



PROJECT RISK MANAGEMENT IN MAJOR OIL & GAS PROJECTS

By

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This is to certify that Mr. Jerry Tom George, a student of MBA (Oil & Gas), SAP ID: 500041839 of UPES will write a dissertation report on "Project Risk Management in Major Oil & Gas Projects" under my supervision.

Further, I certify that the work will be based on the investigations made, data collected and analyzed by him and has not been submitted in any other university or Institution for award of any degree. It will be fully adequate in scope and utility, as a dissertation towards partial fulfillment for the award of Degree of MBA.

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Abstract

The purpose of this project is to study the overall parameters affecting projects' risks and analyze different methodologies of project risk management in order to narrow down and develop a customized methodology applicable for Engineering, Procurement and Construction (EPC) projects in the oil and gas industry.

To approach this goal, Abu Dhabi Gas Industries Limited (GASCO) Plant project was selected as an appropriate case study. This case project has been analyzed by combining various risk management methodologies, and based on this analysis a new methodology was suggested to the company for risk management.

Additionally, necessary changes in the organization have been proposed to handle the project risk issues in different levels with higher performance. The developed methodology can be applicable for other companies involved in EPC projects.

Chapter 1. Introduction

The demand for scientific management in different types of projects is constantly increasing, especially for project base organizations. Risk Management, one of the newest concepts of project management is interesting to focus on because of its advantages and capabilities. Engineering, Procurement and Construction (EPC) projects have become one of the more popular methods of project execution by both clients and contractors.

Utilization of Project Risk Management methodologies, especially in mega-projects or international projects can lead to huge advantages on all aspects of projects' development. It can also be implemented as the main reference and basis for bidding, tendering and execution (including cost, time, resource, and quality management).

By risk identification, assessment and control, probable gaps between estimated and real cost, time, and quality of projects can be prevented or decreased. This approach also provides facilities to predict the final cost and end dates of projects with a greater level of confidence.

While many and various research studies have been undertaken on risk management in several industries, including IT, manufacturing and construction sectors, there appears to be a lack of definitive procedures for oil and gas industry in general.

The currently available project risk management methodologies tend to be generic and their utilization requires that they be adapted and customized for specific applications, especially in industrial procedures with unique and highly specialized instructions. Lack of a certain methodology in a specific industry can bring limitations and needs more efforts to adjust and develop it for a company in a particular industry. This thesis will focus on a typical EPC project as the case study and will attempt to analyze and answer the following question:

- What is the appropriate pattern and project specific customized methodology to manage risks of EPC projects in the oil and gas industry?

1.1 Gap in the present researches and necessity of doing more studies

Based on Haghnevis and Sajedi (2006) various studies and research studies have been undertaken in the field of risk management. As a result, there are several models and methodologies for managing risk. However, no specific model or methodology has been developed to date, which specializes or focuses on an individual industry with its own unique applications, although some companies have developed their own approaches to risk management.

Most commonly used standards and methodologies for risk management cannot be productively applied to all types of projects. Most of the research is general or tend to be too specific and limited (Haghnevis and Sajedi, 2006). Consequently, there is a need for a framework to be developed for EPC projects, with a focused view towards oil and gas industry.

1.1.1 Objectives:

(Consists of scientific and functional objectives including plan for additional research)

The objectives of the thesis are as follows:

- To present a new methodology for project risk management in a particular industry.
- To create background and foundation of further research in this area and lay the groundwork for preparing risk management standards in gas projects.
- To assist project risk management of Abu Dhabi Gas Industries Limited (GASCO), Abu Dhabi.
- To develop an optimal procedure and system for project risk management and interaction with the project management plan.
- To determine the roles of stakeholders in EPC projects (Client, consultant, and suppliers)

1.1.2 Desired applications from establishing this thesis

- The results of the thesis may be applied practically and functionally on oil and gas projects.
- The thesis is capable of developing an accurate and correct basis of evaluation and estimation in these types of projects.
- Utilization of the results of the thesis should be very helpful towards developing better and more realistic bids, tenders and contracts related to oil and gas projects.
- This research is theoretically and potentially a groundwork for developing project risk management models which makes it possible to implement project risk management in the other industries accordingly.
- Since Abu Dhabi is an oil-rich country and has the second highest volume of gas reservoirs in the world (CIA, 2013), several oil and gas and petrochemical projects have been executed in the region. Performing a master thesis in order to develop risk management framework in the oil and gas industry can be effective and resolving.

Chapter 2. Theory and Main Concepts

2.1. Risk

The term “risk” does not have a single unanimous definition. Based on the Oxford English Dictionary risk is “the possibility that something unpleasant will happen” and its origin refers to the Italian words “risco”, “riscare” and “richiare” from the 17th century (Hay-Gibson, 2009, cited in Lemieux, 2010, p.200). In the other hand Althaus states that the term risk has an origin in Portuguese with the meaning of “to dare” (Althaus, 2005; Hay-Gibson, 2009; Lemieux, 2010).

Risk can be theoretically described as any potential deviation from the predefined target with its defined specifications. It is normally linked to terms such as uncertainty, the unknown, and unpredictability. Basically all efforts and movements of people contain risks and uncertainties. Daily life is fraught with dynamic situations involving unknown factors which can have pleasant or unpleasant, and mostly unforeseen and unpredictable consequences (Mulcahy, 2003).

Risk can be defined in different ways:

- Rescher (1983) has defined it as an uncertain situation with potential unwilling consequences.
- “Risk is most commonly conceived as reflecting variation in the distribution of possible outcomes, their likelihoods, and their subjective values” (March & Shapira, 1987, p. 1404).
- In accordance with Williams et al., (1998) Risk is defined as the possible variation in results and can be either positive or negative (upside or downside risk).
- Risk is “the likelihood that it will actually cause harm” (Jeynes, 2002, p.viii)
- Based on ISO/IEC Guide 73(BSI, 2002, p.2) risk is defined as “the combination of the probability of an event and its consequences”. “In some situations, risk arises from the possibility of deviation from the expected outcome or event” but it “is generally used only when there is at least the possibility of negative consequences.”
- Joint Technical Committee OB-007 (Standards Australia/Standards New Zealand, 2009, p.1) defines risk as the “effect of uncertainty on objectives” while “An effect is a deviation from the expected - positive and/or negative. Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process). Risk is often characterized by reference to potential events and consequences or a combination of these. Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.”
- “The quantitative engineering definition of the risk is: Risk = (probability of an accident) x (losses per accident)” (Agrawal, 2009, P.7)

Considering the definitions above, a wide variety of risk descriptions can be found based on the circumstances and applications. These definitions reveal two important aspects of the risk in general; uncertainty and consequences. Therefore the occurrence probability of the risk and the severity of the effects are considered as two major parameters of defining the risk.

All in all, risk is interpreted as a type of unknown event with unpleasant effects, although it can be a pleasant happening with positive consequences which would normally be considered as an opportunity. Risk analysis focuses on both pleasant and unpleasant aspects of the risk.

2.2 Project Risk

Thompson and Perry (1992, p.3) define the project as “a new structure, system or service and also a substantial renovation extension or replacement”. Based on Boyce (2003) a project is a certain type of service which gathers different products together in order to achieve an inclusive solution. From this perspective, projects are generally considered to have greater risk than products. Project risk is categorized separately from financial or technical risks. In accordance with King and O'Connor (2000) project risk is different from hazard, while hazard is defined as “a condition or set of conditions that may lead to an undesirable event, such as an accident, injury, loss or breach of the law.” (King and O'Connor, 2000, p.15)

Risk is involved in the nature of all projects and zero risk projects do not generate attraction to follow due to the fact that facing with risk is a major factor to earn desired benefits in return for ventured resources. Project risk can be considered as threat or opportunity (Chapman & Ward, 2003) which affects time, cost, quality, performance and productivity of the project (Kangari, 1995).

According to the Project Management Body of Knowledge standard, PMBOK® Guide (PMI, 2008, p.275) project risk “is an uncertain event or condition that, if it occurs, has an effect on at least one project objective. A risk may have one or more causes and, if it occurs, it may have one or more impacts”. A cause can be considered as an assumption, condition, constraint, or a requirement that makes the probability of positive or negative results, and project objectives consist of cost, time, resource, scope and quality.

Mulcahy (2003) classifies project risks into dynamic and static categories. Static risks are those who keep their characteristics during the whole project life cycle but dynamic risks can change their occurrence probability and consequences severity in the project time span.

2.3 Project Risk Management

Based on PMBOK® Guide (PMI, 2008, p.273), "Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, and monitoring and control on a project. The objectives of Project Risk Management are to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project."

Thompson and Perry (1992) state that the aim of applying risk management is not to remove all of the risks from the project, but it is to ensure that all risks are managed effectively. From this view point, risk management is considered more than only one single approach to

accomplish projects within defined timeframes and costs. This approach provides many benefits for various types of enterprises. Some examples are, but not limited to:

- The improvement of decision-making methods in order to be less subjective and more systematic.
- Enable the projects to be compared together for sturdiness against particular uncertainties.
- Illustrate the importance of any single risk.
- Provide an advanced image of the project by recognizing the risks and developing response strategies.
- Express the corporation's responsibility to the clients.
- Strongly influence managers by providing an understanding about the variety of probable outcomes of projects.
- Enhance company's track record and successfully executed portfolio of projects.

2.4 Risk in different types of contracts

The results of discussions in 2.3 show that if risk management starts from the early stages of the project, the best probable result will be achieved. Since the awarded contract of each project is the initial factual evidence of the scope of work, it defines and clarifies the project objectives and conditions.

Given to the importance of risk identification along with detailed specification of the contract terms and conditions at an early stage, it would seem practical to analyze and study different types of contracts and the relevant risk level of each individual project.

In order to optimize the strategy to deal with project risks, construction contracts can be differentiated based on two characteristics (Loots, 2007).

1. Payment methods.

2. Duties and responsibilities of the various disciplines of the project.

2.4.1 Fixed price contracts

Based on Burke (1999) Fixed price contracts, also called lump sum, are term contracts with a certain amount of budget. The budget is defined at the starting point of the project and cannot be changed during the project execution. This characteristic is responsible for the risk occurring by adopting this type of contract. The factors of cost and time cannot be modified after they have been established. It should be noted that there may be delays due to lack of information. On the other hand this type of contract can lead – if planned and executed correctly – to a higher earning potential. To narrow down the risks it is essential to plan precisely, to distinguish possible secondary expenditures, and to prepare an accurate schedule.

2.4.2 Reimbursable / Cost-plus contracts

Cost-plus contracts are those that act in accordance with certain rates of work. These fixed rates exist for the working time of different occupational groups and other expenditures. This type of contract is not very vulnerable to risks because it is used to avoid the problem of uncertainty at the beginning of the project. The complexity in projects that are set up as cost-plus is not captured entirely from the start. Therefore it may be advantageous to select this approach of contracting to ensure that the principal can apply for further terms, conditions, and benefits (Burke, 1999).

2.4.3 Cost-plus contracts with a cap

In accordance with Burke (1999) cost-plus contracts with a cap are an extrapolation of the cost-plus contract. The main characteristic of this contract is that the budget is terminated at a certain cost level. The billing proceeds in a similar manner to the cost-plus contract until the expenses reach the maximum limits.

There are two options to consider in the approach to the project execution. The first is ascertaining that the duties and responsibilities end when the budget allocation is reached. The second is that there may be certain agreements regarding the detailed scope of activities to be executed. If these agreements have been negotiated and accepted, it is the responsibility of the executives to cover the additional costs in case the work has not been completed before the transgression of the budget (Burke, 1999).

