						
Function	Major Risk Area	Other Risks (add new risk)	Probability (%)	Risk Impact		
				Low	Most Likely	High
ENGINEERING				✓	✓	✓
EG-1	Risk related to engineering resourse mobalization					
EG-2	Design optimation oppurtunity during engineering					
EG-3	Risk related to client awareness of client standards					
EG-4	Risk related to working sharing with different engineering offices					
EG-5	Risk related enginnering by sub-contractors					
EG-6	Interface risks					
EG-7	Risk related to scope increase					
EG-8	3D modelling software issues					
EG-9	Risk related to changes after Safety Studies / HAZOP					
EG-10	Electrical & Instrument bulk items:					
EG-11	Estimate accuracy & quantity variation for piping bulks					
EG-12	Risk of overspend of manhours based on earlier benchmarck figures is considered in the PROM.					
PROCUREMENT						
PR-1	Risk related Vendor Validity lapsing					
PR-2	Delay in supplier deliveries due to Vendor / Shop Capacity Constraints					
PR-3	Delays is Delivery Schedule due to late Engineering, late PO					
PR-4	Material Cost increase due to qty growth					
PR-5	Supplier warranty periods vs actual warranty periods					
PR-6	Exotoc steel Commodity Escalation					
PR-7	Steel Commoidty Escalation					
SUBCONTRACTS						
SC-1	Price validity on subcontracts quotes received					
SC-2	Difference in Main Contract and Subcon T's and C's (Like Insurance, Indemnities, Liabilities, warranty, etc)					
SC-3	Subcontractor standby - offshore works - in waiting for Company to be ready.					
SC-4	Pipe coating plant incapability to handle the delivery schedule due to multiple orders.					
SC-5	Geophysical Survey- additional survey requirement					
SC-6	LQ and Archictural/HVAC Schedule interface problems between Company and LQ/Architectural /HVAC Subcontractor.					
FABRICATION						
FA-1	Deterioration in yard productivity due to Yard congestion					
FA-2	Concurrent awards of prospective works result in additional external storage area for materials/warehouse					
FA-3	Risk of renting additional yard equipment/resourcesdue to other project awards.					
FA-4	Unavailability of Trailer Frames for loadout of structures Frames could not be available upon concurrent awards of prospective works or change to schedule.					
FA-5	Valves fail encountered during valve testing					
FA-6	Labour union disturbance					
FA-7	Lack of experience working with client requirement					
HSES						
HS-1	client certified rigger requirement					
HS-2	Additional permit to work issuers trained by client requirement					
QAQC						
QA-1	Delay in delivery of CS linepipe for welding qualification test					
QA-2	Overrun in vendor inspection cost					
QA-3	Availability of PAUT and PMI machine during Offshore Installation/Hook Up campaign					
QA-4	Additional welding procedure qualification					

RISK ASSESSMENT SURVEY QUESTIONNAIRE						
Function	Major Risk Area	Other Risks (add new risk)	Probability (%)	Risk Impact		
				Low	Most Likely	High
Offshore Hook-up				✓	✓	✓
HU-1	Significant Change in Sequence of identified tasks resulting in significant increase in Jack Up Barge Spread durations for offshore installation					
HU-2	Unavailabilty of proposed 3rd party chartered vessels					
HU-3	Adverse productivity of offshore activities due to Congestion and concurrent activities on the topsides					
HU-4	Over run on Vendor Services or Stand-by at Onshore and Offshore					
HU-5	Delay in Vessel Inspection Standby of HUC spread due to rejection / extensive punch list during Vessel inspection					
HU-6	Delay in permits of Vessel Crew at Port					
MARINE						
MA-1	Change in schedule (3.5km Dredging for Pipeline scope caused delays and others) requiring work in adverse weather condition.					
MA-2	Restrictions may be imposed for moving anchors at night during pipelay					
MA-3	Requirement of coral / seagrass etc relocation from trenching affected zome (For Cable Laying Scope and pipeline scope)					
MA-4	Damage to the submarine cables, Emergency cut and laydown of a submarine cable due to weather					
MA-5	Leak of pipeline or spools during hydro testing					
MA-6	Standby of whole spread due to breakdown of one tug.					
MA-7	Incur excess weather down time than estimated based on historical information & Fugro data					
PMT						
PM-1	PMT Manpower / resources for the key positions at the beginning of the Project					
PM-2	PMT Interface with other Marjan offshore / onshore packages and otherGovt Depts. Which is a first of kind					
PM-3	Over run on Package Engineer / Management costs - risk of Management Personnel getting involved in managing the Big Packages (230KV cables / Compressors / GIS / Emerson etc.,)					
PM-4	Increase in visa charges/ no of visas/ Travel					
CONTRACTUAL & FINANCIAL						
CF-1	Contract does not provide for compensation for any Government caused cost increases imposed at any time					
CF-2	Increase in Bank Guarantee costs					
CF-3	Standby delays are disputed by Client and not reimbursed.					
CF-4	Customs duty cost escalation due to legislation changes (trade wars in China)					
CF-5	US China Trade War and associated Tarif or regulation changes to materials from China					

APPENDIX- II

RISK REGISTER PROJECT-1 (Case Study-1)

RISK REGISTER - PROJECT 1

Function	R/O Event Detailed Description	RISK- UNMANAGED IMPACT: Un managed Impact ($000's) (A)	Probability (%) (B)	Probability Ranking (C)	Impact Ranking (D)	Impact Score (C x D)	Contingency ($000's) (A x B)	RISK- MITIGATION STRATEGY: Strategy Detail Description	RISK- MANAGED IMPACT: Probability (%) (E)	Managed Impact likelyhood (F): Low	Most Likely	High	Probability Ranking (G)	Impact Ranking (H)	Impact Score (G X H)	Contingency ($000's) (E X F)
ENGINEERING																
EG-1	RISK DUE TO DELAY IN MOBILIZATION KEY ENGG STAFF IN Middle East: (a) Risk associated with delayed hiring and mobilization due to the need to hire additional staff and knock on effect on procurement and AFC drawing issuance impacting Project schedule and completion.	2,025	40%	3	5	15	810	(i) Pre investment to hire key resources as identified in mobilization plan (cost 2.422 MUSD) to be committed ahead of project award. (ii) Early identification of new recruit i.e., 60 to 90 days of CA to complete interviews and issue conditional offers to around 100 personnel. (iii) Identify a team in India to continue work either from India or short term assignment to Middle east until the Middle east Project team is in place.	25%	1,013	1,215	1,823	2	5	10	304
EG-2	Loss of Optimzation opp.. due to lack of suitable expereinced persoonel in Middle East Engg. office affecting some of the Optimizations (lost opportunity) dialed in initial stage could not be realized during execution.	6,000	40%	3	5	15	2400	(i) Early identification (3 months ahead of contract award) and complete setup office to occupy atleast 1 month ahead of formal CA. (ii) Initial start of work for Pre-award shall be executed from India by mobilizing a small team from Middle east to India, if approved by Mgmt.	30%	1,800	3,000	5,400	3	5	15	900
EG-3	CLIENT STANDARD & PROCEDURE AWARNESS: Engineering new recruit inengineering office-1 & Main Engineering office office may not be familiar withClientspecification, Standards and requirement / approval procedure and this could result in rework, delay in Engg progress and productivity related issue.	354	40%	3	4	12	142	(i) As part of pre investment / early mobilization, ensure all key personnel working in the project undergo a initial training period (2 weeks) for Client standard familiarization. (ii) A set of Client experienced super leads from Main Location shall be relocated as part of Engg PMT toengineering office-1 office to ensure Client requirement / approval procedures are proactively followed. (iii) Perform LL workshop & client standard awareness workshop at each location during early stage of project.	25%	248	283	319	2	4	8	71
EG-4	SUCONTRACTOR's INVOLVEMENT IN ENGINEERNIG: Collaborative way of working between Subcontractor& company Engineering could lead to rework / quality / productivity issues as first time both Engg organization are working together and Subcontractor Engineering team is not familiar with Client standards.	363	40%	3	4	12	145	(i) Deliverables produced by Sub-Contractoe engineering team to be checked for quality & accuracy by Company personnel as Company owns the engineering responsibility and any design error / omission will result in equipment cost escalation. Accordingly additional supervision hours has been included in estimates. (ii) Consider only 50% of Sub-Contractoe hours as productive hours in the manhour adjustment while taking credit of Sub-Contractoe engineeirng team presence inCompany's engineering office.	30%	254	290	327	3	4	12	87
EG-5	Work share (scope split) betweenengineering office-1 and Main Engineering office , interface issues leading to delay in issuing AFC and over run of budget	350	40%	3	4	12	140	(i) Clear demarcation of scope and transfer work at stage completion (IFA, AFD) rather than percentage (ii) Develop a detailed RACI matrix to clearly identify the responsibilities of the offices. (iii) Assign interface engineers inengineering office-1 from Main Engineering office to manage the interface between Main Engineering office andengineering office-1 (included in estimates)	25%	245	280	315	2	3	6	70
EG-6	Main Engineering office Capacity: Availability of experienced personnel in required number to perform the work in Main Engineering office due to additional work being transferred from other offices	375	40%	3	4	12	150	(i) Early planning and identification of key resource. (ii) Keep provision of additional supervision (DM support, support from Main Location) (iii) Clear recruitment plan (at least 3 months in advance) (iv) Change in execution philosophy by shifting 30% of the scope (EDP, Aux platform and Flare, Bridges & bridge support platform, Onshore & brownfield scope totalling to ~350K) to Main Location.	25%	263	300	338	2	4	8	75
EG-7	Non-availability of Client experienced resources in Main Engineering office office to deliver required quality meeting projects requirements due to other project commitments	125	75%	5	2	10	94	(i) Early planning and identification/lock personnel experienced with Client project execution. (ii) Keep provision of additional supervision (DM support, support from Main Location) (iii)Deputation of key personnel (superleads for each discipline) from Main Location / Saudi for a period of 6 months to bridge the gap.	50%	88	100	113	4	2	8	50

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelyhood			Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
										Low	Most Likely	High				
EG-8	MEETING Sub-Contractor Fab yard EXPECTATION: AFC deliverables meeting fabrication yard requirements (Second yard)/Sub-Contractoe in terms of completeness and details of information	400	40%	3	4	12	160	(i) Typical AFC deliverables for Structural, Electrical, Instrument and Piping shared with Sub-Contractoe/Second yard and agreed in principle the level of detailing. (ii) Have early constructability session with Second yard and Sub-Contractoe during project execution stage. (ii) Regular discussion with Second yard /Sub-Contractoe team and alignment with engineering on any new/late changes to project SOW and requirements. (iii) During project execution, all key FAB deliverables Second yard / Sub-Contractoe should be included in IDC reviews.	25%	280	320	360	2	4	8	80
EG-9	INTERFACE RISK: Risk of engineering growth due to unforeseen additional engineering effort or material growth due to complex interface between Package 1/2/3/4 contractors and Package 1 contractor identified as Lead Interface Integrator.	1,000	60%	4	5	20	600	(i) Conduct early interface meeting & workshop with all other packages / Client stake holders to update the Interface register and eliminate any ambiguity on scope. (ii) Robust interface management plan by dedicated interface manager (iii) Pursue Change Order for any Change from base scope of work	40%	500	600	900	3	5	15	240
EG-10	CSE SCOPE INCREASE: CSE budget over-run as a result of unplanned changes in Marine and Fabrication work. This comes about due to lasts minute changes in cargo barges, crane changes and many other operation changes that need to be supported to allow operation to keep moving.	57	75%	5	2	10	43	(i) Identify Marine installation solution and lock in installation assets to avoid late changes. (ii) Identify Fabrication methodology early enough. (iii) Continuous engagement with FAB & Marine team on regular basis. (iv) Close coordination between CSE & Engg	50%	40	46	51	3	1	3	23
EG-11	3D MODELLING TOOL (PDS Vs S3D): Client clarification calls for usage of PDS as 3D modelling software, however ITT contract document specify S3D as software to be used. Due to Company's internal constraint's and workshare requirement, the software considered for 3D modelling is SP3D. Client may reject use of SP3D during execution and as-builts.	250	40%	3	3	9	100	(i) As per interface requirement, the 3D models for all packages 1/2/4 to be integrated in S3D environment, hence it is most likely the 3D model need to be develpoed in S3D although in SOW and clarificaiton response Client has stated to use PDS. (ii) During conflict resolution period (120days) post award, this conflict shall be highlighted and obtained client acceptance on usage of SP3D. (iii) As contigency measures to cover for any rejection of the Company proposal to use S3D modelling tool, additional modelling hours for converting SP3D model to PDS shall be considered at Main Engineering office rate.	25%	175	200	225	2	3	6	50
EG-12	DROPPED OBJECT PROTECTION: Inclusion of dropped object protection above transformers or subsea asset (pipeline corridor), not included in FEED design.	450	60%	4	4	16	270	Dropped object study is included as part of the safety studies and the critical safety study (preliminary study) shall be completed during 120 days conflict identification period. Any potential impact shall be covered as part of 120days conflict identification period.	40%	315	360	405	3	4	12	144
EG-13	**EQUIPMENT SIZE GROWTH:** Layout / platform deck size increase due to increased vendor footprints or valve / equipment material handling access requirement identified during detail Engg.	121	40%	3	2	6	48	(i) Current layout provided in ITT is verified w.r.t vendor details and installation / operational point of view. Tie In / EDP / GCP / Aux platform layout modified appropriately as part of bid engineering. (ii) Early engineering and engagement of vendor to confirm preliminary design within the 120days verification period and transfer the change to Client. (iii) Identify key list of equipment which has potential impact on the layout and engage with potential vendor during early design stage. A dedicated task force to manage this activity shall be set up. (iv) Keep provision to allow reasonable contingency as per prevailing practices adopted for similar type of projects. (this cost kept under Joint risk)	10%	85	97	109	1	2	2	10
EG-14	**Process Interface building size growth:** Dimensions of Process Interface Buildings (PIB) on platforms could increase during execution, due to increased system cabinets (based on I/O growth) and electrical MCC size increase	121	40%	3	2	6	48	(i) PIB size verified during bid phase based on technically qualified vendors. (ii) Based on engagement with MAC vendor system cabinet quantity and size shall be finalized based on adequate margin for I/O growth. (iii) MCC size verified with electrical loads also considering the mechanical package loads, electrical building size updated in bid stage. (ii) During execution, include NTE weight and dimension in PO's where possible.	25%	85	97	109	2	2	4	24