2.4.4 Turnkey contracts

Turnkey contracts are an extrapolation of fixed-price contracts. However this type of contract has additional capacity since it also covers elements for construction and building. In order to plan these components efficiently, an extensive preliminary analysis is required to clarify the stipulation and the budget. For the principal there are some advantages of choosing this type of contract. First of all the budget is determined at the beginning of the project. Second, the preliminary analysis is cost-effective, and third, the product or service can be supplied rapidly. Including construction phase into the proposal yields a more complex contract and therefore a higher risk potential. It is difficult to calculate the expenditures for designing and construction due to the fact that the deliverable may not be described comprehensively. In addition the agent and the principle can have dissonance about the responsibilities. On the other hand the commitments made by Turnkey contracts often lead to a bigger profit margin due to the early adjustments of the contractual partners (Huse, 2002).

2.4.5 Partnership/Joint Venture

Based on Burke (1999), a Joint Venture is created when two or more parties decide to collaborate and work together. The Joint Venture exists for a certain specified period of time, mostly for the duration of the project. The goal of this partnership is to achieve greater economies of scale. This should be obtained by the parties having a common commitment and sharing resources such as procedures, expenditures, know-how and economic units. There are various partnerships that are built on the idea of guarantee. For Joint Ventures the characteristic of the guarantee is that the different participants hold shares of each other's interest. Partnerships between two or more individuals are called Joint Ventures when they

join together and collaborate for a terminable project. In this case the individuals are named co-ventures.

As mentioned before, Joint Ventures mainly arise for the duration of one particular project but may be a lasting partnership as well. The one-time Joint Venture is known as a consortium or a cooperative agreement. One reason why a particular participant is seeking a partner for a specific project is that the participant company requires resources which the other party can offer. These offers may include proprietary technical knowledge, brand awareness, access to estate and management contracting among others. After the project has been completed, the Joint Venture is normally closed (Burke, 1999).

2.4.6 Build-Operate-Transfer

Build-Operate-Transfer (BOT) is a method to finance projects based on concessions. The concessions are presented by a private or public division to a private business in order to fund and execute the project, and to manage the interpretation of the contract. In this way it is possible for the project owner to cover the expenditures generated by building and operating the project's objective. BOT projects normally run for a longer period of time. Therefore there is a need to make decisions about the contract's contents at an early stage, usually at the beginning of the project (Grimsey & Lewis, 2004).

According to Walker and Smith (2004), there are certain internal and external factors that have an effect on the rate of increase and internal rate of return for the capital spending. The concession given to the private business is for a limited period of time. This duration is called the concession period. During the concession period the executor finances, designs and builds the contract's subject. During this period, ownership of the facility belongs to, and is operated by, the private company. After the expiration of the concession, the ownership of asset/facility/system is transferred to the private or public division responsible for the issue of the initial concession.

The adoption of BOT can, for the most part, be witnessed in projects that require financing since newly built facilities do not normally have revenue support in the early stages. Investors strive to seek out the most suitable company to implement the project and ensure that all consequent risks are transferred to the appropriate parties. It is essential for the project company to find on the one hand other companies with construction or operating expertise and on the other hand, shareholders who have the history of managing these types of projects. The shareholders should ideally be familiar with all aspects of the processes involved, in order to minimize the risk of BOT projects. The public or private company which inherits the facility after concession period has expired will be motivated to retain the shareholders in the company after the transfer, as they have contributed to the success of the project execution to date. Although the operator may have issued assignments to other companies, the purchaser will be interested in retaining the knowledge and expertise of these firms (Delmon, 2008).

Contract Type	Rate of Contractor's Risk	Rate of Client's Risk	Rate of Flexibility against the Changes Applied by the Client	Applications
Cost plus	Low	High	High	Generally this method is used when the project plan has not been accepted. This method will be implemented if the client and contractor have strong relationship and trust level
Partnership	Equal	Equal	Depends on the contract's conditions	Bulky projects, Being specific in different items, and the political necessity of the project
Fixed Price	High	Low	Low	Generally the contractor selects this kind of contract when all aspects of the project are specified. However, most of the time the client selects this method in order to transfer project risk to the contractor.
Unit Rates	High	Low	High	Generally this method is used when project design is not completed before the contract assignment time or is used when it is required to determine a limit for the prices in the bidding.
Turnkey	High	Low	Low	The client does not have sufficient staffing to supervise and manage the project, or when the project involves a specific technology which is not available to everyone.
B.O.T (Build, Operate and Transfer)	High	Low	Low	The client is unable to finance the project- The project applies a specific technology which is not available to everyone.

Figure 1 - Risk comparison in different contracts, adapted from Delmon (2008), Huse (2002), Burke(1999).

2.5 EPC concept

2.5.1 Overview of EPC contracts

According to Loots and Henchie (2007), EPC is a common type of contractual arrangement in the construction industry. In EPC contracts, the contractor is responsible for engineering and designing the project, procurement of all materials, tools and equipment and fabrication or construction of the project, either in house or by subcontracting some work packages or some phases of the project. Sometimes, the contractor transfers the time or cost related risks of the project to the subcontractors within a fixed price or lump sum contract payment.

EPC stands for Engineering Procurement and Construction, but it is not summarized in these three phases and the knowledge of these three items is not enough to implement the EPC project. In fact the combination of these elements and their interactions, consequences and their quadruple and/or mutual influences on each other is more extensive and complicated than a simple collection of engineering, procurement and construction.

For the most part, cost based contracts will transfer risk to the client and price based contract will transfer risk to the contractor (PMI, 2008).

In EPC projects, working with issues such as deadlines, controls, mission statements and submissions combinations, along with delivery (with defined cost, time and quality by considering risks in the domain of each contract), all in all means management, although the management of an EPC contract must be committed for all pre-defined responsibilities (Huse, 2002).

2.5.2 Advantages and disadvantage of EPC contracts

- Advantages and disadvantages from the client's point of view

Advantages:

- a) More security in executive costs
- b) Less human resource requirements, as there is no need for the client to provide links among different contractors.
- c) Better integration

Disadvantages:

- a) Increased costs
- b) Less control on details

- Advantages and disadvantages from the contractor's point of view

Advantages:

- a) More flexibility in implementation
- b) More integration

Disadvantages:

- a) Increased risks

2.5.3 Quality control and supervision in EPC contracts

In the beginning of the 1980s the concept of Total Quality Management (TQM) was introduced and many large scale contractors became aware of the concept. The organizations deploying TQM knowledge have the ability to assess the quality control of the projects implemented by EPC contracts. Since this method limits the client's control over the project and also restricts interference in contractor's issues, it follows that supervision of the client on project progress and assurance of complete compliance with project time schedules, control over the defined qualities, and good performance tests, are performed by the client representative (Ramasamy, 2005).

In EPC contracts, the client's representative has the duty of supervision and project control. Basically responsibility of the client's representative is primarily to provide the required quality assurance services and is also designated to assume the client's authorities and powers. The client's representative should also be qualified and knowledgeable about the project. Therefore, the expertise of engineers who have the necessary background and specialization in the project would be suitable candidates for this position, and could exercise leadership role (Kangari, 1995).

In this regard, the International Federation of Consulting Engineers (FIDIC) believes that along with the general issues that consulting engineers perform i.e., identification, codification of feasibility study and design, supervision of construction, they are in a position to provide additional services. In the draft of new regulation scheme provided by the organization of plan and budgetary affairs, these new duties have been discussed including the supervision of construction, project management, management of construction, project control, cost management, contemplation and task delegation, contract termination, legal affairs, technical training, risk management analysis, along with the evaluation of value engineering and other related issues (Jaeger & Hök, 2010).

2.5.4 Introducing EPC project with risk perspective

Based on Loots and Henchie (2007) projects implemented by the EPC method have special executive characteristics and cannot be generalized. The focal point of these characteristics is targeted towards planning, control and facilitating simultaneous activities, along with maintaining the performance quality. The companies, who have accepted to implement the project in the EPC format, are also committed to perform a series of parallel activities in the framework of project time schedule.

In the EPC method, the engineering, procurement and construction phases will be performed based on a single contract. The approach involves the execution of engineering and procurement activities running concurrently with required at site deliveries timed match the schedule for efficient construction and installation. The management of the EPC project has a prominent role in the successful implementation and delivery of the project; therefore, organizations that have successful track records of management and project control are highly recommended. Basically a successful company should be able to control and manage the engineering and procurement phases in a way that apart from maintaining all mentioned

reference standards in the contract, they have the ability to minimize excess expenses in the procurement phase (Loots and Henchie, 2007).

The supervision is one of the factors contributing to costs and schedule and is minimized in the EPC method; accordingly, it is necessary to completely implement quality assurance mechanisms, gate reviews and hold points in basic design and detailed engineering, construction and installation phases.

The procurement phase is allocated the highest risk in the cost distribution of an EPC project and, as such, it is imperative to ensure accurate and correct collaborations between the engineering and procurement sectors.

In the annual FIDIC conference held in Norway in 1990, Design and Built contracts were discussed and it was agreed that FIDIC should consider this approach for large scale multi-tasking projects; moreover, risk should be partitioned between the contractor and the owner based on the Design & Built contract. It is worth mentioning that recent trends indicate that the word “owner” is often substituted for the word “client”, in order to differentiate from the word “client”. Generally, the term “client” does imply all capabilities in a way that it does not need contractor or consulting sectors; therefore it is recommended not to use this word often (Jaeger & Hök, 2010).

2.5.5 Reason for the demand of EPC contracts in the market

Clearly in this context the first reason for the demand of EPC contracts is the fact that the client or the owner can have a realistic expectation of the final cost and duration of the project. As the penalties and liquidated damages for involved parties in the contract are considerable, the various parties will naturally strive to avoid these additional costs and losing the reputation as well. Consequently EPC schedule tend to be more realistic and adhered to. The EPC contracts should be employed especially when a private enterprise is participating in the project finance.

Another advantage of EPC contracts is to prevent misleading dependability and responsibility. Basically, in EPC contracts all of the responsibilities are assumed by a single party and consequently the contractor is responsible for performance, practicality, technicality, procurement and affectability (Huse, 2002).

2.6 Project risk management implementation in project base organizations

The main goal of this section is to determine responsibilities of risk management in the organization and the project. According to an organization’s hierarchy, the CEO undertakes the responsibility of risk in the company before the board of directors and stakeholders. Figure 8 shows that risk responsibility will be entrusted to project managers to deal with project risks and also will be entrusted to the discipline managers to address the risks of their particular divisions. These managers are responsible for the implementation of risk management plan that consists of identification, analysis, response and methods to control those risks which affect their work scope. Based on the other management techniques, all managers should be confident that all of their team members have an accurate grasp and

understanding of the risks existing in their work scope. Moreover, they should be respondent to the consequences of their action (Burke, 1999).

Sometimes unplanned and unexpected events occur in the project which may cause the company to cease some of its activities for a limited time. Consequently, the company will sustain losses and damages. In these cases, the company requires a disaster recovery plan. The main goal of this plan is, to reduce the consequences of undesired events to an acceptable level. A suitably qualified and experienced manager is appointed with the task of preparing and implementing the plan, as a part of the risk management plan of the company. Therefore, in the case of an unexpected unpleasant event, this plan will be implemented and the operational group will follow and execute the plan in order to mitigate the consequences. (Burke, 1999)

Although it is impossible to concentrate on all risks and decisions in a specific duty unit or project, large companies assign individuals and departments with specialized proficiency to handle risk management in the project and duty units.