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelyhood			Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
										Low	Most Likely	High				
EG-15	RAM report not provided by Company as part of IFB package and no availability value specified. During detail engg, based on RAM study, there is potential to discover that additional spare equipment may be required. Also RAM study outcome could result in additional operational spare part requirement which is not considered in bid stage.	600	60%	4	5	20	360	(i) Early identification of subcontract to perform this study and identify potential changes early enough. (ii) Work closely with Client to resolve any major issues during 120 day verification period post award of contract and any growth to negotiate with Client as Change order. (iii) The equipment configuration not changed from ITT design, except for Air compressor. For Air compressor, current configuration offered by vendor is 2x100% which may not be accepted by Client. Hence the cost difference for alternative design with 4x50% with marginal higher capacity is considered (based on standard range available with vendors) in PROM should Client demand 4x50% capacity.	40%	420	480	540	3	4	12	192
EG-16	Flow assurance report results not provided. Risks: larger HPPTs due to increased slug volume, more compression ratio, more compression power, increased design pressure or dimensions for the oil export pipeline.	120	25%	3	2	6	30	(i) Early identification of subcontract to perform Flow assurance study and identify potential changes early enough. (ii) Work closely with Client to resolve any major issues during 120 day verification period post award of contract and any growth to negotiate with Client as Change order.	25%	84	96	108	2	2	4	24
EG-17	Delayed vendor data affecting engineering schedule, man-hours and issue of AFC drawings to yard	242	50%	3	4	12	121	(i) Early identification of LLI packages with less than 4 weeks positive float. (ii) Engage with vendors during Bid sage and possibly partnership at pre bid stage- early engineering freeze. (iii) Dedicated Package management team to be deployed for key packages. This ensure effective expediting and tracking to mitigate any delays.	40%	169	194	218	3	3	9	77
EG-18	Safety Studies / HAZOP / SIL study will be carried out at detailed engineering stage and changes due to these studies (which cannot be contractually defended) are unknown at bid stage. Additional design changes to meet HAZOP, HAZID, Safety studies and design review recommendations	650	40%	3	5	15	260	(i) Early identification of subcontract to perform Flow assurance study and identify potential changes early enough. (ii) Work closely with Client to resolve any major issues during 120 day verification period post award of contract and any growth to negotiate with Client as Change order. (iii) However referring to safety studies / Workshop outcomes may lead to some detail design growth based on respective recommendations, which could lead to growth / changes to the Procured items	25%	455	520	585	2	5	10	130
EG-19	As per CONTRACT, SPPID, Intools data base is to provided immediately after project award. In case on non-receipt of SPPID database, Company may need to proceed with P&IDs, considering the project schedule and convert to SPPID as and when it is available.	75	15%	2	2	4	11	(i) Early engagement with Client to obtain the native files and SPPID & Intool data base to avoid any delay to project works. (ii) Project manhours is estimated considering SPPID & Intools native files availability at project start. Any change will be dealt as change order by PMT.	10%	53	60	68	2	2	4	6
EG-20	As per spec "On platforms handling hydrocarbons, buildings shall have two-hour fire-rated external walls and roof per UL 1709". UL 1709 test applicability is only for PFP intumescent coating related fire test, it will not be applicable to validate insulation (bulkhead) related fire ratings. As provided in previous projects, Insulation is considered for the walls, floor and roof. Insulation used to achieve the required two hour(s) fire rating will be certified as per SOLAS - IMO resolution FTP code A.754(18). As TQ was not raised in this regard, if Company insist in providing PFP (Intumescent Coating) for walls this will have a huge cost impact and schedule impact.	705	40%	3	5	15	282	(i) For past Client experience, this same strategy has been accepted by Client. (ii) Issue early TQ to Client post award and reach an agreement with Client on this requirement. (ii) Should Client insist on UL-1709 requirement this will require PFP intumescent coating atleast on platform that has hydrocarbons (TP/GCP/PP) and PROM considered for coating the external surface area with PFP coating.	15%	423	494	635	2	4	8	74
EG-21	COMPANY has not provided the data sheets for valves and field instruments and cost has been considered based on the typical provided. Any design development during EPIC which may lead to a higher spec requirement, will have cost and schedule impact.	580	40%	3	5	15	232	(i) Pre award work to be considered to develop PMS and valve data sheet for all large bore valves. (ii) Post contract award, have early engagement with Client to get the PMS & valve data sheet approved as these large bore valves are LLI & expensive. (iii) Any change to valve specification from the ITT shall be identified during 120 day verification period and negotiate with Client as Change order.	25%	406	464	522	2	4	8	116

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelyhood Low	Managed Impact likelyhood Most Likely	Managed Impact likelyhood High	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
EG-22	**Full Bore Valves** considered only for Scrapable lines and as denoted as "FB" in P&ID. Any change to this requirement will have a substantial impact on cost and weight .	320	40%	3	4	12	128	(i) Pre award work to be considered to develope PFD, P&ID, PMS and valve data sheet. (ii) Post contract award, have early engagement with Client to get the pre award documents approved as any changes will have commercial impact & weight increase. (iii) Any change to valve specification from the ITT shall be identified during 120 day verification period and negotiate with Client as Change order.	25%	192	224	288	2	4	8	56
EG-23	**Valve data's provided as part of ITT had inconsistencies** in Piping class, rating, overlay requirements. It was decided not to float those data sheets to vendor instead develop Valve data sheets for ball valves sizes more than 6inch for Inquiry. However only the major requirements such as Valve type, size, rating, body, seat and trim materials are considered as per PMS provided part of ITT and requirements such as sealing, stem packing, etc. are based on past executed projects due to unavailability of details. Any change to consideration with respect to sealing, stem packing etc will have impact on cost.	875	40%	3	5	15	350	(i) Pre award work to be considered to develope PMS and valve data sheet for all major valves. (ii) Post contract award, have early engagement with Client to get the PMS & valve data sheet approved. (iii) Any change to valve specification from the ITT shall be identified during 120 day verification period and negotiate with Client as Change order.	25%	525	613	788	2	5	10	153
EG-24	Electrical & Instrument bulk items: Cable tray, cables and bulks quantities for GOSP4 package is based on preliminary design done by Company as no layout / detail was provided as part of IFB package. During detail engg, the E&I bulk MTO may increase based on design development. Although sanitary checks are done, this risk is not 100% eliminated and post award MTO can increase.	725	40%	3	5	15	290	(i) Adequate design contingency based on historical data for similar complex project is considered in estimation to allow for unforeseen growth. (ii) Any major growth in MTO due to scope growth or in adequate FEED shall be identified and negotiated as a change order with Client.	25%	363	435	653	2	4	8	109
EG-25	**Material Handling requirement:** Material handling requirement provided in IFB package is very generic and does not address the MH requirement for large bore valves (36" and above).	350	40%	3	4	12	140	(i) As part of FEED verification, the MH philosophy was further reviewed and provision for Pad eye / Monorail with electric hoist included for handling the equipment / valves. (ii) During 120 days conflict identification period, clarify the MH philosophy to be followed via TQ / discussion with Company.	25%	210	245	315	2	3	6	61
EG-26	**The motor starting study report** assumes a motor starting torque preliminary values provided by client in the feed. Any appreciable changes in the value will impact the complete 13.8KV system of the Auxiliary platform. Any change in the upstream transformer 75/100 MVA to facilitate motor sizing will result in selection of next size 100MVA posing a major electrical system design rework and large cost impact to due limitation on 13.8KV system ratings	920	25%	2	5	10	230	(i) Early finalization of Electrical system study subcontract and identify potential changes early enough during 120 day conflict period. (ii) Work closely with Client to resolve any major issues during 120 day verification period post award of contract and any growth to negotiate with Client as Change order.	10%	460	552	828	2	5	10	55
EG-27	**230KV Composite Subsea cable burial / trenching** nearshore / landfall section scope defines soil usage of 0.7 KM/W soil thermal resistivity which is not feasible. The limitation in the soil thermal resistivity will lead to higher cable size in landfall portion & increased subsea cable weight.	125	40%	3	2	6	50	(i) Based on subsea cable high level sizing done as part of bid verification, the issue can be mitigated by increasing the cable size at landfall to 1200mm2 or backfilling the trench with special sand having min 0.8 km/W soil thermal resistivity. (0.7 km/W soil thermal resisitivity is not feasible to achieve) (ii) Even for 0.8km/W thermal resistivity, special soil consultant and Onshore subcontract for special sand preparation (Fluidized thermal back fill soil) need to be executed (iii) Fluidized thermal back fill soil is priced in the bid and during detail engg, engagement with Client is requried to finalize the subsea cable size at landfall point.	25%	88	100	113	2	2	4	25
EG-28	**PKG # 1 systems (SCADA, CRMS , DCS,ESD, FGS etc..)** Integration & Modification for Onshore facilities and other PKGs (2, 3, & 4). Based on Interface matrix PKG #1 scope is considered as providing the required space in systems panels at CCR for other PKG # contractors to modify as required as per the present ITT I/O qty.	250	40%	3	3	9	100	(i) Based on package 2/3/4 scope, the space required in CCR system panel were verified and found adequate. (ii) However for space required in system cabinet for Onshore scope not verified and considered as per ITT design. (iii) Have early pre engineering onshore survey to verify the onshore cabinet (iv) Any change from ITT requirement shall be identified during 120 days conflict identification period and negotiate with Client as change order.	25%	175	200	225	2	3	6	50

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelyhood Low	Most Likely	High	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
EG-29	6 Big Jackets Lift solution: Currently all major 6 jackets are installed by Sub-Contractoe with ZH30 barge as base option. However during execution phase, if Sub-Contractoe is unable to secure ZH30, then alternative installation design to be considered.	360	55%	4	4	16	198	(i) Sub-Contractoe has confirmed availability of suitable lift vessel for all the 6 jackets lift / installation on 18 Jan 2019. Based on this risk retained as "Un-Priced" (ii) Sub-Contractoe to secure installation vessel or finalize the installation philosophy during bid stage. (iii) For alternative design, additional buoyancy tank is required resulting in approximate additional steel tonnage of ~2000MT for all 6 jacket, however this alternaitve backup design is not included in PROM based on PMT decision as Sub-Contractoe confirmed securing ZH30 barge.	40%	252	288	324	3	4	12	115
EG-30	<u>Process Guarantee -</u> Change in equipment, size, rating to meet the overall guarantee as required by the contract when vendors complete their design.	80	40%	3	2	6	32	This is not applicable for Client Contract as there is no Process Gaurantee requirement as part of Contractor Scope. (i) As part of bid verificaiton process, Hysis simulation performed by Hague Process Engg team and confirmed no major concern on equipment sizing. (ii) Perform preaward engineering for critical equipment and issue PO early enough so as to get vendor confirmation on the equipment size & design for the process parameters. (iii) Any major changes to ITT design shall be identified during 120 days verificaiton period and negotiated with Client as Change order.	25%	56	64	72	2	2	4	16
EG-31	<u>Optimization done during Bid:</u> As part of bid, Engg has relocated the Electrical Substation # 2 from Aux platform to EDP and all transformer are located in EDP. Further the equipment arrangement layout of EDP is modified to suit the optimization. During detail engg, Client may mandate to follow ITT distribution philosophy of having emergency distribution system away from GCP (high blast impact is expected from GCP compressor failure).	900	40%	3	5	15	360	(i) As part of pre award engineering work, develope key engineering deliverables so as to get Client buy in early upon contract award. (ii) Post contract award, have early engagement with key stake holder in Client to submit the optimized solution and seek approval. (iii) Should this optimization not accepted, there is a risk for an increase in cost & HUC duration.	25%	360	540	810	2	5	10	135
EG-32	<u>Optimization done during Bid:</u> Concrete weight coating (CWC) optimzation. The CWC requirement for shallow water section (up to water depth 25m) for cohesive soil is coming very high and it exceed even the ITT specified thickness. Following assumptions made for optimized CWC. (i)The allowed movement for the pipeline is considered 10D as defined in DNVGL RP F109 (ii) We also consider to use AGA level-3 during actual execution to commensurate the 10D approach of DNVGL. (iii) The benefit of increased water depth is taken care in calculation on account of proposed re-routing of shallow water patches.	950	40%	3	5	15	380	(i) Proposed to perform detailed pipe-soil interaction study (PSI) by third party (approx. 150K US$). This will help us to demonstrate the approach we are considering and for further optimization of CWC post award. (ii) Have early engagement with Client CSD to get the proposal reviewed and approved. (ii) ManageClientto avoid negative Change Order.	25%	475	570	855	2	5	10	143
EG-33	Optimization done during Bid: Trunkline re-routing in shallow water patches proposed to avoid trenching for approx.3.4 kms, where water depth is less than 5m. This will require to mobilize a separate dredging/trenching spread. Also a dedicated shallow water lay barge will have to be mobilized just for this short length.	800	40%	3	5	15	320	(i) Post award, manage the interface with Package-4 Contractor to ensure both Package 4 & Package 1 Contractor propose rerouting solution toClientfor the shallow water patch as the re-routing is possible only when similar re-routing is considered by Package 4 Contractor.	25%	400	480	720	2	4	8	120
EG-34	Global Buckling for 36" Trunkline - Client clarified that this analysis and mitigation measures (if any) shall be part of lump sum.	75	40%	3	2	6	30	(i) Engineering hours to carry this analysis is already accounted by Engg. However provision for mitigation measures (required if any during actual execution) like snake lay, more CWC etc., needs to be suitably dialed-in.	25%	53	60	68	2	2	4	15
EG-35	<u>Optimization done during Bid:</u> The external FJC system considered is in-line with previous concluded project i.e. STOPAQ. Instead of powder based coating system as specified in ITT document. Liquid based FJC system reduced offshore marine time.	80	40%	3	2	6	32	(i) Strategy will be to regularize with TQ immediate upon award. (ii)Retained unpriced based on the confidence thatClienthas approved such substitution and has been used in past for manyClientprojects.	25%	56	64	72	2	2	4	16
EG-36	Additional cost impact in the event Engineering execution plan is revised during project execution and Enginnering is performed from more than 2 locations (ie 2 Decks in Main Location)	950	40%	3	5	15	380	Ensure that the Bid execution Philosophy is not changed Ensure adequate ramp up of personnel pre-award so that the capacity for the performance of engineering from 2 locations is not compromised	25%	380	570	855	2	5	10	143

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EG-37	<u>Geo-Physical survey (Pre-engineering Survey)</u> for the pipe line route is not included in cost considering that the details will be provided by COMPANY to successful bidder. However during execution, the information provided by COMPANY may not be adequate to perform certain engineering analysis and generating the drawing in desired format which requires additional effort from Fuguro to provide the required inputs.	250	40%	3	3	9	100	(i) Native file (in required format for dwg. & dgn. file) of these drawings shall be for pipeline route, platform approach, crossing locations shall be expedited with Client post award. (ii) Consider adequate cost to be paid to Fugro for getting the additional design data.	25%	175	200	225	2	3	6	50
EG-38	<u>Optimization done during Bid:</u> Reduction in pipeline wall thickness by removing additional conservatism considered in ITT. Around 2500MT of weight reduced.	750	40%	3	5	15	300	(i) Have early engagement with Client CSD to get the proposal reviewed and approved. (ii)Retain Unpriced based on the confidence thatClienthas approved such WT reduction / optimization in past.	25%	525	600	675	2	5	10	150
EG-39	<u>LP Flare Header size</u> is reduced in Addendum 2 from 10" to 8" with no change in the flow rate. With 8" back pressure is 50 psig and in relation with the compressor seals the 50 psig is much higher than the typical that vendors can handle. In order to reduce back pressure LP Flare Header size needs to increase to 12"	800	40%	3	5	15	320	(i) During detail engineering, if flowrate is not reduced, then the cost of increasing the LP header from 8" to 12" need to be considered. (ii) As ITT line size is indicated as 8", in proposal the differential cost for change in line size from 8" to 12" is not considered (bid as per ITT). (iii) Post contract award, during 120 days period more detailed study to be conducted and identify any potential impact so as to negotiate with Client as Change.	25%	480	560	720	2	5	10	140
EG-40	<u>The Nitrogen flow for the compressor seals</u> does not specify worn seals consumption. Additional nitrogen consumption might be needed when seals are worn out. During detail engg, Client may demand to consider seal worn condition which shall result in increase of Nitrogen consumption and increase the Instrument air Compressor Capacity.	80	40%	3	2	6	32	(i) During early stage of design, verify the Nitorgen utility consumption and identify any potential possibility for growth. (ii) Have early engagement with Client and issue technical clarificaiton to resolve this issue. (iii) Should the Air compressor capacity increases, negotiate with Client as a change as part of 120 days verificaiton period.	25%	56	64	72	2	2	4	16
EG-41	Estimate accuracy & qty variation for piping bulks Piping MTO is based on bid engineering done by Hague / Main Location / Gurgaon offices. Due to multiple revision of P&IDs, addendum and huge number of bid clarification coupled with MOPEX execution followed in bid estimation, there are possibility for estimation accuracy and qty variation between bid estimates & detail engg quantities.	4,000	40%	3	5	15	1600	(i) Adequate design margin considered to cover the estimation accuracy & nominal design growth anticipated during detail engg based on similar project executed in the past. (ii) However certain additional budget shall be reserved to cover for unknown factors / package vendor driven changes which may result in increased MTO and is covered as part of estimation accuracy	25%	1,600	2,000	3,600	2	5	10	500
EG-42	<u>ITT Piping Material specification</u> does not define the <u>MOC for line size < 6"</u> and for bidding purpose the MOC for these lines are based on the Client provided PMS for 6" above and from past projects (for Cladded and FBE lined piping Class). In response to the clarification raised, Client indicated that PMS for 4" & below to be developed post award by detail engineering contractor and approved by Company. The MOC for line size <6" has the potential for change post award based on Client approval.	825	50%	3	5	15	413	(i) As part of pre-award engg, devlope the PMS incoporating all Client bid clarificaiton response. (ii) Post award, approval on PMS shall be obtained from Client during 120 days conflict identification period. (iii) Any special or additional requirement from Client shall be dealt as a change order.	25%	578	660	743	2	5	10	165
EG-43	<u>The pipe wall thickness for certain pipe sizes</u> under Piping class 9SDP02, 9CS2P06, 1LE2W, 3LL0P12, 9LL0P12, 15LE2P06 are found to be inadequate for the applicable design pressure. This point was raised as technical clarification (ref. Sr No 971-978) and company responsed to follow the thickness as per the ITT PMS. It is noticed that some of these Specs have inadequate wall thickness and change to wall thickness will have significant impact on cost and weight	550	40%	3	5	15	220	(i) As part of pre-award engg, devlope the PMS incoporating all Client bid clarificaiton response. (ii) Post award, approval on PMS shall be obtained from Client during 120 days conflict identification period. (iii) Based on Client technical clarification response (Sr No 2352). Client has confirmed that any change in wall thickness w.r.t ITT design will be considered as change in scope. Hence any change shall be negotiated as Change in scope.	25%	385	440	495	2	4	8	110
EG-44	Optimization done during Bid: Type of 1st and 2nd stage after coolers (Shell & tube heat exchangers) in Gas Compression platform specified in the ITT is AET (floating head) type. During bid engineering, BEU type heat exchangers which is technically acceptable and meeting the design requirement is proposed as this is commercially attractive. There is a risk that Client may not accept to change the exchanger type or ask for give back.	240	30%	3	3	9	72	(i) Manage Client as AET type exchanger is not suitable for very high design pressure due to high chance of leakage and also requires robust design and fabrication challenges. (ii) BEU type exchanger is verified for technically suitability for entire operating range by Hauge Engineeirng team and hence the risk for rejection by Client is unlikely. (iii) Post award, in 120 days design review period highlight this issue and get approval from Client for BEU design in form of TQ.	10%	168	192	216	2	3	6	19

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EG-45	Optimization done during Bid: Pedestal crane in Auxiliary platform capacity optimized from 50MT to 20MT as the max. weight of equipment that requires lifitng is only ~15MT. There is a risk that Client may not accept to reduce the pedestal crane capacity or ask for give back.	120	60%	4	2	8	72	(i) In material handling report, no detailed MH philosophy provided by Client. Post award, develope a detailed MH philosophy and manage this optimization as 50MT crane in Aux platform is not required. (ii) Post award, during 120 days design review period the crane capacity for all platform to be verified and agreed with cleint in form of TQ. (iii) ManageClientto avoid negative Change Order.	40%	84	96	108	3	2	6	38
EG-46	RISK on Strech MHs Based on project executed by Company in the past, for a complex facility of this nature the average manhours / MT is around 17 hrs. For this bid, average MHrs for major 6 topside is 13.37hrs Risk of overspend of manhours based on earlier benchmarck figures is considered in the PROM.	1,100	40%	3	5	15	440	(i) Around 350,000 MH (91500MT x 3.63 hrs/MT - i.e. difference between average bench mark hours & calculated average hours) @ $ 52.25 /MH (the average rate of the four centres) is included in risk	25%	440	550	880	2	5	10	138
ENGINEERING Total / Average			**43%**			**12**	**13,035**		**27%**						**8**	**5,284**
PROCUREMENT																
PR-1	Vendor Validity lapsing prior to PO Placement exposing us to higher price (action for SCM to substantiate the escaltion $$ risk by listing all the packages / bulks in a separate spreadsheet to link it to the L / M / H $$ and also the probaility %)	9,000	40%	3	5	15	3600	Pricing is mostly based on bid specific RFQ / quotes (94%) - Vendors were requested to provide validity to December 2019 and where the requested validity cover is not provided by Vendor, escalation cost is included at the rate of 1% for each quarter for each such item where Risk is anticipated. However, there is a residual risk of incurring escalation over and above what is included in the bid due to initial PO placements and top-ups are likely to happen right up to Q4 CY2020. Contingency for this risk event is recommended.	25%	2,700	3,600	5,400	2	5	10	900
PR-2	Shop Capacity Constraints / Upturn in Market is expected for next 2 years especially considering the volume / tonnage requirement of this Project along with Marjan P2 / P4 plus many other projects that are going to be awarded by various MEA / ASA Clients in the next 12 months - significant price escalation risk (specially on some commodities) - all Contractors will be going to the same mills / shops / suppliers.	2,400	40%	3	5	15	960	We are negotiating pre-bid agreements and this can mitigate some of this risk, however residual risk on selected items such as Ni-alloy piping, SAW linepipe and CRA linepipe, an allowance is recommnded for such an event risk. With the restricted AVL from Client, some suppliers will have capacity constraints (I.e., compressors and pumps). Pre-bid agreements where necessary to help mitigate some of this risk is done / will be done prior to bid submission. However, a realistic P80 PO to delivery Ex. Works and shipment duration is included in the schedule to generate achievable schedule.	25%	1,200	960	1,440	2	5	10	240
PR-3	Delay in supplier deliveries due to Vendor / Shop Capacity Constraints - this risk is covered under PR-2 above and hence can be deleted (or) mitigated based on planned measures to be deployed under PR-2 / PR-3 / PR-4 items in this Section.	3,000	40%	3	5	15	1200	With the restricted AVL from Client, some suppliers will have capacity constraints (I.e., compressors and pumps). Pre-bid agreements where necessary to help mitigate some of this risk is done / will be done prior to bid submission. However, a realistic P80 PO to delivery Ex. Works and shipment duration is included in the schedule to generate achievable schedule. Any residual risk caused due to delay in Vendor deliveries shall be mitigated by Fabrication work-arounds where we negative float in the Fabrication estimate. Based on this approach, no additional risk money is included under this line items.	25%	900	1,800	2,400	2	5	10	450
PR-4	Delays is Delivery Schedule due to late Engineering, late PO placements due to lack of maturity of FEED - this risk is covered under PR-2 above and hence can be deleted (or) mitigated based on planned measures to be deployed under PR-2 / PR-3 / PR-4 items in this Section.	3,000	40%	3	5	15	1200	FEED is not matured, expect delays in execution to finalise from FEED to detail design. Refer to Event Risk PR-2 & PR-3 above for the mitigation strategy considered. Whether the delay in Vendor delivery is caused due Engg. delay (for variety of reasons i/c poor FEED quality / Client Delay in Approval of PO etc.,) or caused due to Poor Vendor Performance or tight Market situations the effect or impact on the overall project / fabrication is still same and further cascaded to T&I / HUC.	25%	900	1,200	1,800	2	5	10	300
PR-5	Material Cost increase due to qty growth as FEED is not matured, increase in number of top-ups. (we do not anticipate any major change / growth in size of Tagged Eqpt. / Packages based on the FEED validation done during bid. If there is any such Eqpt size growth, the same will be raised as "CHANGE" during 120 days verification period. But such scenario is highly unlikley and hence left un-priced)	6,000	40%	3	5	15	2400	Engineering has considered specific deisgn allowance for SP Items / Tagged bulks and other bulk materials based on the similar sized deck historicals based on the advice fromengineering office-1 Engg. And this allowance (approx. US$17.5mn = 5.7% of bulks cost) is already included in the MTOs issued to SCM / SUBCON / FAB (Main Fabrication Yard / Second yard / Sub-Contractoe). Based on this approach this risk is treated as priced in Base Estimate.	25%	3,000	3,600	4,800	2	5	10	900