The extent and the organization of risk management department depends on the organization size, number of projects, number of departments and the complexity level of activities and projects. However, the risk management department has some dedicated personnel which typically include a risk manager, assistant, and secretary. The risk manager and assistant manager play the roles of facilitator in the risk identification sessions, both in the duty unit and projects (Burke, 1999).

- The position of risk management varies depending on the organizational structure.
- Duty organizational structure: The risk management department is managed independently or may be under the direct supervision of the project management department

Project organizational structure: Establishment of the risk management department in the project organizational structure is possible in three ways as follows:

- A risk management department should be established for every project independently. This condition is beneficial and advantageous for Multi-Functional companies.
- An independent risk management department should be established company wide. The project manager, once appointed, ensures that the risk management process is applied on the project, if deemed necessary.
- The risk management department provides services to each project under the supervision of planning department, as required.

Organizational structure matrix: Establishment of the risk management department in the matrix organizational structure is possible in two ways as follows:

- An independent risk management department should be established throughout the company. The project manager ensures that the risk management process is applied on the project, as required.

- The risk management department provides services to each project under the supervision of planning department, if deemed necessary.

If the scope of the project is very extensive or the type of contract warrants, an independent risk management department will be established. For example, in an oil and gas project management company intending to invest in an oil and gas project (BOT type), it is possible to establish the risk management department under the supervision of the investment department of the company, and if required, provide risk management services to the other projects within the company.

Some organizations prefer to use consultant companies instead of establishing an in-house risk management department. This depends on the size and complexity of the project and the rate of company's familiarity with the risk management process (Walker & Smith 1995).

2.7 Risk Management Models and Methodologies

In order to end up with an optimum model of risk management in EPC projects for oil and gas industry, it is useful to analyze and compare different methodologies and models for risk management. Although there are plenty of applicable models, the main focus is normally on the most popular models used by the construction industry (Haghnevis and Sajedi, 2006):

Table 1 – Risk Models - Adapted from Haghnevis and Sajedi,(2006)

Model	Year	Description
Boehm	1991	Identification, analysis, prioritizing, risk management control, risk resolution, risk monitoring planning, tracking, corrective action
Fairley	1994	Identification of risk factors, assess risk probabilities and effects, develop strategies to mitigate identified risks, monitor risk factor, invoke a contingency plan, manage the crisis, crisis recovery
SEI (Software Engineering Institute)	1996	Identification, analysis, response planning, tracking, control
Kliem & Ludin	1997	Identification, analysis, control, reporting
SHAMPU (Shape, Harness and Manage Project Uncertainty)	1997	Define, focus, identify, structure, ownership, estimate, evaluate, plan, manage
PRAM (Project risk analysis and management)	1997	Define, focus, assess, planning, management
Leach	2000	Identify potential risk events, estimate the risk probability, estimate the risk impact, identify potential risk triggers, analyze risks, prevent risk event, plan for mitigation, insure against risk, monitor for risk triggers
IRM/AIRMIC/ALARM (The Institute of Risk Management/The Association of Insurance and Risk Management/The National Forum for Risk Management in Public Sector)	2002	Strategic objective, assessment, reporting, decision, response, reporting, monitoring
Smith & Merritt	2002	Identification, analysis, prioritizing & mapping, response, monitoring
PMBOK(Project Management Body of Knowledge)	2003	Risk management planning, risk identification, qualitative & quantitative, risk response planning, risk monitoring & control
PRMA(The Project Risk Management Approach)	2004	Establish context, identify risks, analyze risks, evaluate risk, response risks, review & monitoring, communication with consultants

2.7.1 PMBOK Methodology

This model is the most frequently used method in project management as defined by the Project Management Institute (PMI). Based on PMBOK® Guide (PMI, 2008), project risk management is a process which consists of six iterative processes below:

1. Risk Management Planning
2. Risk Identification
3. Qualitative Risk Analysis
4. Quantitative Risk Analysis
5. Risk Response Planning
6. Risk Monitoring and Control

This model is built up based on input-process-output structure, and has the intention to utilize certain inputs, various tools and techniques, and defined outputs, in each step of the risk management process.

This model is registered as an ANSI standard (The American National Standards Institute) and applied internationally.

2.7.2 PRINCE2 Model

As defined by Cabinet Office (2012), PRINCE2 stands for PProjects IN Controlled Environments, which is a de facto standard adopted and utilized widely by the UK government and is extensively accepted and employed in the private sector globally. It is a non-proprietary process-based method for project management and is recognized as the best practice in project management application in the public domain.

At 1989 this methodology was primarily established by The Central Computer and Telecommunications Agency (CCTA). It was initially intended to be applied as a UK Government standard for managing information technology projects however, after the release in 1996 as a generic project management model, it became globally recognized and accepted. As it is stated in PRINCE2 (2002), this standard describes how to divide a project into smaller manageable parts in order to control the resources and work progress effectively. In this model risk management is defined in two parts and six steps as below:

Risk analysis:

- Risk identification
- Risk evaluation
- Risk response
- Selection
- Risk management:
- Planning and resource assignment
- Tracking and reporting

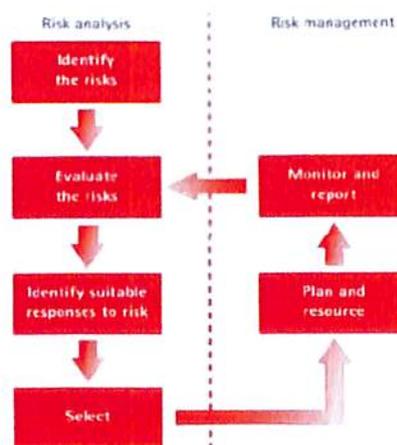


Figure 2 - The risk management cycle (PRINCE2, 2002, p.241)

2.7.3 SHAMPU Model

In accordance with Chapman & Ward (2003), SHAMPU is the acronym in the project management process framework, which stands for: Shape, Harness, And Manage Project Uncertainty. Regarding the level of details, this methodology can be presented in three forms. The simplest has three phases and the detailed process involves nine phases. Shaping the project strategy is the first step to be considered in the strategic level of efforts towards the project uncertainty in order to catch productivity. Harnessing the plan is carried out by developing a productive risk plan at a tactical level in order to harness the uncertainty outlined at a strategic level. Managing the implementation is considered in four aspects; the planned work management, the action plan development, monitoring and control and crisis dealing.

2.7.4 Chapman & Ward’s Methodology

Based on Chapman & Ward (2003), the effective risk management model should underline specific sources of uncertainty on the structure of the project life cycle, and consists of phases and stages as follow: Conceptualization (Conceptive), Planning (design, plan, allocate), execution (execute), Termination (deliver, review, support). The stages should be considered in more detailed levels called “steps”, which should be defined based on the nature of the product or service deliverable.

2.7.5 Dale Cooper’s Model

Cooper et al. (2005, p.15) defines the project risk management approach as below:

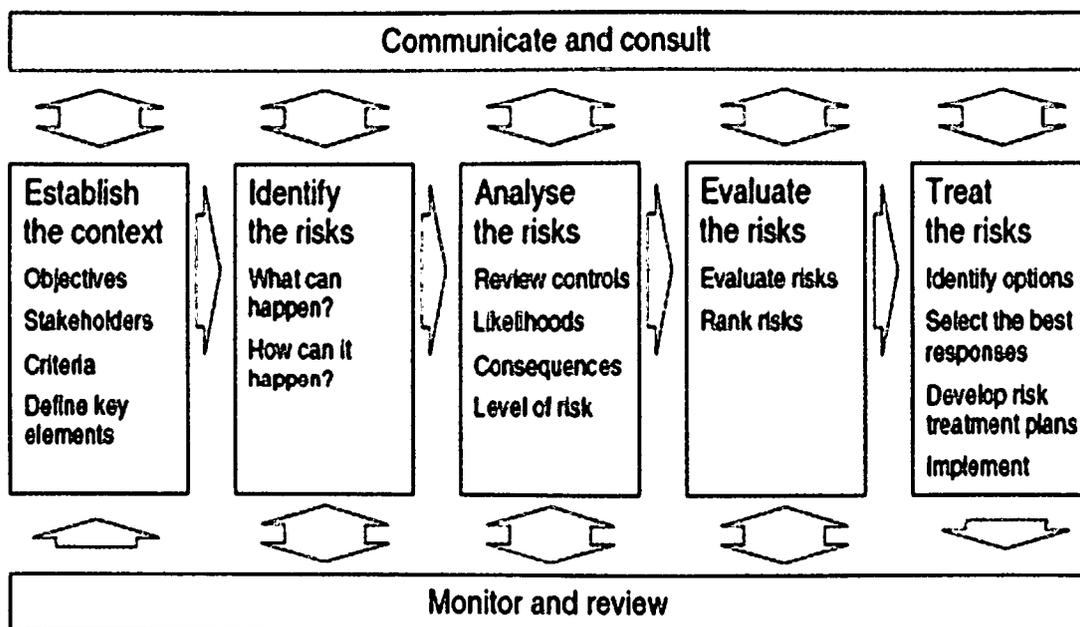


Figure 3 - The project risk management process (Cooper et al., 2005, p.15)

The project manager should prepare appropriate responses for typical questions at each step of the project risk management process, as defined below (Cooper et al., 2005, p.15):

Risk management process step	Management question
Establish the context	What are we trying to achieve?
Identify the risks	What might happen?
Analyze the risks	What might that mean for the project's key criteria?
Evaluate the risks	What are the most important things?
Treat the risks	What are we going to do about them?
Monitor and review	How do we keep the risks under control?
Communicate and consult	Who should be involved in the process?

Table 2 - Questions for the project manager (Cooper et al., 2005, p.15)

2.7.6 Weaknesses analysis of current risk management models

The reference models alluded to, can be categorized into two general groups:

Group A: These models specifically deal with risk management subjects, refer to the details of the processes, and provide different case studies and solutions, such as Cooper's Model.

Group B: These models are parts or subsets of project management models and processes. As a result, they do not go into detailed description and analysis of the risk management processes; rather, their purpose is to describe the general and overall processes of risk management. They do not normally refer to complete details of the risk management process.

Analyzing weaknesses of risk management models, leads to the outcomes as listed below:

- Most of these models have introduced the first step of risk management as "Risk Identification"
- None of these models relate to a specific industry. They are all generic models as opposed to being industry customized and tailor made.
- There are no sample formats, nor patterns or examples introduced in them, except for PRINCE2 and Cooper's model which use risk classification patterns and samples.
- None of them introduce a pattern for risk management in a specific project type.
- The models do not use PERT or GERT methods nor project management and project risk management softwares.

Mentioned methods are mostly presented in standard and modeling levels and do not analyze details or do not provide instructions or tools for detailed usage. Although the nature of models and standards is to cope with principles and general processes, and one cannot question them for this matter, it is obvious that these models are sometimes difficult to be adopted for use by experts and managers of a specific industry. This results in less

performance, productivity while implementation and consequently poor implementation. A trend of, defining and creating practical methods for risk management in different industries is recently emerging and being developed (as in the project risk management methodology of Sasol South Africa, Statoil, Michigan oil and gas), however in Abu Dhabi there is no national or specific methodology for risk management in specified industries. This encourages further development.

Chapter 3. Methodology and Research Design

Selection of the factual kind of research methodology is beneficial for directing a prosperous case study. Since this thesis is focused on analyzing different methods of risk management mainly PMBOK, PRINCE2, Cooper, and aims to develop a methodology of risk management in EPC projects, particularly in oil and gas industry, a qualitative research methodology has been chosen as the adequate approach to perform our research. Considering that the purpose of this thesis is the development of a methodology for risk management in EPC projects, various oil and gas companies in Sweden and Norway were contacted regarding our interest towards methodology development on project risk management. As a result of lack of responses, it has been decided to select an on-going Abu Dhabi EPC oil and gas project called “Abu Dhabi Gas Industries Limited (GASCO) Gas Treating Plant” as a case study. The authors of this thesis had previous job experience on both main office and construction site of the project.

According to Ghauri and Gronhaug (2005), the pivotal fact of qualitative research methodology is to accumulate awareness, visions and perceptions and to create theory. With the application of this methodology it is possible to accumulate awareness and shape theoretical clarification in order to approach our research challenges.

In accordance with Bryman and Bell (2007) qualitative research is a methodology that mainly gives priority to words instead of calculations and it focuses on the association among theoretical framework and research. This thesis has been conducted with material mainly obtained from the project and the communications we had with the individuals working there. This method of data gathering for research from organizations and individuals has been supported by Eriksson and Kovalainen (2008) who have stated that most researchers using qualitative research methodology concentrate on companies and individuals as sources of data.

3.1 Scheme of Research

The strategy and design of a research is generally part of a research scheme. The overall view of the research is provided by the research strategy for instance, if the research is intended to clarify a problem or if it is focused on finding an answer and providing recommendations. The research strategy also assists in labeling the concentration of the study. On the other hand research design delivers a general plan and approach to gather information. Philliber et al. (1980) state that research design provides guidelines of the research. It also provides responses and solutions to areas of research questions, appropriate information, and method of collecting and analyzing the contents.

One of the main focuses of this thesis is to direct an investigative research and to concentrate on a specific case study, with the aim of creating a tailor maid methodology which can be implemented in similar projects, particularly in the oil and gas industry and in EPC projects.

3.2 Data Gathering

We have utilized two different steps for data gathering, one for theoretical framework, and the other for the empirical work.

5.1 Data gathering for theoretical framework

In order to acquire an understanding of the subject of risk management, various books have been studied. To obtain an extended understanding of this field, scientific articles from the databases Emerald and Business Source Premiere have also been studied. First the result of the literature review concerning the risk, risk management, general procedures and related topics is presented. This is followed by comparison of different methodologies of risk and the process of data gathering is presenting in the step below.

5.2 Data gathering for empirical work

Among the different possibilities, the appropriate method for our thesis was the case study, mentioned previously. According to Ghauri and Gronhaug (2005) a case study is an explanation of controlling and managing circumstances including information gathering from several sources.

In this thesis we used various ways to gather information. Our primary source was interviews with the project team, personal experience in similar projects, organizations web pages, different reports and documents from the organization. Using the advantage of prior job experience in the project and knowing the staff, conducting informal conversations provided us with a broader idea of the challenges and possible solutions.

Other research methods use a broader focus, which leads to a less in depth analysis of problems. In our case, since we used case study research method, it focuses on one specific concern or problem and then analyzes it in depth. To strengthen the statement above, Kothari (2004) indicates the identical approach in his article by characterizing this process of study which uses depth rather than breadth. By using our earlier knowledge and existing theories, data gathering was carried out very cautiously and its assessment was carefully examined.

According to Bechhofer and Paterson (2000), data collection by interview is a method that requires communication. Various types of interviews exist, with their advantages and disadvantages. This places the responsibility on the researcher to decide whether an interview is the proper way to collect information. The reason for selecting the interview method as our research procedure is our accessibility to the top management of project organization as a result of our previous work and also as it is a practical way to gather useful information from the appropriate personnel. Similarly Eriksson and Kovalainen (2008) stress the fact that mutual motivations of interview usage in various researches is that they are well-organized, capable, real and practical techniques to gather data that are not easily accessible in articles and books.

Two possible interview techniques were useful for our research, namely the semi-structured interview and the structured interview. From those two techniques, we selected the semi-structured interview model which provided the possibility and sufficient freedom to gather more data that led us to produce a solution to our research problem. It is very important that the respondents are comfortable with the questions and the interviewer, and in this regard, we decided to conduct the interviews in the Arabic language. This led to comprehensive responses in a friendly atmosphere. Philliber et al. (1980), states that it is essential to have a

pleasant and approachable manner during the interview. They also stress the fact that the use of acquainted language helps respondents relax.

The aim of conducting the interviews was to create a database from opinions of those experts involved in the oil and gas industry of Abu Dhabi and of the GASCO gas treating plant project. The goal was to build a basis for further analysis regarding risk situations within the project and the industry as a whole, along with effective risk organization, methodology development, lessons learned and their related experiences.

Thirteen managers among Abu Dhabi Gas Industries Limited (GASCO) staff were selected for Interviews. They belong to different managerial levels, some are located at main office (Abu Dhabi) and some are site residents (Abu Dhabi). Since this was authors' previous working environment, and the respondents were familiar with the interviewer, interviews booked easily and approximately one hour was allocated to each interview. Interview questions handed in a few days in advance to get better results. During the interviews short notes were kept for later analysis. Appendix A and B contain the list of interview questions and interviewed personnel.

Furthermore, the process triangulation technique was selected as a suitable approach for comparison of the gathered information. Triangulation is a significant technique for comparison and complementary evaluation of same situation in various versions (Altrichter et al. 2008). Information gathered from various methods mentioned above including web pages, interviews, and organization reports, enhanced trustworthiness and consistency of the information.

Appendix A and B contain the list of interview questions and interviewed personnel.

3.3 Data Analysis

When all of the data is collected, the final and essential step is data analysis. It involves treating, managing, and analyzing of all information gathered in previous phases particularly in data collection. In most cases of qualitative research methodology, the information gathered is in words which create complications for a researcher. According to Miles and Huberman (1994) information gathered through qualitative research is amorphous and bulky considering the fact that it usually consists of texts. It follows that the main responsibility falls on the researcher to evaluate the collected data and present it in an appropriate manner.

Chapter 4. Findings and Analysis

4.1 Case Description

Project name: Abu Dhabi Gas Industries Limited (GASCO) Gas Treating Plant

Client: Abu Dhabi National Oil Company (ADNOC)

Location: Habshan, South West of Abu Dhabi

Contract price: 3.3 Billion USD

Duration of work: 43 months

Project description:

EPC phases of the Gas Treating Plant with capacity of 56 MMM³/d (million cubic meters per day) of gas processing for production of C1, C2, Naphtha, and Liquefied Petroleum Gas (LPG) and also pipelines facilities. The project is on turnkey basis.

Scope of work:

- Review of engineering and necessary amendments for the new gas feed.
- Procurement.
- Construction of civil, mechanical, electrical, instrumentation, control room (DCS – Distributed Control System) and switch room.
- Commissioning and start-up.

Target Production:

- Naphtha 450,000 tons/year
- LPG 1,650,000 tons/year
- C2 1,650,000 tons/year
- C1 45 mm m³/day

Facilities Comprising:

- Slug Catcher
- High Pressure (HP) Separator
- Acid Gas Removal
- Gas Dehydration
- Gas Refrigeration
- Natural Gas Liquids (NGL) Fractionation
- C3/C4 Treaters

- Liquefied Petroleum Gas (LPG) Tanks, Sulphur Recovery and Tanks
- Condensate Stabilizer and Storages
- Sour Water Separator

Further description:

The Abu Dhabi Gas Industries Limited (GASCO) Gas Treating Plant is located at Habshan, South West of Abu Dhabi, close to the Arabian Gulf. The feed gas of the plant will be 2,000,000,000 cubic foot per day (1,700 Million cubic foot sour gas plus 300 Million cubic foot sweet gas per day) which is supplied by pipelines from four NGL plants called NGL-900-1000-1200-1300 near Ruwais city. The plant's final products will be various gases such as ethane, butane, propane and sweet gas for home usage. These products will be transported to Ruwais Port in Arabian Gulf via pipelines.

The primary contract was signed in June 2005 between ADNOC (the client) and a consortium of four engineering and construction companies: Costain (UK), Dragados (Spain), Technip (Abu Dhabi), and Technimont (Abu Dhabi), with the registration number of 7942. The first adjustment of the contract was signed in Jan 2007 between the client and the Technip-Technimont consortium, due to the fact that Costain and Dragados left the project. Early work agreement of the project was signed in Sep 2007 and SNC Lavalin (Canada), Prosernat (Malaysia) and WorleyParsons (Abu Dhabi) commenced the Front End Engineering Design (FEED). Rough grading of the plant was assigned to the consortium as a variation order of 27,302,992 American dollars and the effective date of the contract was on Dec 1th 2007.

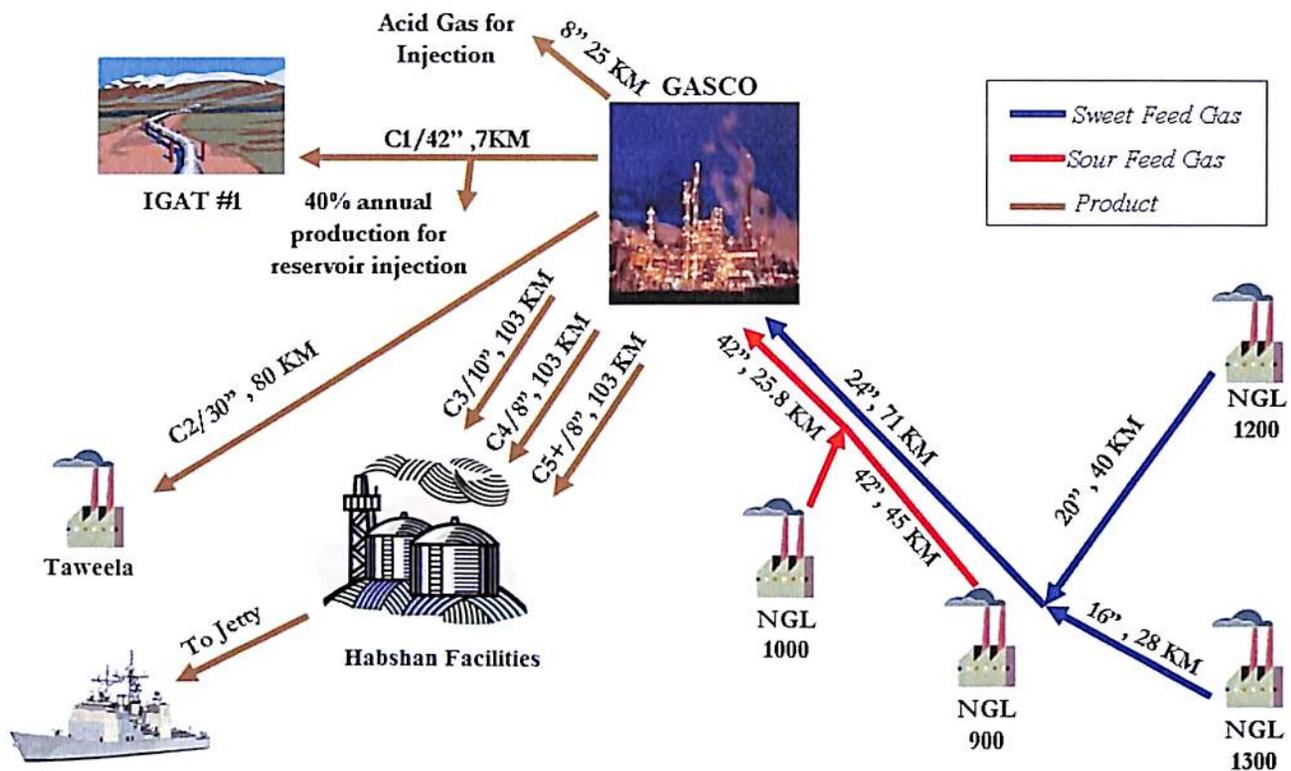


Figure 4 - Feed and Products Pipeline Block Diagram

The project consists of three parts, referred to as the packages: A, B and C.