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PR-6	Risk of penalties payment to Client for not complying with very onerous in-house requirements as stipulated in ITT considering the Engg / Procurement / Fabrication dominated scope with very minor scope in IK (save for line pipe coating plus T&I-HUC scope) and also the most of the supply are outside the range of Saudi Vendors / shops who supply for typical LTA-II PDM / TP type Projects. Contract Schedule G item 4.3.2 states "If there are three (3) or more technically acceptable Saudi Manufacturers, CONTRACTOR must place the purchase order with a technically acceptable Saudi Manufacturer without further COMPANY compensation." Bid pricing is based on L1. There may be a negative cost impact if this requirement is imposed.	750	40%	3	5	15	300	Key Competition are likely to be having the same problem as Company-Sub-Contractoe for Base / MAlt-1 / Malt-2 Proposals. Considering all the key drivers for this Package-1 project such as Schedule / E&P / Fabrication Capacity issues,inhoiuse may not be the decider in award of this Project. However an assessment will be made prior to the MENA / EXCOM Review on the risks of non compliance or short fall inin-house / Penalty etc., and the same will be highlighted to Mgmt for their Approval.	25%	375	600	675	2	5	10	150
PR-7	Delay in the issuance of Engg drawings or the manufacturing cycle of vendors may result in additional costs by way of expediting and air freights	3,510	60%	4	5	20	2106	Package Managers to be made responsible for on-time delivery of equipment Utilise dummy spools for delayed valves Combine charters for multiple items where possible	40%	1,053	1,404	2,808	3	5	15	562
PR-8	**Supplier warranty periods vs actual warranty periods** (action on SCM for more detailed strategy / mitigation measure to reduce PROM Risk $$)	1,500	40%	3	5	15	600	For the residual event risk, develop an estimate to deal with the unlikely event of incurring cost due to warranty expiration and that is included as the High value with reasonable probability. Most Likely and Low value shall be derived from that.	25%	450	600	1,200	2	5	10	150
PR-9	Optimization not Accepted by COMPANY - Pipeline Wall thickness optimization - covered as part of Engg risks - Covered under Engineering Section including material supply / installation - Refer line items from EG-34 to EG-40	800	40%	3	5	15	320	Mateial Price Exposure including the Engg / Supply / subcontract / T&I is covered under the Engg. PROM	25%	400	480	640	2	4	8	120
PR-10	Nickel Commodity Escalation	3,000	60%	4	5	20	1800	Commodity price escalations due to constrained supply of Ni; prebid agreements under discussion to negate the commodity price increases	40%	900	1,200	2,400	3	5	15	480
PR-11	Steel Commoidty Escalation	15,000	60%	4	5	20	9000	Commodity price escalations due to large volume of orders expected in the market at the time of PO Placement. Strong negotiations to minimise impacts	40%	4,500	6,000	#####	3	5	15	2,400
PR-12	Change in vendor to Venturi Flow meter deviation not being accepted by client (Inconel 625 Clad vs. Metal Sheet)	100	60%	4	2	8	60	Raise a deviation request upon project award; vendor states similar deviations have been accepted by Client in the past	45%	50	60	80	3	2	6	27
PROCUREMENT Total/ Average			**47%**			**16**	**23546**		**30%**	**-**		**-**			**11**	**6679**
SUBCONTRACTS																
SC-1	Price validity on subcontracts quotes received	400	40%	3	4	12	160	Offers received at bidding stage should be valid until end of Dec 2019. After the award, focus on early award of subcontract, wherever potential escalation / non-availability of capacity is anticipated. Other mitigation measures include negotation with Subcontractors to extend the validity in writing to suit our schedule requirements after Contract Award.	25%	200	240	320	2	3	6	60
SC-2	Difference in Main Contract and Subcon T's and C's (Like Insurance, Indemnities, Liabilities, warranty, etc)	800	45%	3	5	15	360	Provide the Main Contract T's and C's to the bidders of major subcontract scope; negotiate to the extent commercially possible.	30%	400	480	640	3	4	12	144
SC-3	**FJC, Pre Comm** Non availability of proposed Subcontractors' resources due to schedule overlap between different packages.	120	60%	4	2	8	72	a) Early award of Subcontracts. b) Close coordination with Subcontractors and to provide them with adequate mobilization notification to arrange resources.	40%	60	72	96	3	2	6	29
SC-4	FJC, Pre Comm a. Subcontractors claims of standby due to delay in obtaining clearances and permits. c. Subcontractor standby - offshore works - in waiting for Company to be ready.	25	75%	5	1	5	19	a. Use of window mechanism for mobilization. b.Close coordination and planning with SC by having an Interface coordinator in PMT. c.Ensure to give work access to subcontractor on time with proper planning, to avoid standby claims. (10 days of infield rate included in PROM)	55%	13	15	20	4	1	4	8
SC-5	**Pipe Coating** Pipe coating plant incapability to handle the delivery schedule due to multiple orders.	140	40%	3	3	9	56	a) Consider the use of more than one subcontractors for pipe coating during execution based on the market condition. b) Make sure that bare pipes are delivered as planned to have continuous production.	25%	70	84	112	2	2	4	21
SC-6	**Geophysical Survey** In the event of additional Survey required in case of Client provided Data is insufficient. Note:- Company has provided Geophysical Report and considered as rely upon data	100	50%	3	2	6	50	Engineering to review and assess the Company provided Geophysical data. Allow contigency allowance for the residual risk that we may not be able to get paid by Client through Change Order.	35%	50	60	80	3	2	6	21

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										Low	Most Likely	High				
SC-7	**EIA and Environment Monitoring** Costs incurred to complete remedial actions specified by EIA study and the duration of Monitoring Services for Cable Trenching (Silt Screen etc.). These will not be known until study is completed.	60	40%	3	2	6	24	a. Silt Screens required for cable trenching is priced in the estimate. b. Environment Monitoing is priced in the estimate. c. Include for corral survey cost in the estimate. d.Any other remedial actions resulting from EIA study are assumed to be reimbursed by Company.	25%	30	36	48	2	1	2	9
SC-8	**Cable Lay** Re routing of cables in the platform approach	50	30%	3	2	6	15	Allow 2 days extra for JDN vessel for cable re routing	15%	25	30	40	2	1	2	5
SC-9	Onshore Works a.Growth in subcontractors scope which is not transferable to Client as change orders. b.Poor performance by the Onshore Subcontractor results in additional costs for recovery actions. c.Poor standard of office facilities provided by subcontractor which are not in standard of Company and Company.	275	55%	4	4	16	151	a. Ensure that all prices are included in the Lump Sum. b. Ensure clear scope, responsibility matrix, set deliverables and early planning. c.Allow cost for improvement of office facility Allow contigency allowance for the residual risk to step in to offer better office facilities to Client personnel to comply with ITT / poor performance / standby due to local govt. permit / clearences etc.,.	30%	138	165	220	3	3	9	50
SC-10	**Cable Trenching/Post Trenching** a. In the event of Non-compliance with burial and backfill requirement - allow for extra burial and backfill runs. B. Potential increase in Post-Trenching duration and cost due to soil information assumed by SC during the tender stage.	225	40%	3	3	9	90	a.Review trench/burial method with SC prior to work execution to ensure that it will meet the requirement b.Basis of bid will be based on soil data provided as part of bid. (Allow extra 5 days of infield rate in PROM).	25%	113	135	180	2	3	6	34
SC-11	**LQ and Architectural /HVAC** Lack of maturity of FEED for LQS and buildings, coupled with lack of experience in such large 200 plus pax LQs. In addition, large complexity in execution with multiple subcontractors involved as opposed to single modularised approach	550	45%	3	5	15	248	Specific workshop required on this major risk - multiple mitigation strategies required as well as maybe some funding (Allow 2% of TCV in most likely)	30%	275	330	440	2	4	8	99
SC-12	LQ and Archictural/HVAC Schedule interface problems between Company and LQ/Architectural /HVAC Subcontractor.	100	65%	4	2	8	65	Manage the interface and schedule between Company and Subcontractor, provide assistance and support while working in the yard; Define overall responsibility matrix at early stage and robust monitoring and planning of the works.	45%	50	60	80	3	2	6	27
SC-13	LQ and Architectural/HVAC Growth in the LQ/Architectural and HVAC scope of work, i.e. Increase in Building size, additional scope, that will results in cost claims against Company.	225	40%	3	3	9	90	Ensure detailed engineering and pre survey to be done; Risk assosciated with the growth to be included in estimating contingency	25%	113	135	180	2	3	6	34
SUBCONTRACTS Total / Average			**48%**			**10**	**1,400**		**31%**	**-**		**-**			**6**	**540**
FABRICATION																
FA-1	Main Fabrication Yard - Yard Productivity Deterioration in yard productivity due to first of a kind bridge scope	250	55%	4	3	12	138	Hire competent labor	25%	150	175	225	2	3	6	44
FA-2	Yard Congestion - Main Fabrication Yard Deterioration in yard productivity due to Yard congestion This is an enterprise risk	3,060	55%	4	5	20	1683	- Review and monitor the schedule, control the resources for assigned works and forecast the required resources. - forecast labor requirement based on material deliverables and schedule requirement.	25%	1,836	2,142	2,754	2	5	10	536
FA-3	Risk of external storage area - Main Fabrication Yard Concurrent awards of prospective works result in additional external storage area for materials/warehouse in Main Fabrication Yard	2,540	60%	3	5	15	1524	- Efficient usage of yard space and avoid to use warehouse area for fabrication. - Allow contingency in the bid considering package 2 is utilizing warehouse area for assembling structures when material for this bid will be received. Also there could be other awards in the next 2 years.	40%	1,524	1,778	2,286	3	5	15	711
FA-4	Main Fabrication Yard - Risk of renting additional yard equipment including material handling. Risk of renting additional yard equipment/resources (Retro jet equipment, test pumps, bolt tensioning equipment, compressor, hydraulic flushing equipment, crane/Pettibone winches, cranes) due to other project awards.	250	75%	5	3	15	188	- Additional mhrs spending over and above 7M yard cpacity will offset the additional equipment rental cost for project. - Proper planning of all assembly, testing activities in coordination with rigging, pipe shop, precommissioning groups to ensure optimum utilization of existing equipment	50%	150	175	225	3	3	9	88
FA-5	Main Fabrication Yard - Pickling of joints. RFQ sent to subcontracts to be priced or PROM by subcontracts	112	40%	3	2	6	45	Citing example of previous SAF projects convince Client for waiver of pickling of weld joints.	20%	67	78	101	2	2	4	16
FA-6	Main Fabrication Yard - Unavailability of temporary supports (Engineered Supports) Current estimate is based on availability of temps as stand alone bid is considered. There is risk that these temporaries may not be available due to upon concurrent awards of prospective works.	1,600	55%	4	5	20	880	Temps to be reserved from returning barges, surplus material from ex-projects to be reserved & utilized.	35%	960	1,120	1,440	3	5	15	392

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										Low	Most Likely	High				
FA-7	Main Fabrication Yard - Unavailability of Trailer Frames. Current estimate is based on availability of frames as stand alone bid is considered. Frames could not be available upon concurrent awards of prospective works or change to schedule.	750	50%	3	5	15	375	Best utilization of available frames	25%	450	525	675	2	5	10	131
FA-8	**Yard Productivity** Detoriation in yard productivity due to change in schedule or loadout priorities driven by change in installation sequence.	612	60%	4	5	20	367	based on project progress - Main Fabrication Yard to be aware of latest schedule / installation seqence to start fabrication of structures accordingly. Changes to schedule shall be communicated in an timely manner.	25%	367	428	551	2	4	8	107
FA-9	**Yard Productivity -** Deterioration in yard productivity due to Delay in receipt of materials	317	60%	4	4	16	190	Early PO placement & Proactive expediting and Package management.	35%	190	222	285	3	3	9	78
FA-10	**Send yard - Yard Productivity** Deterioration in yard productivity due to Inefficiency of yard labor	125	40%	3	2	6	50	Hire competent labor	10%	75	88	113	2	2	4	9
FA-11	_Valves fail encountered during valve testing	80	50%	3	2	6	40	Ensure all HSE and transportation procedures are followed during valve handling. Valve warranties from valve vendors to be valid.	25%	48	56	72	2	2	4	14
FA-12	Second yard - Delayed release of fabricated related engineering deliverables results in out-of-sequence working, impacting productivity and schedule.	600	60%	4	5	20	360	Engg to ensure timely completion of deliverables as per agreed Project Schedule	30%	360	420	540	3	4	12	126
FA-13	Second yard - Labour union disturbance	2,400	50%	3	5	15	1200	- to be managed	30%	1,440	1,680	2,160	3	5	15	504
FA-14	Second yard - Lack of experience working with client requirement	250	60%	4	3	12	150	- Second yard has substantial fabrication exp. Of execution similar project and has also worked for Client for Jacket project. - Main Fabrication Yard to share exp. From recent projects. - Ensure seamless alignment between Second yard and Project PMT.	30%	150	175	225	3	3	9	53
FA-15	Second yard - Sub Contractor performance on the pre-fabrication activities	600	45%	3	5	15	270	- Supervision and QC inspector assigned for subcontracted prefabrication.	20%	360	420	540	2	4	8	84
FABRICATION Total / Average			**54%**			**14**	**7,459**		**26%**	**-**		**-**			**8**	**2,891**
HSES																
HS-1	Client may require Client approved and certified riggers during offshore execution.	500	45%	3	4	12	225	Get Client to accept Company internal certification as is currently being done in on going projects. Consider cost impact percentage for training shall be captured in estimation	25%	300	350	450	2	4	8	88
HS-2	Project could incur additional cost for PTW receiver training if nominees fails to achieve required passing scores at their first attempt in passing COMPANY required certification.	250	35%	3	3	9	88	PMT to ensure candidates are well prepared prior to examination. Include contingency for personnel failing in the commercial cost.	20%	150	175	225	2	2	4	35
HSES Total / Average			**40%**			**11**	**313**		**23%**	**-**		**-**			**6**	**123**
QAQC																
QA-1	Delay in delivery of CS linepipe for welding qualification test, it may delay the whole procedure qualification process and subsequently affect the pipe lay schedule.	346	40%	3	5	15	138	1. Deliver (via air freight) for first 10 pipes produced to give us better lead time. 2. Allow additional cost and air freight.	20%	208	242	312	2	4	8	48
QA-2	Overrun in vendor inspection cost due to change in vendor selection (Different geographic location) over and above those identified at bid stage.	2,885	60%	4	5	20	1731	1. Utilize in-house inspectors as much as possible suppose to TPI. 2. Synergies vendor inspections with Client other projects, where possible. 3. Evaluate all cost , including inspection, prior to PO finalization/ placement. 4. Allow for additional cost for overrun as contingency based on previous project actuals.	40%	1,731	2,020	2,597	3	5	15	808
QA-3	Availability of PAUT and PMI machine during Offshore Installation/Hook Up campaign (Structural , Piping and Subsea Tie-ins spools Installation)	294	40%	3	3	9	118	1. Inform NDT Department and QAQC Offshore Supervisor on PAUT /PMI machine requirements during offshore campaign. 2. Provide project schedule (Offshore campaign period & duration) to NDT Department and QAQC Offshore Supervisor.	15%	176	206	265	2	3	6	31
QA-4	Client may reject the of previously approved welding procedures (PQRs) due to CSD interpretation of impact test clause for multiple welding process .	120	40%	3	2	6	48	1. Convince Client to allow use of previous approved procedures. 2. Submit all welding procedures well in advance for project specific approval along with copies of previous approvals.	10%	72	84	108	2	2	4	8
QA-5	Simultaneous Pipelay campaign in offshore - Availability of JBBS and AWS equipment allocation.	215	55%	4	3	12	118	Forward Marine barge spread and project schedule to AWS and Welding group to review availabilty of JBBS & equipment allocation.	35%	129	151	194	3	3	9	53

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelihood			Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
										Low	Most Likely	High				
QA-6	Non-compliance to Schedule-Q requirements and not noticed or over looked during the intial stages for any long lead / critical packages, which impacts additional inspection / documentation / schedule impact etc.,	185	40%	3	3	9	74	Due diligence during project for each critical package management - to be elaborated further on the mitigation measure especially Sub-Contractoe scope. Non compliance to Schedule-Q can not be acceptable and hence all necessary QA / Inspection personnel is identified and included in the bid as base cost	20%	111	130	167	2	3	6	26
QA-7	Additional vendor inspection cost due to top up in bulk items and equipment's during Procurement stage.	2,225	40%	3	5	15	890	1.Engineering to ensure that quantities are feezed and adequate contingency are considered prior to issuance P.O. 2. Any change order /top-up / additional quantity shall be identified and finalized before last lot inspection visit to vendors.	20%	1,335	1,558	2,003	2	5	10	312
QAQC Total / Average			45%			12	3,117		23%	-		-			8	1,286
ok-up																
HU-1	Significant Change in Sequence of identified tasks post award due to change in basis in terms of assumptions made on cable pulling operations across platforms / bridges due to change in layout of deck & bridge / installation aids or constructability provisions discussed with Engg during bid period is not implemented due to Client not approving such provisions etc., resulting in significant increase in JUB Spread durations	1,330	40%	3	5	15	532	Continue to monitor the overall schedule and in particular the T&I schedule that will impact the HUC JUB arrival. Between CA and offshore HUC Mob 30 to 36 months lead time is available to come up optimal HUC execution plan. However, allow additional duarion of JUB for residual risk.	20%	798	931	1,197	2	5	10	186
HU-2	Delay in deploying in Key Leads / Support personnel during EPC phase at Main Location / Main Fabrication Yard / Second yard / Sub-Contractoe yards in ensuring Offshore Completions requirements from both documentation and true assessment of level of onshore Completions including bagging / tagging etc., - Ensuring each yard hand-over is accepted / approved by Offshore HUC Manager or its deputees prior to Sail-away.	135	50%	3	3	9	68	- Proper planning and scheduling. - Proper cordination with Sub-Contractoe and Second yard teams - HUC/3COM - PMT personnel to be deployed at Second yard & Sub-Contractoe is already identified included in Base Price and This Mob Plan to be followed up and ensured after contract award.	30%	81	95	122	3	2	6	28
HU-3	Unavailabilty of proposed 3rd party chartered vessels Unavailabilty of proposed JUB at the time of CA resulting in charter of more expensive JUB	6,500	40%	3	5	15	2600	- Identify and source early at execution - Look for long term charter synergy with other ongoing projects. - Mob JUB from Other Regions, if necessary. - Add contingency when selecting an alternate JUB (delta cost of $3000, $5000 and $10000/day and LS MDM to be added). The LS MDM is calculated at 2 days multiplied by the delta vessel day rate. Total 650 days of JUB i/c MDM and IF durations for 4 JUB spreads	20%	3,900	4,550	5,850	2	5	10	910
HU-4	Adverse productivity of offshore activities due to: Congestion and concurrent activities on the bridge Loop tests not progressing at the estimated rate per day	150	45%	3	3	9	68	Proper planning of job prior to execution Have a good relation with POD, provide proper accommodation facilities at offshore site, and request POD to attend loop checks during weekends	25%	90	105	135	2	2	4	26
HU-5	Adverse HU productivity due to hours lost in the day for meals and rest breaks taken by labour to the Jack-up barges parked 0.25 to 0.5km away from the location of work	150	40%	3	3	9	60	Group the workers on JU barges based on the work planned for upcoming activities/days and accommodate them on the nearest JU barge Arange to provide meals and rest room facilities at or near the work locations	25%	90	105	135	2	2	4	26
HU-6	Unavailabilty of proposed Supply vessel Unavailabilty of proposed non-DP workboats at time of CA resulting in charter of more expensive vessels	75	75%	5	2	10	56	- Identify and source early at execution - Look for long term charter synergy with other ongoing projects. - Add contingency when selecting an alternate WB (delta cost of $2000, $3000 and $5000/day and LS MDM to be added). The LS MDM is calculated at 2 days multiplied by the delta vessel day rate. - 3 SBs/CBs considered	45%	45	53	68	3	2	6	24
HU-7	Over run on Vendor Services or Stand-by at Onshore and Offshore Over run on vendor rep. services cost due to interface issues during yard and offshore commissioning activities. Extended durtaions on vendor service related activities due to POD/Proponents unavailability.	125	40%	3	2	6	50	`- Regular coordination and interface with Sub-Contractoe and Second yard fabrication & completion team. - Ensure integrated tests between the packages are planned and interface package vendors are mobilized to mitigate delays/stand-by - Dedicated coordinators shall periodically monitor vendor requirements. - Close coordination with Fabrication and Compleitions team prior to vendor mobilization. - Negotiate LS instead of Day Rate with vendors -	20%	75	88	113	2	2	4	18

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelyhood Low	Most Likely	High	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
HU-8	Delay in Vessel Inspection Standby of HUC spread due to rejection / extensive punch list during Vessel inspection by Client marine at RT.	285	40%	3	4	12	114	- Marine assurance team to carryout vessel inspection prior to charter commitments. - Lumpsum MDM with charterer which includes duration up to Client Marine approval at RT - Allow contingency for Company personnel and equipment standby cost at full spread rate for 1 ,2 and 3 offshore days waiting at port	20%	171	200	257	2	3	6	40
HU-9	Delay in permits of Vessel Crew at Port HUC Third party vessel standby due to vessel crews waiting on permit approval @IK port or vessel crews disapproval delaying the dispatch of vessel to site.	175	35%	3	3	9	61	- Seek early approval from Company, especially for new hires and identify alternative candidates. - Lumpsum MDM with charterer which includes duration up to Client Marine approval at RT	15%	105	123	158	2	2	4	18
HU-10	Additional Company Personnel Rotations Additional cost related to personnel rotation at offshore with respect to safety training, Visa	125	40%	3	2	6	50	Cost included as part of the P&E logistics estimate and with due allowance estimating accuracy. Based on that additional contigency through PROM is not required.	20%	75	88	113	2	2	4	18
HU-11	WDT for JUs Over run on Weather Standby costs incurred during Jackup infield moves and set up.	150	40%	3	3	9	60	- 1.5 days WOW per move is priced in estimate, consider additional .5, 1 and 1.5 days WOW per move to be included in contingency for one each moves per JUB. Working in winter months is inefficient as it results in boats not being able to deliver supplies or personnel. In addition to that, Client will not be able to deliver permits on some days	20%	90	105	135	2	2	4	21
HU-12	Replacement of Temp Equip due to Breakage Replacement cost for breakage and damage of temporary equipment used for testing construction / commissioning	80	65%	4	2	8	52	1- Train yard employees for best methods in handling equipment's. 2- follow safety instructions and avoid shortcuts 3- continues inspecting and maintaining the equipment and verify for any damages	40%	48	56	72	3	2	6	22
HU-13	Unavailability of in-house test equipment Unavailability of in-house test equipment and tools due to parallel projects.	75	40%	3	2	6	30	- Proper planning and reservation of equipment in advance. - $8/mhr is priced in EBS, as per current norms. 9 hr productive shift considered for the total HUC infield duration days. The Total number of direct labour on the vessel is considered.	25%	45	53	68	2	2	4	13
HU-14	Standby due to unavailability of permanent Power supply for energization at offshore Delay in Onshore readiness by other Contractor resulting in Hook-up spread stand-by.	665	40%	3	5	15	266	`- Coordination with other Contractor and COMPANY - Seek for CO from Company if any delay occurs	20%	399	466	599	2	4	8	93
HU-15	Offshore - Poor Productivity of HUC Personnel due to movement of long length of Bridges / Big Platforms with multiple level etc.,	3,000	35%	3	5	15	1050	JUB being set-up at 5 to 6 locations minimizing crew walking during break time. Careful / advance planning of task sheets is necessary that involves work at extreme ends of GOSP4 complex (Flare to LQM) by the same personnel on the same day. Based on careful planning during project and assumptions made in the base estimate on productivity, no additional PROM contingecy is anticipated.	20%	1,800	2,100	2,700	2	5	10	420
HUC Total / Average			**44%**			**10**	**5,117**		**24%**	**-**		**-**			**6**	**1,864**
MARINE																
MA-1	Change in schedule (3.5km Dredging for Pipeline scope caused delays and others) requiring work in adverse weather condition.	500	50%	3	4	12	250	avoid dredging requirement by rerouting the pipeline and obtaininig Client Approval on the new propsed route .	25%	300	350	450	2	4	8	88
MA-2	Risk of SIMPOS for DB32 nearshore works with Dredging spreads resulting in standbys.	1,250	45%	3	5	15	563	Base Case is to avoid dredging requirement by rerouting the pipeline and obtaininig Client Approval on the new propsed route after project award.	25%	750	1,000	1,125	2	5	10	250
MA-3	Restrictions may be imposed for moving anchors at night (DB) during pipelay	475	35%	3	4	12	166	1. Setup Anchors which are in the vicinity of subsea assets during daylight hours. 2. Submit Anchor movements during night time to Rig Move Office daily before 2PM for approval (Anchors which are not in the vicinity of subsea assets) 2. Estimate waiting on daylight (2 days; 0.5day x 4 for 5 crossing locations and a laydown) 3. Not applicable for DB-50 (DP Barge) for the structural scope	20%	285	380	428	2	4	8	76