Package A: Gas Treating Plant

Package A includes a gas treating plant which is awarded to Technip-Technimont consortiums.

Package B: Habshan pipelines and facilities

Package B includes Habshan pipelines and facilities which is awarded to Abu Dhabi CBI consortium.

Package C: Infrastructures

Package C consists of various components including: Electrical supply, water supply, non-industrial buildings, access roads, residential building, communication system and jetty.

All contractors are supervised and managed by the EIED Company who has been assigned the role of direct representative of the client.

4.2 Risk management and insurance in oil and gas and petrochemical industry

The insurance industry as an economic subsection is responsible for accumulation of the capital and to increase excitability of production factors most effectively in order to reduce the risk costs of the economic activities. At the present time, the insurance industry of name country is not able to respond to demands for liability coverage, especially in the energy, transport, industries and mining sections. Consequently, it is unable to effectively participate in the existing economic climate (BIH, 2006).

Fossil energies are among the main sources of energy supply for human life and it does not appear that present situation will evolve significantly in the near future. This further emphasizes the importance of the oil and gas industry for Abu Dhabi as the main source of income. Production processes in the oil and gas industries consist of long lead time and various phases including exploration, transport, refining, petrochemical and transportation to domestic and foreign consumption markets and distribution. Oil and gas production processes involve many risks including economic, social, technical, technological risks and hazards and also risks related to natural disasters. These risks highlight the requirement for insurance coverage (BIH, 2006).

Specific risks include:

- Severe dependency of various aspects of social and economic life of the communities on the oil and gas industry.
- Economic sanctions.
- Great gap between consumers and producers in this area.
- Contracts related to these industries are long term and are usually longer than the tenure of states and governments.
- Non-payment and violation of contract.
- Risk raising nature of the consuming raw materials and production processes.
- Technical complexity and high technology used in this industry.
- Even though Abu Dhabi is one of the significant exploration, mining, transport, refining and oil and gas exports centers capable of production and distribution of the related products throughout internationally, the extent and scope of operations seems unrelated.

While nearly 27 percent of Gross Domestic Product (GDP) is related to the oil group, only 3 percent of the portfolio of the insurance industry of Abu Dhabi is devoted to oil and energy. Meanwhile, the risks of oil and gas production and distribution scope are among the high risks (BIH, 2006). Therefore, due to considerable diversity and extent of risks in this area, would suggest that its share of the insurance industry portfolio should be much higher.

The development of a stable and efficient insurance industry in the oil and gas sector and creation of sound economic policies including import and export requires more interaction and cooperation between the insurance industry and the oil and gas industry. In this regard, the major players in the oil and gas sector should support and encourage the domestic insurance. The domestic insurance industry is striving to increase its financial and technical capabilities and competitiveness with foreign insurers. They have been able to reduce their international and domestic risk transfer ratio for liability coverage in the oil and gas industry from 21% in 2004 to 7.16% in 2006 (BIH, 2006).

4.3 Mutual cooperation between two industries

More than two decades have passed since the last major investment crisis in oil, gas and petrochemical industries in 1990. In the middle of that decade, oil prices dropped sharply and supply exceeded demand. From 1986 to 1996, Organization of the Petroleum Exporting Countries (OPEC)'s efforts to peg price and production quotas failed. Consequently in 1997 oil prices dipped to below \$10 a barrel. This was the result of inconsistent strategies at competitive prices between oil companies and oil producing countries to supply oil (BIH, 2006).

Investment in oil requires huge investment capital and highly developed technology. Foreign investors mostly from developed countries are not willing to seed projects without some assurance of steady supply and a measure of political stability. The insurance industry role should be to protect major investments from losses due to economic, human, political and natural disasters origin by offering various insurance covers. Insurers need to compensate damages occurring in the exploration, mining, technology and supply risks steps resulting from explosions, fires, earthquakes, contractors, equipment and machinery installation in addition to large economic investment, the oil industry requires advanced technology. To use this technology, the provision of professional and skilled manpower is inevitable (BIH, 2006).

4.4 Overall risks of oil gas projects at a glance

A broader view of risks in oil and gas projects is summarized in the table below. This table is adapted from Mulcahy (2003) which alludes to general risks of the projects and consists of data gathered from the oil and gas industry of Abu Dhabi.

Risk	Strategies to deal with the Risks
A- Development and Procurement Risks	
1- Not win the bidding	<ul style="list-style-type: none"> -Accurate Evaluation of bid documents -Clear process of bidding and elimination of bureaucratic structure
2-Not obtain Licenses	<ul style="list-style-type: none"> -Select a clear strategy for granting licenses by the government -Anticipate responsibilities of parties explicitly -Determine accurate scheduling to obtain licenses
3- winner bid price is high	<ul style="list-style-type: none"> -Select an experienced technical, financial and legal consultant -Hold bidding as an international competitive bidding or as a combination of competitive negotiation and bidding along with process of determining eligibility of bidders -select accurately and clearly the evaluation criteria of the recommended prices and determine weight and importance of these criteria
B- Construction and Completion Risks	
1- Project has not been completed	-Commitment to prepare financial resources by the project sponsors , under the financial supplementary agreement
2-Delay in completion	<ul style="list-style-type: none"> -Sign turnkey contract while the date of project completion is specified -Employ experienced contractors with good track records

	<ul style="list-style-type: none"> -Impose financial damages in case of delay and pay early completion bonuses
	<ul style="list-style-type: none"> -Supervision of construction agreement
	<ul style="list-style-type: none"> -Constructive contractor will share with the stocks of the project company
	<ul style="list-style-type: none"> -use familiar method and technology
	<ul style="list-style-type: none"> -Guarantee the operation of the contractor by a reputable financial institute
3-Cost increase	<ul style="list-style-type: none"> -Sign contract according to the fixed-price method
	<ul style="list-style-type: none"> -Establish certain level of investment in the form of stock
	<ul style="list-style-type: none"> -Stakeholders commitment to maintain the stocks until the completion of construction operation
	<ul style="list-style-type: none"> -Observe a minimum ratio of Debt/Equity (loan to stock) in a specified limit
	<ul style="list-style-type: none"> -Monitor and inspect construction stages
	<ul style="list-style-type: none"> -Control financial process of construction operation
	<ul style="list-style-type: none"> -Consider contingency credits
4- Quantitative and qualitative criteria have not been observed during building process	<ul style="list-style-type: none"> -Monitor and inspect construction operation
	<ul style="list-style-type: none"> -Impose fines and pay compensation by the constructive contractor
5- Site accessibility	<ul style="list-style-type: none"> -The agreement of using the land

Table 3: General risks of projects in oil & gas industry

4.5 Introducing Risk Management Model for EPC projects

Principle steps of Risk Management Methodology through Oil and Gas EPC projects.

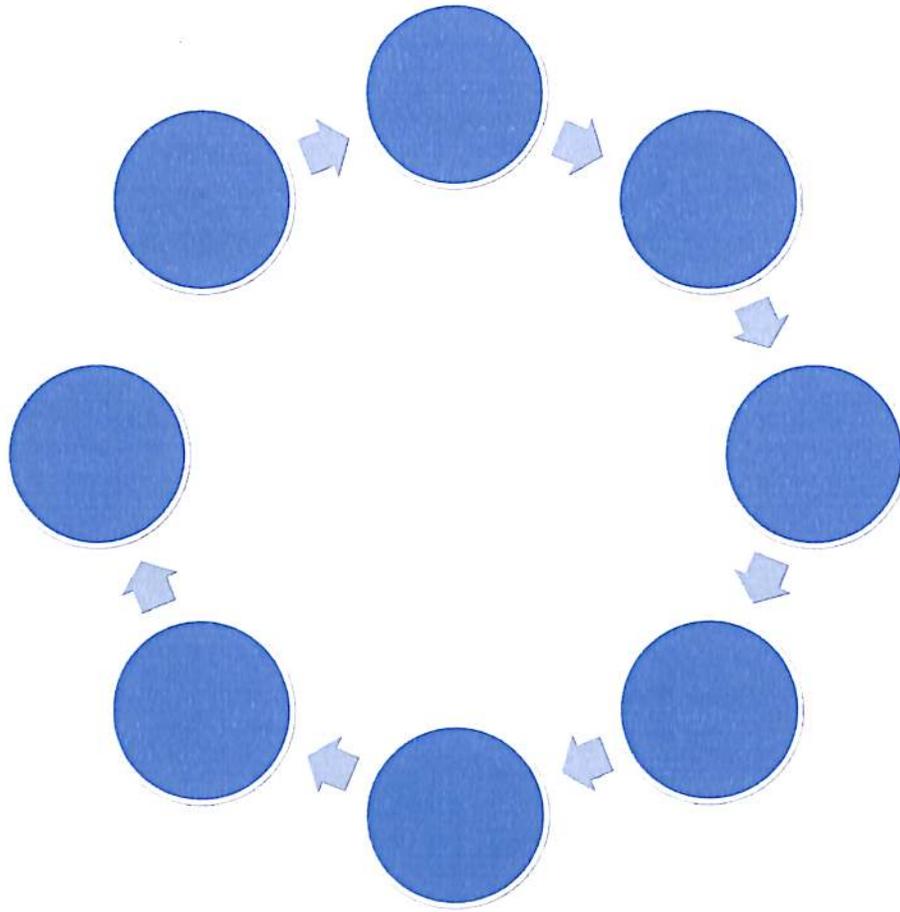


Figure 5 - Developed methodology suggested by authors

Step 1: Risk Feasibility study

Main Input:

- Plan or project feasibility study

Major Activities:

- Project risk management strategic planning (Is there a need for project risk management or not)
- Project life cycle study (both after and before contract)
- Project structure study (private, governmental, ...)
- Study of project implementation method (in house, EPC, DB, DBB...)(Engineering Procurement and Construction / Design-Build / Design-Bid-Build)
- Project contract and the payment method study (lump sum, cost plus...)
- Contractors and consultants analysis (domestic, foreign, expert or inexpert...)

- Project portfolio study, based on the portfolio of the organization, ministry, country and region.
- Select desired level for risk management (client, contractor, E or P or C...)

Main Output:

- Risk feasibility package and the requirements measurement table of project risk management.

Step 2: To develop stakeholders' objectives and expectations

Main Input:

- Risk feasibility Package

Major Activities:

- Identify stakeholders and their specifications.
- Analyze stakeholders' requirements and expectations and then conform to steps of feasibility.

Main Output:

- Package of stakeholders' requirements and expectations analysis, according to the risk management approach.

Step 3: To develop regulations and procedures of the project risk management in the selected scopes and desired levels (engineering, procurement and construction)

Main Inputs:

- Risk feasibility package
- Package of stakeholders' requirements and expectations analysis

Major Activities:

- Determine objectives and missions
- Determine risk management organization and team
- Define tools, models and software packages to be used.
- Prepare forms, documents and procedures required for information circulation.
- Provide required RBS (Risk Breakdown Structure) along with the primary check list.

Main Output:

- Risk management manual through various phases.

Step 4: To consider and develop a definite scheduling (develop a distinct plan)

- The planning division is responsible for this step. Furthermore, this unit will be considered as the Main Input too.

Main output:

- Definite project plan(Time schedule should be preferably given to level 3 or 4.Also ,process of risk analysis must be applied on the work packages level).