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelyhood			Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
										Low	Most Likely	High				
MA-4	COMPANY may insist to use FBE external FJC system	125	50%	3	2	6	63	1. Proposal is based on STOPAQ and Engineering confirmed compliance technically. 2. Historically, Company accepted STOPAQ and Project Team needs to seek Company Approval for STOPAQ application upon project award.	25%	75	88	113	2	2	4	22
MA-5	Requirement of coral / seagrass etc relocation from trenching affected zome (For Cable Laying Scope and pipeline scope)	500	55%	4	5	20	275	1. Basis of Bid is to reroute the pipeline to avoid the area with corals clusters and obtain approval of Client upon project award on the newly proposed pipeline route. 2. Any coral relocation for identified corals / seagrass for the cable lay campaign is not in Company Scope of Work	30%	300	400	450	3	4	12	120
MA-6	Damage to the submarine cables, Emergency cut and laydown of a submarine cable due to weather	250	30%	3	3	9	75	1. Cable installation to be planned in a good weather window.	20%	150	175	225	2	3	6	35
MA-7	DB standby due to delay in load out of coated line pipes at Loading Port.	450	45%	3	4	12	203	1. Managed with proper planning. 2. Adequate Pipe haul barges availability for the loadout considering turnaround time.	25%	270	360	405	2	4	8	90
MA-8	Standby of DB/DP Vessels over and above estimated IK inspection days (due to adverse weather condition)	250	40%	3	3	9	100	1. Cost allowed for 3days of DB spread for IK inspection and acceptance 2. Arrange for OOK inspection by third party 3. Delays in inspection (over 72 hours) are reimbursable by Client (Sch. H 15.5.1)	15%	150	175	225	2	3	6	26
MA-9	Leak of pipeline or spools during hydro testing	570	35%	3	5	15	200	1. Follow flange management procedures 2. All gaskets to be free of pitting and properely stored Allow residual risk contingency for 1 event - Low / 2 events - ML / 3 events - High - DSV time @3 days per leak per spool	20%	342	399	513	2	4	8	80
MA-10	Waiting on Permits from Field service	875	35%	3	5	15	306	Basis of bid is we will be reimbursed for any Company caused delays - schedule included in technical proposal and continuous uninterrupted access explained as bid basis in PEP	20%	525	700	788	2	5	10	140
MA-11	Standby of whole spread due to breakdown of one tug.	875	35%	3	5	15	306	1. Junk Barge tow tug will be considered as the fourth contingency tug 2. Adequate spares to be available on all Tugs	25%	525	700	788	2	5	10	175
MA-12	Incur excess weather down time than estimated based on historical information & Fugro data	1,750	40%	3	5	15	700	Estimate currently based on 3 years historical data on WOW. Allow contingency for delta between 3 years and 5 years historical data.	25%	1,050	1,400	1,575	2	5	10	350
MA-13	Debris on pipeline and cable routes (including the route section which has been modified; survey data doesn't cover this area)	375	55%	4	4	16	206	Carry out pre-construction survey and seek change order from Client in the event new debris are identified. - Seek CO for any obstruction removal as per LTA Contract sch. B 13.1.1	25%	225	263	338	2	4	8	66
MA-14	Due to lack of soil data (at Flare / BSP in south West Location and EDP Platform), the selected hammer spread may not suitable to drive the piles to target penetration.	855	60%	4	5	20	513	1. Obtain Company approval on how many sets of Insert Piles to fabricate for Jackets 2. Fabricate Insurance Piles and seek Client confirmation on the number of sets based on the Pile Drivability Studies carried out.	35%	513	684	770	3	5	15	239
MA-15	Congestion at Tanajib port resulting in operational delay	250	40%	3	3	9	100	Early planning and coordination across various spreads and set defined schedules for port calls. Dedicate an interface coordinator to manage this.	25%	150	175	225	2	3	6	44
MA-16	Flare tower installation as a single unit for 95m is not possible by DB 50. Hence as the base case splicing of the tower into 2 sections to be considered.	188	40%	3	3	9	75	1. With the introduction of Splicing of Flare tower, additional scope for Hook up to be considered. DB 50 will lift and set the heavier section by Main hook/Aux hook and the tip portion to be lifted with Whip hook.	20%	113	131	169	2	3	6	26
MARINE Total / Average			43%			13	4,100		24%	-		-			8	1,826
PMT																
PM-1	PMT Manpower / resources for the key positions inengineering office-1 at the beginning of the Project	375	40%	3	4	12	150	Identify the key / critical positions by discipline and by location to send to HR / recruit firms to locate a minimum of 3 to 5 suitable candidates for further short listing prior to Bid Submission / Contract Award to assess the risk or opp.	25%	225	263	338	2	4	8	66
PM-2	PMT Interface with other Marjan offshore / onshore packages and otherClientGovt Depts. Which is a first of kind	250	40%	3	3	9	100	Due diligence required during bid period and to be discussed withClientinformally and raise RFC and insert soft quals	25%	150	175	225	2	4	8	44
PM-3	CoreWorx - implementation for the Entire Project and its impact on Engg as there is not much time after CA as Engg works starts immediately after award.	150	40%	3	3	9	60	Identify the key / critical positions and by location to send to HR / recruit firms to locate a minimum of 3 to 5 suitable candidates for further short listing prior to Bid Submission / Contract Award. Any CAPEX approval required prior to CA or RFQ to be sent to Vendor and Lead Time required for implementation to be identified during bid stage.	25%	90	105	135	2	2	4	26

Function	R/O Event Detailed Description	Un managed Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)	Strategy Detail Description	Probability (%)	Managed Impact likelyhood Low	Most Likely	High	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
PM-4	Employing personnel in PMT at higher rates as a result of: 1) Sourcing the right person for the job and/or upgrading existing personnel based on requirements/merits 2) Sourcing personnel from overheated market as all packages will be awarded simutaneously	250	50%	3	3	9	125	Commence sourcing efforts 3 months prior to CA Try to issue conditional offers and confirmation on Contract Award	30%	150	175	225	3	3	9	53
PM-5	Over run on Package Engineer / Management costs - risk of Management Personnel getting involved in managing the Big Packages (230KV cables / Compressors / GIS / Emerson etc.,)	175	60%	4	3	12	105	Manage with available resources and multiple project assignments during execution. Some part of Estimating Contingency and some in PROM.	35%	105	123	158	3	2	6	43
PM-6	Increase in visa charges/ no of visas/ Travel	700	40%	3	5	15	280	Allow contingency for overruns due to extensive travel requirements for resolution of issues and change orders	25%	420	490	630	2	4	8	123
PMT Total / Average			**45%**			**11**	**820**		**28%**	**-**		**-**			**7**	**354**
CONTRACTUAL & FINANCIAL																
CF-1	Remedy of defects includes wear and tear, or deterioration. Client delay in issuing MCAN will lead to maintenance by Contractor for a period. This will involve additional offshore spread costs and PMT costs for the duration	1,140	40%	3	5	15	456	Synergize punch list clearance with spread mobilized on other ongoing projects. Allow contingency for additional costs for extended maintenance period, & for superfluous punch list remedy	25%	456	570	798	2	5	10	143
CF-2	Contract does not provide for compensation for any Government caused cost increases imposed at any time (any other items not covered by provsions of Fiscal Measures clause in the Contract)	900	50%	3	5	15	450	Continue to monitor changes and raise such matters with COMPANY asap on a proactive basis. For bid purpose this event risk to remain un-priced	30%	540	630	810	3	5	15	189
CF-3	Increase in Bank Guarantee costs incase APG drawdown is not in with the increase in the Retention BG due to delays in invoice approvals, as planned during the bid. Procurement BG costs are higher than envisaged due to material delivery delays.	1,000	30%	3	5	15	300	a. Monitor the BG's closely and reduce APG's to match the increase in RBG's, as planned during the bid. b. Monitor the Procurement deliveries and ensure that the Procurement BG's are released as soon as the material is delivered. c. Invoice materials as soon as they arrive so that the Proc BG's can be drawdown.	20%	500	600	700	2	5	10	120
CF-4	Standby delays are disputed by Client and not reimbursed.	1,140	40%	3	5	15	456	1) Ensure all standbys are notified correctly to Company in accordance with the contract terms 2) Interface with Company, particularly with respect to the drilling schedule, to prevent standbys occurring.	25%	570	684	798	2	5	10	171
CF-5	Curency fluctuation from when we bid vs. project award over and above the flexibility in Price Form / Contract for 4 currencies on top of SAR and US$	6,000	35%	3	5	15	2100	Volatile environment, difficulty in finding viable mitigation strategies. However, we do not anticipate major exposure based on payments in 4 currencies by Client for OOK paymants plus the SAR for IK payments. Relying on this, we will not price any currency risk in the bid. However an assessment will be made prior to the MENA / EXCOM Review on the risks and the same will be highlighted to Mgmt for their Approval.	25%	2,400	3,000	4,800	2	5	10	750
CF-6	Customs duty cost escalation due to legislation changes (either in Saudi or trade wars in China)	500	75%	5	4	20	375	Company applied for duty concession in Saudi - decision pending. Additionally Company to consider qualify bid submission to Client	40%	300	350	450	3	4	12	140
CF-7	PRC VAT applicable on Company Free issued materials to Sub-Contractoe for the 4 big decks and 6 big jackets / piles fabrication HOLD	200	60%	4	3	12	120	Due diligence done during the bid stage to explore the potential risks / mitigation measure by discussing with QMW / Clearing & Forwarding Agencies in PRC. 1. PRC VAT exposure can be mitigated by establishing bonded warehouse with help of C&F Agent in Qingdao for the Project Duration and the necessary cost for that is included in the bid 2. C&F Agents confirmed that this is managable and not a FOAK issue.	25%	120	140	180	2	3	6	35
CF-8	US China Trade War and associated Tarif or regulation changes to materials from China	200	75%	5	3	15	150	Monitor situation. Place order in advance	50%	120	140	180	3	3	9	70
CONTRACTUAL & FINANCIAL Total / Average			**51%**			**15**	**4,407**		**30%**	**-**		**-**			**10**	**1,618**

APPENDIX- III

RISK REGISTER PROJECT-2 (Case Study-2)