Step 5: Risk identification and risk mitigation according to the scheduling plan and check lists of risks and risk groups (WBS, RBS) (Work Breakdown Structure, Risk Breakdown Structure)

Main inputs:

- Project time schedule
- RBS and check list of risks
- Risk management annual and procedures

Major Activities:

- Risks identification
- Risk refinement

Main Outputs:

- Complete list of crucial, effective and prioritized risks.
- List of secondary and uncertain risks.

Step 6: Qualitative risk analysis and development of an integrated risk plan and schedule

Main Inputs:

- Complete list of crucial, effective and prioritized risks.
- Project time schedule

Major Activities:

- Apply risks on the project time schedule
- Risks' cost analysis
- Risks' time analysis

Main Output:

- Risk plan(scheduling along with applying risk)

Step 7: To develop response plan and analyze its costs

Main Inputs:

- Risk planning (scheduling along with applying risk)
- Risk management annual and procedures through different phases of the project

Major Activities:

- Develop recommended response plan
- Analyze main plan before and also after the risk reduction according to a definite plan.
- Finalize and approve primary risk response plan, develop time schedule and define relevant responsibilities.

Main Outputs:

- Risk plan before and after response to the risk
- Analyze costs of response to the risk
- Risk response plan and identified related executives

Step 8: Periodical risk monitoring, controlling and tracking

Main Inputs:

- Risk plan before and after risk response
- Analyze costs of risk response
- Risk response plan and identified related executives

Major Activities:

- Risk response plan execution
- Periodical update of risk lists and risk plan
- Periodical risk reporting
- Recording lessons learned about risks during the project implementation

Main Output:

- Updated risk plans

Chapter 5. Implementing methodology in Abu Dhabi Gas Industries Limited (GASCO) gas treating plant project

In order to analyze and test this methodology, we have focused on different steps of the methodology through the project.

5.1 Step 1: Risk feasibility Study

5.1.1 Project risk management strategic planning

In the case of executing project strategic management, it is possible to make utilize the outcomes and results of the strategic management at this level. The results obtained of SWOT analysis are especially useful at this level. Otherwise, implementing risk management in the project will be dependent upon wide-ranging SWOT analysis and experts' interview. In this project, SWOT analysis has been carried out in a comprehensive manner. After gathering comments and holding interview sessions, the following results have been collected:

According to these factors, inspecting risks in the projects are necessary:

- Nature of the project is consortium base
- This project is an EPC and the risks existing in the engineering, procurement and construction phases affect the other phases.
- The project has been bid for a second time, because of cancellation of the first bid due the exit of two of the consortium parties (out of four).
- Considerable increase of internal gas demand which has made it a critical product.
- The country's unique position of possessing the second largest reservoirs of natural gas in the world and desire to export.

5.1.2 Considering to the project life cycle status (both before and after contract)

The scope of the project is clearly defined and the project is ongoing. Therefore, the need for a detailed and comprehensive analysis is obvious.

5.1.3 Analyzing the project's organizational hierarchy (private, governmental...)

It should be considered that the project is being carried out by the private sector which increases the importance of the issue. Furthermore, the project is to be accomplished by a consortium and will be executed by multi corporations. Consequently, the executive management of the consortium should follow the contract framework of time, cost and quality and provide more profit to the related companies through an effective risk management process.

5.1.4 Considering to the project implementation method (EPC, in house, DB, DBB...)

The method of project implementation is EPC and all phases consisting of design, purchase, build and operate are under the management and control of the consortium contractor. Consequently, engineering phase risks will have an effect on the procurement and construction phases and procurement risks will influence the other phases.

5.1.5 Considering to the project contract and payment method (lump sum-cost plus...)

The payment method of the project contract is lump sum .This method will increase the risk of the contractor and will necessitate the implementation of a risk management model in the project. Therefore, the contractor must implement risk management in the project in order to decrease the costs.

5.1.6 Contractors, consultants and involved parties assessment (domestic, foreign, experienced, unskilled). The list of the contractors is as follows:

R o w	company	Related experience rate	Main expertise	Participation rate in the project
1	Technip (Abu Dhabi)	over 30 years	Engineering, Procurement	high
2	Technimont (Abu	over 30 years	Construction, Procurement	high
3	SNC Lavalin (Canada)	over 50 years	Engineering	moderate
4	WorleyParsons(AbuDha	about 20 years	Engineering	low
5	Prosernat (Malaysia)	about 30 years	Engineering	low

According to the contractors’ status and their perspective background and records, it would appear that all of these companies do not have the necessary experience in all EPC phases. However, they are very experienced in one or two phases. Therefore, it may increase the risk of integration of different approaches for project execution.

Based on this fact, the project will be carried out in the consortium format and there is a risk of project implementation in different methods by individual contractors, as opposed to an integrated unit. This may have a major effect on the project.

5.1.7 Project analysis at the portfolio level (organization, ministry, country and region)

The project will be analyzed at the contractor’s organization level. The consortium management will attempt to decrease the costs through risk management and create more profits for the project; the management will strive to deliver the project on time and within the defined specification to the client.

5.1.8 Decision making about desired level of risk management (client, contractor, E or P or C or...)

The project is analyzed at the consortium contractor level. Therefore, in the following table, the seventh level is evaluated and risk management will be considered throughout the project even in Basic, FEED, EPC levels.

Summary and outcomes of the feasibility study package:

No.	Item description	Weight of item	Need to risk management*	score
1	Project risk management strategic planning	0.16	9	1.44
2	Project life cycle statues	0.14	10	1.4
3	Project overall structure	0.06	5	0.3
4	Project implementation method	0.16	9	1.44
5	Project contract and payment method	0.18	10	1.8
6	Contractors and consultants	0.14	4	0.56
7	Project at the portfolio level of organization, ministry, country, region	0.1	3	0.3
8	Desired level of risk management	0.06	7	0.42
Sum		1		7.66

*(1-10) number 10 means strong need to risk management and number 1 means no need.

Score	0-2.5	2.5-5.0	5-7.5	7.5-10
Need to the risk management and risk analysis	Without any need to the risk management	Risk management at the overall level of the project	Risk management along with allocating an expert	Establishing risk management team, evaluating details and develop risk procedure

According to the acquired score, it becomes obvious that implementing risk management is an essential and necessary matter.

Score	0-2.5	2.5-5.0	5-7.5	7.5-10
Need to the risk management and risk analysis	Without any need to the risk management	Risk management at the overall level of the project	Risk management along with allocating an expert	Establishing risk management team, evaluating details and develop risk procedure
Step 1				
Step 2				
Step 3	☒			
Step 4	☒	☒		
Step 5	☒	☒		
Step 6	☒	☒		
Step 7	☒	☒	☒	
Step 8	☒	☒	☒	

5.2 Step 2: Development of stakeholders' objectives and expectation

Fulfillment of this step is dependent on step 1 and the outcomes of risk management feasibility study. Note that, step 2 will start if step 1 carries out and the score of the risk management feasibility is greater than 7.5 points. Since the feasibility study shows 7.5 points in this project, we begin to evaluate and analyze this step.

5.2.1 Identify stakeholders and their specifications

Considering the extent of this project, in terms of scope and budget, excessive direct and indirect stakeholders may exist in the project. Main stakeholders are as follows:

No	stakeholders	Responsible	Direct or indirect
1	Technimont Company	EPC contractor	Direct
2	Technip Company	EPC contractor and Lead consortium	Direct
3	SNC Lavalin Company	FEED Subcontractor	Direct
4	WorleyParsons	Licensors	Direct
5	Prosemot	Licensors	Direct
6	Ristec	Licensors	Direct
7	Office of the Habshan governor		Indirect
8	Citizens of Habshan and the areas around the treating station		Indirect
9	Abu Dhabi National Oil Company	Client	Indirect
10	EIED	Managing Contractor	Direct
11	Consortium Management	Contractors 'coordinator	Direct
12	Environment and Natural Resources		Indirect

5.2.2 Analyze stakeholders' requirements and expectations and then conform to the steps of feasibility study.

No	stakeholders	Project 's expectations from the stakeholders	Stakeholders 'expectations from the project
1	Technimont Company	Very High	Very High
2	Technip Company	High	Very High
3	SNC Lavalin Company	Very High	High
4	WorleyParsons	Low	Low
5	Prosemot	Low	Medium
6	Ristec	Medium	Medium
7	Office of the Habshan governor	Medium	High
8	Citizens of Habshan and the areas around the treating station	Low	High
9	Abu Dhabi National Oil Company	Very High	Very High
10	EIED	High	Very High
11	Consortium Management	Very High	Very High
12	Environment and Natural Resources	High	Low

Note that the mentioned requirements and expectations may affect Risk Identification and Analysis phase.

Main output:

- Package of stakeholders' requirements and expectations analysis.

5.3 Step 3: Development of Annual and procedures of the project risk management in the selected scopes and desired levels

Main Inputs:

- Risk feasibility study package
- Package of stakeholders' requirements and expectations analysis

Major Activities:

5.3.1 Objective and Mission

According to the obtained information from the feasibility study section of the project, implementing risk management in the project is an essential and definitive action. Consequently, objectives and missions which are defined based on the fulfilled feasibility study in the project are as follows:

Mission: End cost reduction and on-time project delivery to the client.

Objective: Risk management implementation in the project's levels in order to realize the mission of the organization. Prevention of risks through early risk identification and appropriate response to the risks, which will reduce costs and save time.

5.3.2 Risk management organization and risk management team

According to the project organization chart (in consortium condition), recommended positions for risk management are as follows:

Name of Team Member	Reason of selection
Project manager/Deputy of engineering manager	Main Authority
Purchase Manager	Considering Procurement risks
Construction Manager	Managing site related issues
FEED Manager	Managing Engineering risks
Project Control Manager	Timing
Risk Manager	Core Role
Contracts Manager	Claims, Contractual handling and control
Financial Manager	Cost Control

5.3.3 Applied tools, models and software

The methodology applied on the project, is a combination of Shampo, PMBOK and Prince2 models. Furthermore, all requirements and needs related to the EPC projects and oil and gas projects have been taken into consideration.

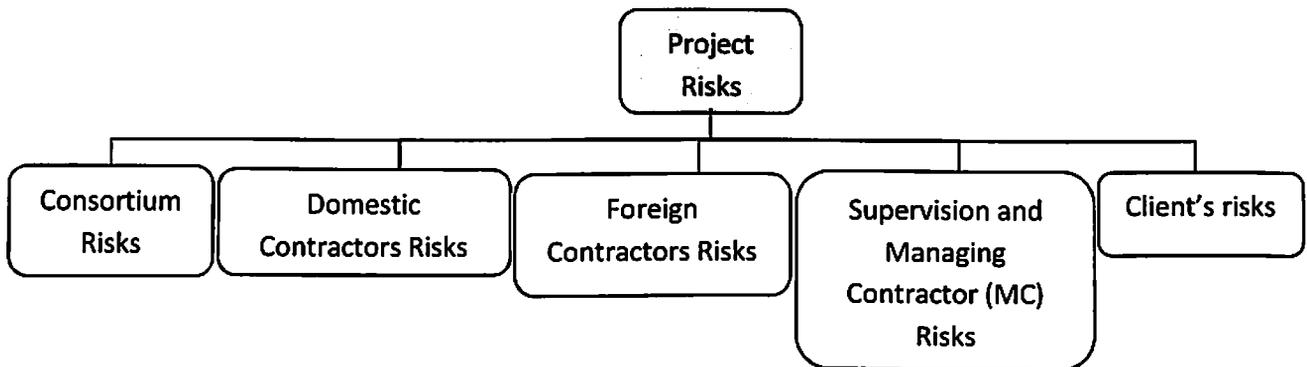
The tools used in this model are listed as follows:

Brain storming method, risk response qualitative, risk response quantitative analysis, risk simulation, etc.

- Applied software: Primavera Pertmaster
- Required forms and procedures
- Prepare required RBS, along with primary check lists.

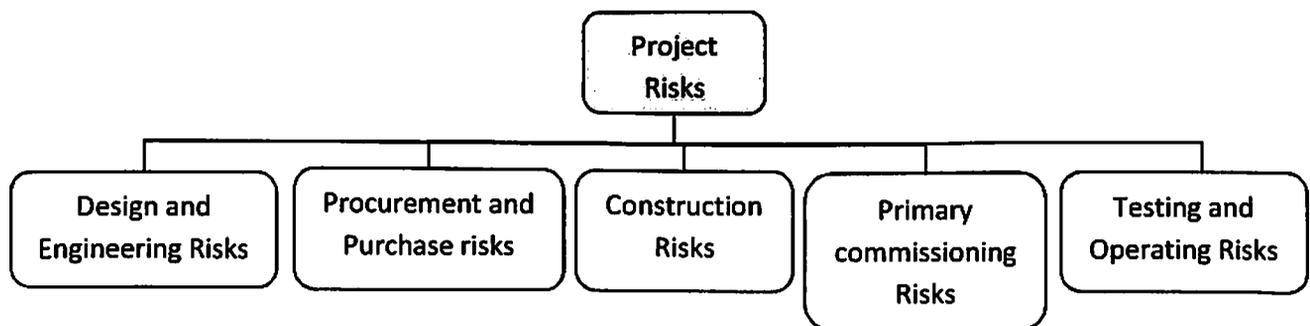
5.3.4 Project's RBS consists of following items:

Based on stakeholders:

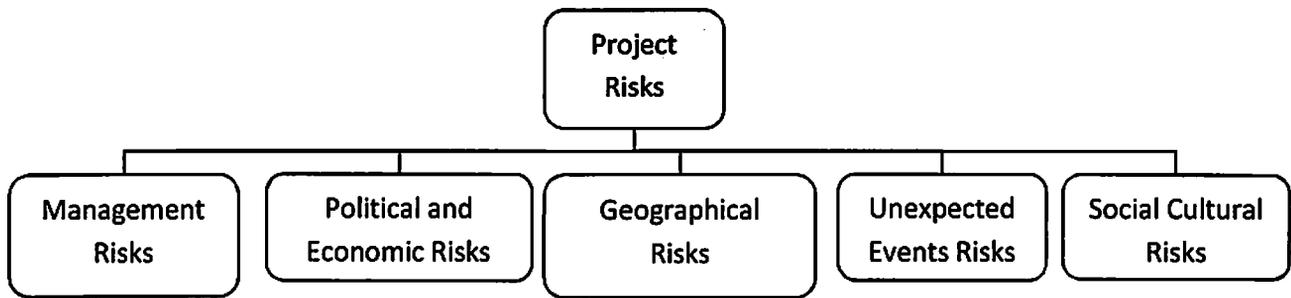


This kind of RBS is very general and has been defined based on the client's perspective towards the project. Therefore, this RBS is not suitable for this level of evaluation (contractor overview).

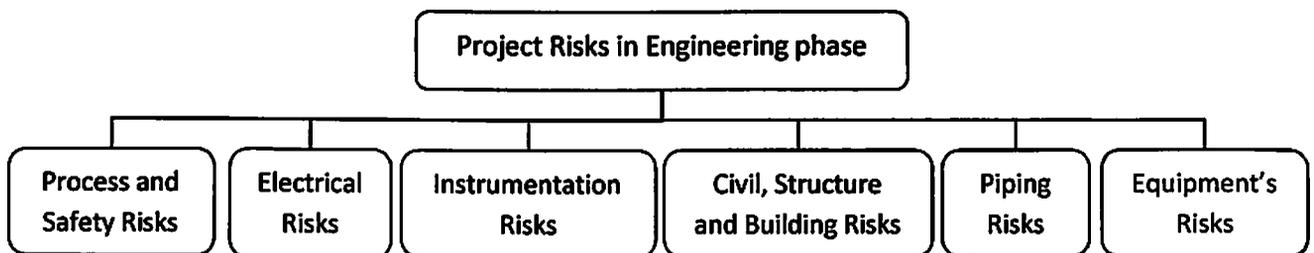
Based on the project phases:



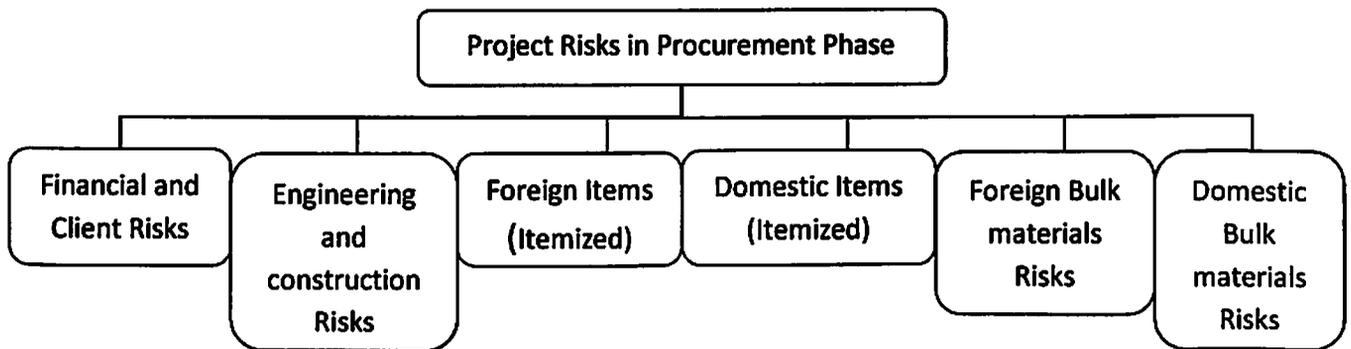
Based on common factors:



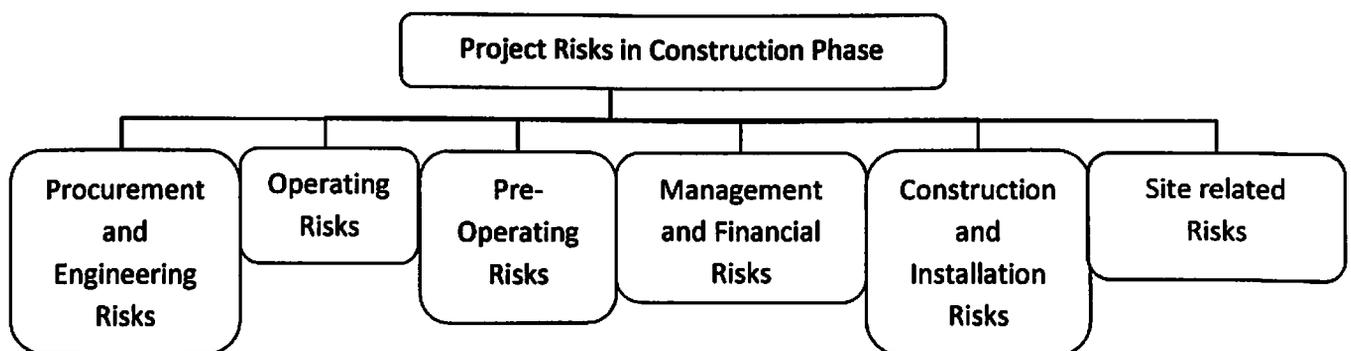
Based on disciplines existing in the engineering phase:



Based on categories of purchased items in procurement phase:



Based on physical activities in the site during construction phase:



By this method, all of the probable RBS for the project will be extracted. The most significant point is that only one of the methods may be selected for the project as being suitable and then check lists will be selected based on the chosen method. In the following table, risk priority is visible:

No	Description of RBS method	Applying method	Priority and Applying Sequence
1	Beneficiary oriented	Through this method, apply project management team for risk determination.	1
2	Phase-oriented	Every phase management and project control manager participates in risk development.	2
3	Discipline-oriented in E	Manager of every discipline participate in risk identification.	3
4	General	Through this method, managers of the other units participate in risk identification. For example: administrative director, financial manager, contracts manager, site manager, project manager ...	4
5	Based on Items in P	This method is used to identify risks more precisely in procurement phase.	5
6	Physical in Site	This method is used to identify risks in the construction, installation and operating phases.	6

Main Output:

- Risk management annual and procedures through various phases.

5.4 Step 4: Development of definite time schedule for risk analysis

- The planning division is responsible for the execution of this step. Furthermore, this unit will also be considered as the main input.
- Since the project time schedule is very detailed, it may be difficult or very time consuming to extract and analyze risks based on this plan. It is important to note that the qualitative risk analysis step, a suitable time schedule is required for qualitative analysis.

Since the project time schedule consists of various activities, a limited section has been selected to analyze. This scheduling plan has been prepared by the contractor and has been verified by the client and project MC (Managing Contractor).

Main output:

Definite project plan(Time schedule should be preferably given to level 3 or 4.Also ,process of risk analysis must be applied on the work packages).

5.5 Step 5: Risk identification and risk mitigation according to the time schedule and check lists of risks and risk groups (WBS, RBS)

Main inputs:

- Time schedule
- RBS and check list of risks
- Risk management regulations

Major Activities:

At this stage, project risks are extracted based on RBS, check lists and the project main plan. The complete time schedule was divided into different disciplines which were intended to execute different sets of tasks. With the aid of brain storming, expert method, Delphi method and the other tools, each discipline was involved to identify the risk of the project. Using the RBS in parallel with the time schedule could possibly raise the problems of over allocation, resource limitation, unforeseen delays, need for extra money, over work, and the use of subcontractors. As a result risk register were developed after gathering, concluding and mitigation of risks. Important risks will be transferred to the next step.

- Risk Identification: Brain storming, Expert method Delphi method are most frequently used during risk identification step.
- Risk mitigation

Main Outputs:

- Complete list of crucial, effective and prioritized risks.
- List of secondary and uncertain risks.

5.6 Step 6: Qualitative risk analysis and develop an integrated risk plan and scheduling

Main Inputs:

- Complete list of crucial, effective and prioritized risks. (updated risk register)
- Time schedule of the EPC project which is detailed down to work package level.

Major Activities:

- Apply risks on scheduling process. The complete time schedule was revised considering to high risk tasks and required lead, lag, extra resources, crashing, fast tracking, etc. As Mulcahy (2003) described tasks with more predecessors are more risky than task with single or less predecessors. These identified tasks in the detailed level of the project were attempted to be risk-mitigated by applying different techniques of planning and scheduling activities in parallel with various resources. Another approach at the top level of the schedule was to consider summery activities

or high risk milestones, and attempt to consign them to a lower level of risk than the revised plan's initial development. Fast tracking and crashing which are two tools used to freeze the time schedule, were in this case utilized to apply the risks to the schedule.

- Cost analysis of risks. Financial consequences of risk were analyzed based on the time schedule and also on the contingency plans. Risks with more severe consequences analyzed and planned to be treated even with higher cost approaches.

Main Output:

- Risk plan (revised time schedule by applying the risk on the primary plan of the project)

5.7 Step 7: To develop response plan and analyze response plan cost

Main Inputs:

- Risk plan (revised time schedule by applying the risk on the primary plan of the project)
- Risk management regulation through different phases of EPC project

Major Activities:

- Develop recommended response plan. Proper strategies for each single risk were considered and as a result, a wide risk response plan was developed. This plan considers the risks across the life cycle of the project and attempts to achieve the most cost effective solution for different types of risks.
- There was a need for a revision of the project plan and analysis of the main plan before and after the risk reduction, which was one of the major activities accomplished in this step.
- Approve and finalize the primary response plan, develop scheduling and indicate executive responsible. Risk response plan were developed and proper responsible resources were assigned to activities. The primary time schedule was revised to lower the risk level and to be coordinated with the risk response plan. As every plan requires resources, various types of resources were assigned to these referred plans.