							RISK REGISTER - PROJECT 2						
		RISK- UNMANAGED IMPACT					RISK- MITIGATION STRATEGY	RISK- MANAGED IMPACT					
Function	R/O Event Detailed Description	Unmanaged Impact ($000's)	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Strategy Detail Description	managed Impact	Probability (%)	Probability Ranking	Impact Ranking	Impact Score	Contingency ($000's)
		(A)	(B)	(C)	(D)	(C x D)		E	F	(G)	(H)	(G X H)	(E X F)
ENGINEERING													
EG-1	RISK DUE TO DELAY IN MOBILIZATION KEY ENGG STAFF	2,422	40%	3	5	15	Both EG-1 and EG-2 risk can occur standalone or both together. Impact is almost same as listed in PROM item EG-2.	2,180	35%	3	5	15	763
EG-2	Loss of Optimzation opp.. due to lack of suitable expereinced persoonel	8,000	40%	3	5	15	(i) Impact indicated is only for Engg hours & lost opportunity from value engg, other impact to be calcualted. (ii) Delay Engg shall result in issuing of Engg deliverables delay with HOLD resulting in rework in Engg, issuing PO without proper design maturity resulting in cost escalation and fabrication rework.	7,200	35%	3	5	15	2,520
EG-3	CLIENT STANDARD & PROCEDURE AWARNESS: .	354	45%	3	4	12	Price included in Manhours & preivestment cost for training of Second Engg Office / Main Engg Office personnel new recruits and movingClientSpecification Specialists	319	30%	3	4	12	96
EG-4	SUCONTRACTOR's INVOLVEMENT IN ENGINEERNIG:	363	40%	3	4	12	Poor performance by Sub-contractor Engineers due to lack of knowledge ofClientrequirements has been factored by using only 50% of their mhrs as part of the base price estimate.	327	30%	3	4	12	98
EG-5	Work share (scope split) between Second Engg Office and Main Engg Office , interface issues leading to delay in issuing AFC and over run of budget	350	40%	3	4	12	(i) Clear demarcation of scope and transfer work at stage completion (IFA, AFD) rather than percentage	315	35%	3	4	12	110
EG-6	Main Engg Office Capacity: Availability of experienced personnel in required number to perform the work in Main Engg Office due to additional work being transferred from other offices	375	35%	3	4	12	Potential cost impact for not mitigating this risk in included in item EG-1	338	30%	3	4	12	101
EG-7	Non-availability ofClientexperienced resources in Main Engg Office office to deliver required quality meeting projects requirements due to other project commitments	250	75%	5	3	15	Mobalize experience personnel.	225	65%	4	3	12	146
EG-8	AFC deliverables meeting fabrication yard requirements (Battam)/Sub-contractor in terms of completeness and details of information	400	30%	3	4	12	Typical AFC deliverables for Structural, Electrical, Instrument and Piping shared with Sub-contractor/Batam and agreed in principle the level of detailing.	360	25%	2	4	8	90
EG-9	Risk of engineering growth due to unforeseen additional engineering effort or material growth due to complex interface	1,000	60%	4	5	20	Pursue Change Order for any Change from base scope of work	900	50%	3	5	15	450
EG-10	the software considered for 3D modelling is SP3D. Client may reject use of SP3D during execution and as-builts.	250	55%	4	3	12	As contignecy measures to cover for any rejection of the Company proposal to use S3D modelling tool, additional modelling hours for converting SP3D model to PDS shall be considered at Main Engg Office rate.	225	50%	3	3	9	113
EG-11	Inclusion of dropped object protection above transformers or subsea asset (pipeline corridor), not included in FEED design.	450	60%	4	4	16	Any potential impact shall be covered as part of 120days conflict identification period.	405	55%	4	4	16	223
EG-12	Dimensions of Process Interface Buildings (PIB) on platforms could increase during execution	121	45%	3	2	6	considered in the bulk MTO as part of base price estimate.	109	35%	3	2	6	38
EG-13	Delayed vendor data affecting engineering	242	50%	3	3	9	FAB rework cost not included in this item.	218	40%	3	3	9	87
EG-14	Additional design changes to meet HAZOP, HAZID, Safety studies and design review recommendations	650	35%	3	5	15	Price certain percentages (10-20%) of small size valves, piping & fittings and instruments in the impact	585	30%	3	5	15	176
EG-15	As provided in previous projects, normal Insulation is considered for the walls, floor and roof. if Company insist in providing PFP (Intumescent Coating) for walls this will have a huge cost impact and schedule impact.	705	40%	3	5	15	PFP coating is required which shall be considered in the cost as unmanaged impact. For costing assume 5% of coating manhours	635	30%	3	5	15	190

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EG-16	Cable tray, cables and bulks quantities for GOSP4 package is based on preliminary design done by Company as no layout / detail was provided as part of IFB package. During detail engg, the E&I bulk MTO may increase based on design development.	725	40%	3	5	15	Design Growth % for each category of bulks is included in the MTO for material pricing	653	30%	3	5	15	196
EG-17	Material handling requirement provided in IFB package is very generic and does not address the MH requirement for large bore valves (36" and above).	350	30%	3	4	12	Allownace is included in the MTO for material pricing and fabrication / installation mhrs as part of the base price estimate	315	25%	2	4	8	79
EG-18	**230KV Composite Subsea cable burial / trenching** nearshore / landfall section scope defines soil usage of 0.7 KM/W soil thermal resistivity which is not feasible. The limitation in the soil thermal resistivity will lead to higher cable size in landfall portion & increased subsea cable weight.	125	40%	3	2	6	(i) Based on subsea cable high level sizing done as part of bid verification, the issue can be mitigated by increasing the cable size at landfall to 1200mm2 or backfilling the trench with special sand having min 0.8 km/W soil thermal resistivity. (0.7 km/W soil thermal resisitivity is not feasible to achieve)	113	35%	3	2	6	39
EG-19	Integration & Modification for Onshore facilities and other PKGs (2, 3, & 4). Based on Interface matrix PKG #1 scope is considered as providing the required space in systems panels at CCR for other PKG # contractors to modify as required as per the present ITT I/O qty.	250	40%	3	3	9	(i) Based on package 2/3/4 scope, the space required in CCR system panel were verified and found adequate. (ii) However for space required in system cabinet for Onshore scope not verified and considered as per ITT design.	225	35%	3	3	9	79
EG-20	Currently all major 6 jackets are installed by Sub-contractor with ZH30 barge as base option. However during execution phase, if Sub-contractor is unable to secure ZH30, then alternative installation design to be considered.	360	55%	4	4	16	Cost impact to be dialed by PMT based on inputs provided by Engg	324	50%	3	4	12	162
EG-21	As part of bid, Engg has relocated the Electrical Substation # 2 from Aux platform to EDP and all transformer are located in EDP. Client may mandate to follow ITT distribution philosophy of having emergency distribution system away from GCP (high blast impact is expected from GCP compressor failure).	900	30%	3	5	15	cabling impact	810	25%	2	5	10	203
EG-22	Concrete weight coating (CWC) optimzation. The CWC requirement for shallow water section (up to water depth 25m) for cohesive soil is coming very high and it exceed even the ITT specified thickness. Following assumptions made for optimized CWC.	950	30%	3	5	15	This impact covers only material cost. Associated Marine impact for extended lay period is not accounted.	855	25%	2	5	10	214
EG-23	Trunkline re-routing in shallow water patches proposed to avoid trenching for approx.3.4 kms, where water depth is less than 5m. This will require to mobilize a separate dredging/trenching spread. Also a dedicated shallow water lay barge will have to be mobilized just for this short length. In order to avoid these significant costs, it has been identified that the trunklines can be rerouted	800	50%	3	5	15	manage the interface with Package-4 Contractor	720	45%	3	5	15	324
EG-24	Additional cost impact in the event Engineering execution plan is revised during project execution and Enginnering is performed from more than 2 locations	1,750	45%	3	5	15	Difference in cost for: 150,000 m-hrs shifted from Main engineering office	1,575	40%	3	5	15	630
EG-25	Reduction in pipeline wall thickness by removing additional conservatism considered in ITT. Around 2500MT of weight reduced.	750	50%	3	5	15	Have early engagement with Client CSD to get the proposal reviewed and approved.	675	45%	3	5	15	304

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EG-26	**LP Flare Header size** is reduced in Addendum 2 from 10" to 8" with no change in the flow rate. With 8" back pressure is 50 psig and in relation with the compressor seals the 50 psig is much higher than the typical that vendors can handle. In order to reduce back pressure LP Flare Header size needs to increase to 12"	800	40%	3	5	15	During detail engineering, if flowrate is not reduced, then the cost of increasing the LP header from 8" to 12" need to be considered.	720	35%	3	5	15	252
EG-27	**Estimate accuracy & qty variation for piping bulks**	6,000	40%	3	5	15	This risk is over and above the neat MTO, Design Growth Allowance included in the initial stage.	5,400	35%	3	5	15	1,890
EG-28	**ITT Piping Material specification** does not define the **MOC for line size < 6"**	825	50%	3	5	15	As part of pre-award engg, devlope the PMS incoporating all Client bid clarificaiton response.	743	45%	3	5	15	334
EG-29	**The pipe wall thickness for certain pipe sizes** under Piping classare inadequate for the applicable design pressure.	550	40%	3	5	15	As part of pre-award engg, devlope the PMS incoporating all Client bid clarificaiton response. (ii) Post award, approval on PMS shall be obtained from Client during 120 days conflict identification period.	495	25%	2	4	8	124
EG-30	Type of 1st and 2nd stage after coolers (Shell & tube heat exchangers) in Gas Compression platform specified in the ITT is AET (floating head) type. During bid engineering, BEU type heat exchangers which is technically acceptable and meeting the design requirement is proposed as this is commercially attractive. There is a risk that Client may not accept to change the exchanger type or ask for give back.	240	30%	3	3	9	BEU type exchanger is verified for technically suitability for entire operating range by Hauge Engineeirng team and hence the risk for rejection by Client is unlikely.	216	25%	2	3	6	54
EG-31	RISK on Strech MHs Based on project executed by Company in the past, for a complex facility of this nature the average manhours / MT is around 17 hrs. For this bid, average MHrs for major 6 topside is 13.37hrs Risk of overspend of manhours based on earlier benchmarck figures is considered in the PROM.	1,200	35%	3	5	15	(i) Around 350,000 MH (91500MT x 3.63 hrs/MT - i.e. difference between average bench mark hours & calculated average hours) @ $ 52.25 /MH (the average rate of the four centres) is included in risk	960	25%	2	5	10	240
ENGINEERING Total / Average			**43%**			**13**			**36%**			**12**	**10,323**
PROCUREMENT													
PR-1	**Vendor Validity lapsing** prior to PO Placement exposing us to higher price	12,000	55%	4	5	20	Pricing is mostly based on bid specific RFQ / quotes (94%) - Vendors were requested to provide validity	7,200	40%	3	5	15	2,880
PR-2	Shop Capacity Constraints / Upturn in Market is expected for next 2 years especially considering the volume / tonnage requirement of this Project	3,000	40%	3	5	15	We are negotiating bid agreements and this can mitigate some of this risk	1,800	30%	3	5	15	540
PR-3	Delay in supplier deliveries due to Vendor / Shop Capacity Constraints	3,000	40%	3	5	15	With the restricted AVL from Client, some suppliers will have capacity constraints (I.e., compressors and pumps). Pre-bid agreements where necessary to help mitigate some of this risk is done / will be done prior to bid submission.	2,400	35%	3	5	15	840
PR-4	Delays is Delivery Schedule due to late Engineering, late PO placements	3,000	45%	3	5	15	FEED is not matured, expect delays in execution to finalise from FEED to detail design. this event risk under SCM is recommended to be left as "Un-Priced"	1,800	30%	3	5	15	540
PR-5	Material Cost increase due to qty growth	6,000	45%	3	5	15	Engineering has considered specific deisgn allowance for SP Items / Tagged bulks and other bulk materials based on the similar sized deck historicals based on the advice from Engg.	4,800	30%	3	5	15	1,440
PR-6	Delay in the issuance of Engg drawings or the manufacturing cycle of vendors may result in additional costs by way of expediting and air freights	3,510	60%	4	5	20	10 personnel for 4 months for expediting 10,000 Mhrs for additional fab or work arounds, $3m for air freights	2,808	50%	3	5	15	1,404

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PR-7	Supplier warranty periods vs actual warranty periods	1,500	45%	3	5	15	For the residual event risk, develop an estimate to deal with the unlikely event of incurring cost due to warranty expiration and that is included as the High value with reasonable probability.	1,200	40%	3	5	15	480
PR-8	Optimization not Accepted by COMPANY - Pipeline Wall thickness optimization	800	40%	3	5	15	Mateial Price Exposure including the Engg / Supply / subcontract / T&I is covered under the Engg. PROM	640	35%	3	5	15	224
PR-9	Nickel Commodity Escalation	3,000	50%	3	5	15	Commodity price escalations due to constrained supply of Ni; prebid agreements under discussion to negate the commodity price increases	2,400	45%	3	5	15	1,080
PR-10	Steel Commoidty Escalation	15,000	50%	3	5	15	Commodity price escalations due to large volume of orders expected in the market at the time of PO Placement. Strong negotiations to minimise impacts	12,000	40%	3	5	15	4,800
PROCUREMENT Total/ Average			**47%**			**16**		-	**38%**			**15**	**14228**
SUBCONTRACTS													
SC-1	Price validity on subcontracts quotes received	800	40%	3	5	15	Offers received at bidding stage should be valid until end of Dec 2019. After the award, focus on early award of subcontract, wherever potential escalation / non-availability of capacity is anticipated.	720	25%	2	5	10	180
SC-2	Difference in Main Contract and Subcon T's and C's (Like Insurance, Indemnities, Liabilities, warranty, etc)	1,600	45%	3	5	15	Provide the Main Contract T's and C's to the bidders of major subcontract scope; negotiate to the extent commercially possible.	1,440	40%	3	5	15	576
SC-3	Pipe coating plant incapability to handle the delivery schedule due to multiple orders.	240	60%	4	3	12	Consider the use of more than one subcontractors for pipe coating during execution based on the market condition.	216	50%	3	3	9	108
SC-4	**Geophysical Survey** In the event of additional Survey required in case of Client provided Data is insufficient. Note:- Company has provided Geophysical Report and considered as rely upon data	225	50%	3	3	9	Company has provided Geophysical Report and considered as rely upon data	203	45%	3	3	9	91
SC-5	Onshore Works a.Growth in subcontractors scope which is not transferable to Client as change orders. b.Poor performance by the Onshore Subcontractor results in additional costs for recovery actions.	775	65%	4	5	20	Ensure that all prices are included in the Lump Sum.	698	50%	3	5	15	349
SC-6	**Cable Trenching/Post Trenching** Potential increase in Post-Trenching duration and cost due to soil information assumed by SC during the tender stage.	1,025	40%	3	5	15	Review trench/burial method with SC prior to work execution to ensure that it will meet the requirement	923	35%	3	5	15	323
SC-7	**LQ and Architectural /HVAC** Lack of maturity of FEED for LQS and buildings, coupled with lack of experience in such large 200 plus pax LQs. In addition, large complexity in execution with multiple subcontractors involved as opposed to single modularised approach	750	50%	3	5	15	use square meter/ dollar value for architectural work from past projects	675	45%	3	5	15	304
SC-8	LQ and Architectural/HVAC Growth in the LQ/Architectural and HVAC scope of work, i.e. Increase in Building size, additional scope, that will results in cost claims against Company.	350	50%	3	4	12	use square meter/ dollar value for architectural work from past projects	315	45%	3	4	12	142
SUBCONTRACTS Total / Average			**50%**			**14**		-	**42%**			**13**	**2,072**
FABRICATION													
FA-1	Deterioration in yard productivity due to new type of work	250	55%	4	3	12	10% of bridge fabrication MHr cost @ 17 $ per hour	225	45%	3	3	9	101
FA-2	Deterioration in yard productivity due to Yard congestion	3,060	50%	3	5	15	2% of fabrication MHr cost @ 17 $ per hour	2,754	40%	3	5	15	1,102