Main Outputs:

- Risk response plan
- Cost analysis on the risk response plan
- Revised time schedule and executives resource assignment

5.8 Step 8: Periodical risk monitoring, controlling and tracking

Main Inputs:

- Risk response plan
- Cost analysis on the risk response plan
- Revised time schedule and executives resource assignment

Major Activities:

- By executing the plan, as the time schedule is gradually being implemented, the risk response plan is being implemented in parallel
- Updating the risk register and the risk response plan as an iterative and continuous task is considered and followed
- Periodical risk reporting plays an important role for collecting the required feedback and performing the corrective actions.
- Record lessons learned about risks during the project implementation

Main Output:

- Updated risk response plans, contingency plans, backup plans
- Updated time schedule
- Recorded lessons learned

Chapter 6. Conclusion & Scope for Future Work

Emerging mega-projects, ever more complex and highly technical, are addressing new challenges within the field of project management. Project risk management as one of the latest areas of project management has become more prominent in recent years as project managers increasingly realize the effects of risk management on delivering a project on time, within the budget, with predefined qualitative and technical characteristics. EPC projects which are generally considered to utilize one of the more complex implementation methods, have three main phases and involve various kinds of contactors and sub-contractors. These participants may be typically from engineering agents, procurement bodies, construction or commissioning contractors. The nature of EPC projects considered with payment methods can introduce various types of risks to the project at different levels. Most of the advanced companies begin the project risk management process at the early steps of tendering, even though there is no guarantee that the tender will result in a contract awarded. , they start the project risk management process as the part of project management works. Project risk management thus becomes an integral part of the overall management philosophy from the initial project proposal. This can be very beneficial to a company as at an early stage, it may sometimes identify projects, which have fewer added values than expected and are not feasible.

The oil and gas industry involves many of projects with high budgets using complex technologies. These projects, with large amount of activities, various involved parties and varied resources, are the main focus of this thesis. The Abu Dhabi oil and gas industry has some unique and challenging risk areas than the other companies around the world due to its geo- political issues. The projects defined in Abu Dhabi are considered as serious contenders of risk management systems which are customized to be applied easily and effectively.

International projects utilize EPC type of contracting and the unwillingness of Abu Dhabi companies to embrace EPC contracts may be one of the reasons for lack of participation in international contracts. The root cause can be related to less technical facilities and capabilities.

Abu Dhabi companies need to consider new arrangements and required strategies for participating in EPC tenders. They need to compete on the international level with the other companies who have been using EPC contracts for many years. Clearly, without a more aggressive approach, Abu Dhabi companies will fail to win tenders and will be unable to establish a market leadership position or they can gain the position of second hand contractors in the best case scenario.

In Abu Dhabi, first FIDIC type contracts were used in the governmental organization of planning and budgetary affairs by acquiring loans from the World Bank in 1960 and then by translation of the Red Books from English to Arabic. These types of contracts were in common up to the early 1990s.

Many companies begin projects without a proper risk management system and subsequently, although they use project management techniques and efforts to handle the projects within the specified time, budget and quality, they are unable to forecast and control unpredicted situations which can impact their projects.

It would appear that companies do not normally invest in risk management systems as they are often not aware of the positive outcomes and benefits of these methods. A further issue is lack of knowledge of the complexity and generalization of project risk management methodologies.

This paper points out that by introducing a simplified, customized and succinct methodology for a specific industry; it is possible to motivate companies to embrace the concept of project risk management. The initial and top level risks related to oil and gas projects can often be identified in early stages of the project. These risks should be considered to have the potential to be more severe due to the major effect on the project. As a general rule in project risk management literature, risks which happen in the early stages of a project should be analyzed in greater detail, as they can have an enormous effect on the overall project lifecycle. The consequences of these effects can lead to unpredicted situations with additional time, money, and resources allocated as a result of unforeseen changes in the project.

Many factors such as project location, environment, current political situation, payment method and terms, financial stability of the client and contractors, along with the current macro-economic conditions, the ability to use banking services for Letter of Credit (LC) works, contractors technical grade and experience on the field of given projects and project organization should be considered as important factors to be evaluated in the early stages of the project, because they may create some risks and there should be proper strategies selected to handle the risks that are emerging because of these characteristics. Insurance and liability coverage is also an important factor to be considered.

There are different approaches to manage project risk as defined by various sources and organizations. The reason for the development of diverse methodologies can be attributed to the various viewpoints toward risk. While the main goal of the risk management models is to manage the risk issues and mitigation of the severity and consequences; their method of achieving this goal may differ. The depth and the level of focus on processes related to different steps of managing the risk are diverse.

Some risk management models are a subset of larger project management model which attempts to analyze and control the risk in a more generalized way. In some groups, there are models which are designed specifically for the application of risk management. These groups tend to consider the risk at a more detailed level. This thesis express that none of these models are customized for a specific industry and furthermore, do not introduce a pattern for a specific project type. Most of these models do not use sample formats and patterns. One of the most important issues with these models is that they do not apply some of most frequently used methods and software packages available to application of the risk and project management, techniques such as PERT, GERT or Mont Carlo. These issues generate sufficient motivation to adopt a methodology development which can be easily applied by

managers of specific industries. This should lead to higher performance and productivity as has been the case with some large companies who began to develop their own risk management methodologies, based on their individual requirements and business environment. Examples are Statoil, Michigan oil and gas, and Sasol.

The authors suggested methodology has been developed based on discussion with experts, lessons learned in the oil and gas industry, and finally a combination of general methodologies of mainly PMBOK, PRINCE2, Cooper, with an eye on strengths and weaknesses of existing methodologies.

Normally related models in this field begin with the risk management procedure and risk identification. The suggestion in this proposal methodology is that the initial step should be risk feasibility study. This approach will encourage the company to take an in depth look at the company's strategic plan, project life cycle, structure, implementation method, payment method, portfolio and organization, along with desired risk level and contractors circumstances and suitability. It will also make it possible to begin the risk management processes prior to setting up a tender meeting. Pre-tender and tender steps are important steps in the project lifecycle. These steps are often overlooked or ignored. The experience in Abu Dhabi Gas Industries Limited (GASCO) gas treating plant project demonstrated that some of companies scheduled to attend to the tender meeting, decided against doing so, after performing a high level risk analysis on the project environment and the clients financial situation. Major affecting factor on their analysis was project environment which was deeply affected by geo-political issues and the final conclusion reached was that there was not enough trust in the client to be able to support the project financially based on the contract type.

Stakeholder's analysis in order to discover detailed requirements is a necessary step which can reveal main risks, desired risk level and also help creating the regulations and procedures of the project risk management.

As risk management has a foot on project planning outcomes, it is necessary to analyze the time schedule with risk outlook to ease risk identification and risk mitigation efforts. In GASCO, with the time schedule of eighty thousand activities planned to be executed within forty four months, lots of detailed risks were identified by analyzing the time schedule with the assistance of discipline managers. The number of predecessors of an activity can be an easy spotlight to discover activities with higher risks. WBS and RBS are useful tools in this step.

Unlike most of the other models, quantitative risk analysis is omitted in presented methodology because of the structure of the model, project type and enough emphasize on qualitative risk analysis. Risk response plan is a set of actions based on their strategies to work on selected risks of the project considering to costs of the consequences and available budget through the whole project life cycle. Development of risk response plan requires applying some changes on the main schedule of the project. Then the new schedule will have a lower risk level, comparing to the previous one. Although main schedule of the project is a subject of cost analysis by responsible parties in the project team, the risk response plan

needs to be treated the same. In Abu Dhabi Gas Industries Limited (GASCO) gas treating plant project, authors did not perform cost analysis and also finalizing the risk response plan development due to boundaries of this research.

To keep the risk management process alive there is a need to perform a periodical risk monitoring, controlling and tracking on the risk response plan, its costs and revised time schedule. Mentioned step guaranties having updated risk register and having an opportunity of discovering secondary risks.

To conclude, the mentioned research question has been answered by developing a methodology for risk management in EPC projects. This methodology is customized for oil and gas industry. The methodology is examined and analyzed in Abu Dhabi Gas Industries Limited (GASCO) gas treating plant project. The result of this thesis can be applied in the other oil and gas projects to manage the project risks in more functional and productive method, from pre-tender till post- commissioning phase.

This thesis can be considered as the groundwork for building the project risk management system for a single project in the oil and gas industry and further more developing different methodologies for various industries.

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Appendixes

Appendix A: Interview Questions

1. Considering project risks, do you think forming a consortium to run this project was the right decision? If yes, why? If not, what is your preferred execution model?
2. Considering to the project risks, are you satisfied with the consortium's organizational structure? If not, what is your preference?
3. Considering to the project risks, what do you think about payment method of the project?
4. Do you think pre-tender risk evaluation has been taken into account enough?
5. Do you think risk management was an effective process within this project? Why?
6. Name some top level risks of oil and gas industry of Abu Dhabi; are they applicable for this project as well? If not, Name some top level risks of this project.
7. Name some detailed level risks of oil and gas industry, especially risk which exist in the discipline of your background profession (Mechanical, Electrical, Instrument, Civil, structural, Rotary Equipment, Fixed Equipment, Firefighting, HSE, Management).
8. Mention to some of the project risks with higher effects and rank them.
9. Mention to some of the project risks with higher severity and rank them.
10. Mention to some the most effective contingency or backup plans for some certain risks in this project.

Appendix B: Interviewed Personnel Positions

No.	Position
1	Project Manager
2	Deputy Project Manager
3	HSE Manager
4	Cost Manager
5	Engineering Manager
6	Procurement Manager
7	Construction Manager
8	Planning and Project Control manager
9	Construction Site Manager
10	Deputy Construction Site Manager
11	Deputy Procurement Manager
12	Site Planning and Project Control manager
13	Site Technical Office Manager

Appendix C: List of Abbreviations

No.	Abbreviation	Explanation
1	AIRMIC	The Association of Insurance and Risk Management
2	ALARM	The National Forum for Risk Management in Public Sector
3	ANSI	The American National Standards Institute
4	BOT	Build-Operate-Transfer
5	CCTA	The Central Computer and Telecommunications Agency
6	DB	Design-Build
7	DBB	Design-Bid-Build
8	DCS	Distributed Control System
9	EPC	Engineering, Procurement and Construction
10	FEED	Front End Engineering Design
11	FIDIC	International Federation of Consulting Engineers
12	GDP	Gross Domestic Product
13	HP	High Pressure
14	IRM	The Institute of Risk Management
15	LC	Letter of Credit
16	LPG	Liquefied Petroleum Gas
17	MC	Managing Contractor
18	NGL	Natural Gas Liquids
19	ADNOC	Abu Dhabi National Oil Company
20	OPEC	Organization of the Petroleum Exporting Countries
21	PMBOK	Project Management Body of Knowledge standard
22	PMI	Project Management Institute
23	PRAM	Project Risk Analysis and Management
24	PRINCE2	Projects in Controlled Environments
25	PRMA	The Project Risk Management Approach
26	RBS	Risk Breakdown Structure
27	SEI	Software Engineering Institute
28	SHAMPU	Shape, Harness and Manage Project Uncertainty
29	TQM	Total Quality Management
30	WBS	Work Breakdown Structure