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FA-3	Concurrent awards of prospective works result in additional external storage area for materials/warehouse in JV Fabrication yard	2,540	60%	4	5	20	• 6 month Storage has been considered for average 10,240 SQM	2,286	55%	4	5	20	1,257
FA-4	Risk of renting additional yard equipment/resources	250	75%	5	3	15	- Additional mhrs spending over and above 7M yard cpacity will offset the additional equipment rental cost for project.	225	65%	4	3	12	146
FA-5	JV Fabrication yard - Unavailability of temporary supports (Engineered Supports) There is risk that these temporaries may not be available due to upon concurrent awards of prospective works.	1,600	55%	4	5	20	25% costed under Fab adder. 35% included under PROM	1,440	50%	3	5	15	720
FA-6	JV Fabrication yard - Unavailability of Trailer Frames. Frames could not be available upon concurrent awards of prospective works or change to schedule.	750	50%	3	5	15	costed considering standalone.	675	40%	3	5	15	270
FA-7	Detoriation in yard productivity due to change in schedule or loadout priorities driven by change in installation sequence.	612	60%	4	5	20	Changes to schedule shall be communicated in an timely manner.	551	55%	4	5	20	303
FA-8	Deterioration in yard productivity due to Delay in receipt of materials	317	60%	4	4	16	Early PO placement & Proactive expediting and Package management.	285	55%	4	4	16	157
FA-9	Deterioration in yard productivity due to Inefficiency of yard labor	125	40%	3	2	6	2% of fabrication MHr cost @ 17 $ per hour	113	30%	3	2	6	34
FA-10	Valves fail encountered during valve testing	80	50%	3	2	6	Valve warranties from valve vendors to be valid.	72	45%	3	2	6	32
FA-11	Delayed release of fabricated related engineering deliverables results in out-of-sequence working, impacting productivity and schedule.	600	60%	4	5	20	Engg to ensure timely completion of deliverables as per agreed Project Schedule	540	55%	4	5	20	297
FA-12	Labour union disturbance	2,400	50%	3	5	15	- to be managed	2,160	25%	2	5	10	540
FA-13	Lack of experience working with client requirement	250	60%	4	3	12	substantial fabrication exp. Of execution similar project	225	55%	4	3	12	124
FA-14	Sub Contractor performance on the pre-fabrication activities	600	45%	3	5	15	- Supervision and QC inspector assigned for subcontracted prefabrication.	540	40%	3	5	15	216
FABRICATION Total / Average			**55%**			**15**		-	**47%**			**14**	**5,299**
HSES													
HS-1	Client may require client approved and certified riggers during offshore execution.	950	50%	3	5	15	Consider cost impact percentage for training shall be captured in estimation	903	45%	3	5	15	406
HS-2	Project could incur additional cost for PTW receiver training if nominees fails to achieve required passing scores at their first attempt in passing COMPANY required certification.	750	45%	3	4	12	PMT to ensure candidates are well prepared prior to examination. Include contingency for personnel failing in the commercial cost.	675	40%	3	4	12	270
HSES Total / Average			**48%**			**14**		-	**43%**			**14**	**676**
QAQC													
QA-1	Overrun in vendor inspection cost due to change in vendor selection (Different geographic location) over and above those identified at bid stage.	2,885	60%	4	5	20	8% of Total Vendor Inspection Cost	2,597	50%	3	5	15	1,298
QA-2	Availability of PAUT and PMI machine during Offshore Installation/Hook Up campaign (Structural , Piping and Subsea Tie-ins spools Installation)	294	40%	3	4	12	2 PMI machine - 55x x 2 = 110k 2 PAUT machine - 92 x 2 = 184k	206	35%	3	3	9	72
QA-3	Client may reject the of previously approved welding procedures (PQRs) due to CSD interpretation of impact test clause for multiple welding process .	120	40%	3	2	6	Assume no. of PQR's $7,500 x 16 = $120K	108	35%	3	2	6	38
QA-4	Additional vendor inspection cost due to top up in bulk items and equipment's during Procurement stage.	2,225	40%	3	5	15	3% of Total Vendor Inspection Cost	2,003	35%	3	5	15	701
QAQC Total / Average			**45%**			**13**		-	**39%**			**11**	**2,109**
Offshore Hook-up													

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HU-1	Significant Change in Sequence of identified tasks due to change in basis in terms of assumptions made on cable pulling operations across platforms	1,330	45%	3	5	15	Continue to monitor the overall schedule and in particular the T&I schedule that will impact the HUC JUB arrival.	1,197	40%	3	5	15	479
HU-2	Unavailabilty of proposed JUB at the time of CA resulting in charter of more expensive JUB	6,500	45%	3	5	15	- Add contingency when selecting an alternate JUB..	5,850	35%	3	5	15	2,048
HU-3	Adverse productivity of offshore activities due to: Congestion and concurrent activities on the bridge Loop tests not progressing at the estimated rate per day	150	50%	3	3	9	cost for 10% productivity on 120 offshore spread days	135	45%	3	3	9	61
HU-4	Adverse HU productivity due to hours lost in the day for meals and rest breaks taken by labour to the Jack-up barges parked 0.25 to 0.5km away from the location of work	150	45%	3	3	9	cost for 8% productivity on 120 offshore spread days	135	35%	3	3	9	47
HU-5	Standby of HUC spread due to rejection / extensive punch list during Vessel inspection byClient marine at RT.	285	50%	3	4	12	- Marine assurance team to carryout vessel inspection prior to charter commitments.	257	40%	3	4	12	103
HU-6	HUC Third party vessel standby due to vessel crews waiting on permit approval	260	45%	3	4	12	- Seek early approval from Company, especially for new hires and identify alternative candidates.	234	40%	3	3	9	94
HU-7	Additional Company Personnel Rotations Additional cost related to personnel rotation at offshore with respect to safety training, Visa	250	50%	3	3	9	Cost included as part of the P&E logistics estimate and with due allowance estimating accuracy.	225	45%	3	2	6	101
HU-8	Over run on Weather Standby costs incurred during Jackup infield moves and set up.	265	45%	3	4	12	cost for 15 HU spread days of lost due to lack of supplies, personnel or permits	239	40%	3	3	9	95
HU-9	Delay in Onshore readiness by other Contractor resulting in Hook-up spread stand-by.	665	45%	3	5	15	`- Coordination with other Contractor and COMPANY	599	40%	3	5	15	239
IU-10	Offshore - Poor Productivity of HUC Personnel due to movement of long length of Bridges / Big Platforms with multiple level etc.,	3,000	45%	3	5	15	JUB being set-up at 5 to 6 locations minimizing crew walking during break time. Careful / advance planning of task sheets is necessary .	2,700	40%	3	5	15	1,080
HUC Total / Average			47%			12		-	40%			11	4,347
MARINE													
MA-1	Change in schedule requiring work in adverse weather condition.	500	50%	3	4	12	avoid dredging requirement by rerouting the pipeline and obtaininig Client Approval on the new propsed route .	450	45%	3	4	12	203
MA-2	Risk of SIMPOS for nearshore works with Dredging spreads resulting in standbys.	1,875	45%	3	5	15	Base Case is to avoid dredging requirement by rerouting the pipeline and obtaininig Client Approval on the new propsed route after project award.	1,688	40%	3	5	15	675
MA-3	Requirement of coral / seagrass etc relocation from trenching affected zome (For Cable Laying Scope and pipeline scope)	500	55%	4	4	16	Any coral relocation for identified corals / seagrass for the cable lay campaign is not in Company Scope of Work	450	45%	3	4	12	203
MA-4	DB standby due to delay in load out of coated line pipes at Loading Port.	450	45%	3	4	12	Adequate Pipe haul barges availability for the loadout considering turnaround time.	405	35%	3	4	12	142
MA-5	Leak of sub-sea pipeline or spools during hydro testing	1,140	40%	3	5	15	Allow residual risk contingency	1,083	35%	3	5	15	379
MA-6	Waiting on Permits from Field service	1,750	35%	3	5	15	Basis of bid is we will be reimbursed for any Company caused delays	1,575	30%	3	5	15	473
MA-7	Standby of whole spread due to breakdown of one tug.	2,250	40%	3	5	15	Junk Barge tow tug will be considered as the fourth contingency tug	2,138	35%	3	5	15	748
MA-8	Incur excess weather down time than estimated based on historical information & Fugro data	2,625	40%	3	5	15	Estimate currently based on 3 years historical data on WOW. Allow contingency for delta between 3 years and 5 years historical data.	2,494	35%	3	5	15	873

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MA-9	Debris on pipeline and cable routes (including the route section which has been modified; survey data doesn't cover this area)	375	55%	4	4	16	Carry out pre-construction survey and seek change order from Client in the event new debris are identified.	338	50%	3	4	12	169
MA-10	Due to lack of soil data the selected hammer spread may not suitable to drive the piles to target penetration.	1,710	60%	4	5	20	Obtain Company approval on how many sets of Insert Piles to fabricate for Jackets	1,539	55%	4	5	20	846
MA-11	Flare tower installation as a single unit for 95m is not possible by DB vessel. Hence as the base case splicing of the tower into 2 sections to be considered.	188	45%	3	3	9	additional scope for Hook up to be considered.	169	40%	3	3	9	68
MARINE Total / Average			46%			15		-	40%			14	4,777
PMT													
PM-1	PMT Manpower / resources for the key positions in Second Engg Office at the beginning of the Project	925	40%	3	5	15	Identify the key / critical positions by discipline and by location	833	35%	3	5	15	291
PM-2	Employing personnel in PMT at higher rates	450	50%	3	4	12	Commence sourcing efforts 3 months in advance	428	45%	3	4	12	192
PM-3	Over run on Package Engineer / Management costs - risk of Management Personnel getting involved in managing the Big Packages	475	60%	4	4	16	Manage with available resources and multiple project assignments during execution. Some part of Estimating Contingency and some in PROM.	451	50%	3	4	12	226
PM-4	Increase in visa charges/ no of visas/ Travel	950	40%	3	5	15	Allow contingency for overruns due to extensive travel requirements for resolution of issues and change orders	903	35%	3	5	15	316
PMT Total / Average			48%			15		-	41%			14	1,025
CONTRACTUAL & FINANCIAL													
CF-1	Contract does not provide for compensation for any Government caused cost increases imposed at any time	1,500	50%	3	5	15	Continue to monitor changes and raise such matters with COMPANY asap on a proactive basis. For bid purpose this event risk to remain un-priced	1,425	45%	3	5	15	641
CF-2	Increase in Bank Guarantee costs incase APG drawdown is not in with the increase in the Retention BG due to delays in invoice approvals, as planned during the bid.	2,000	45%	3	5	15	Monitor the BG's closely and reduce APG's to match the increase in RBG's, as planned during the bid.	1,900	35%	3	5	15	665
CF-3	Standby delays are disputed by Client and not reimbursed.	1,900	45%	3	5	15	Ensure all standbys are notified correctly to Company in accordance with the contract terms	1,805	35%	3	5	15	632
CF-4	Curency fluctuation from when we bid vs. project award over and above the flexibility in Price Form / Contract for 4 currencies on top of SAR and US$	8,000	35%	3	5	15	we do not anticipate major exposure based on payments in 4 currencies	7,600	25%	2	5	10	1,900
CF-5	PRC VAT applicable on Company Free issued materials to Sub-contractor for the 4 big decks and 6 big jackets / piles fabrication HOLD	250	65%	4	3	12	. PRC VAT exposure can be mitigated by establishing bonded warehouse with help of C&F Agent in Qingdao for the Project Duration and the necessary cost for that is included in the bid	225	55%	4	3	12	124
CF-6	US China Trade War and associated Tarif or regulation changes to materials from China	250	75%	5	3	15	Monitor situation. Place order in advance	225	70%	4	3	12	158
CONTRACTUAL & FINANCIAL Total / Average			53%			15		-	44%			13	4,119