

M. DAWOOD

RISK ASSESSMENT OF CONSTRUCTION PROJECTS FOR OIL AND GAS  
PROCESSING FACILITIES IN IRAQ

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES  
OF  
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MUHANNED SAMIR DAWOOD DAWOOD

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Approval of the Graduate School of Natural and Applied Sciences, Atilim University.

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## **ABSTRACT**

### **RISK ASSESSMENT OF CONSTRUCTION PROJECTS FOR OIL AND GAS PROCESSING FACILITIES IN IRAQ**

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Oil and gas are among of the most important economic resources and are considered the main artery of natural reserves in Iraq. Companies and institutions involved in construction of processing facilities associated with such reserves have a pivotal role in the global economy. On the other hand, Iraq's capital budget highly depends on the proportion of oil revenues. In this vein, many researchers have attempted to identify and analyze the risks pertinent to construction projects related to oil and gas processing facilities and have proposed various methods and practical plans for eliminating or reducing their effects on the critical success factors of time, cost, and quality. The aim of this study, analogously, is to determine the risks threatening the desired balance between the main objectives of construction projects in oil and gas sector of Iraq. For this purpose, findings of the literature review are used to develop an online questionnaire including 70 risk items widely referred to in the scientific arena in order to collect empirical data from academia, professionals, and decision-making authorities. Participants are chosen from different governmental and non-governmental institutions and/or companies, namely, Iraq's Ministry of Oil, Kuwait Energy, University of Baghdad, Kerbala and Al-Dorra refineries. General information related to 143 experts and their risk ratings are compiled using a five-point Likert scale. Grouped under eight risk categories, the level of likelihood and impact for each of the risk factors are determined.

Based on the data collected from the respondents, risk matrices are developed to assess and rank the identified risks, whereof, the associated risk responses are proposed herein for the ten highest-ranked factors. SPSS and Microsoft Excel programs are used for statistical analysis of the collected responses and the consistency of the data is validated by using Cronbach's Alpha reliability coefficient. Results points out 'Instability in global oil and gas prices' and 'Delay in payments to the workforce' to be the most significant risk items than can indirectly affect the success of the projects.

Keywords: Risk Assessment, Oil and Gas Fields, Risk Response Strategy, Construction Management.

## ÖZ

### IRAK'TA PETROL VE GAZ İŞLEME TESİSLERİ İÇİN İNŞAAT PROJELERİNİN RİSK DEĞERLENDİRMESİ

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Petrol ve gaz, en önemli ekonomik kaynaklardan biridir ve Irak'taki doğal rezervlerin ana arteri olarak kabul edilmektedir. Bu tür rezervlerle ilişkili işleme tesislerinin inşasında yer alan şirketler ve kurumlar, küresel ekonomide çok önemli bir role sahiptir. Öte yandan, Irak'ın sermaye bütçesi büyük ölçüde petrolün gelirlerinin oranına bağlıdır. Bu bağlamda, birçok araştırmacı, petrol ve gaz işleme tesisleri ile ilgili olan inşaat projeleri ile ilgili riskleri belirlemeye ve analiz etmeye çalışmış zaman, maliyet ve kalite gibi kritik başarı faktörleri üzerindeki etkilerin ortadan kaldırmal için çeşitli yöntemler ve pratik planlar önermişlerdir. Bu çalışmanın amacı, Irak'ın petrol ve gaz sektöründeki inşaat projelerinin ana hedefleri arasında istenen dengeyi tehdit eden risklerin benzer şekilde belirlenmesidir. Bu amaç için, literatür taramasının bulguları, akademik çevrelerden, profesyonellerden ve karar alma otoritelerinden ampirik veriler toplamak için bilimsel alanda yaygın olarak atıfta bulunulan 70 risk ögesini içeren çevrimiçi bir anket geliştirmek için kullanılır. Katılımcılar, Irak'ın Petrol Bakanlığı, Kuveyt Enerji, Bağdat Üniversitesi, Kerbala ve Al-Dorra rafinerileri gibi farklı devletin kurumları ve sivil toplumun kuruluşları ve / veya şirketlerinden seçilir. 143 uzman ve risk derecelendirmelerine ilişkin genel bilgiler beşli Likert ölçeği kullanılarak derlenmiştir. Sekiz risk kategorisi altında gruplandırılarak, risk faktörlerinin her biri için olasılık düzeyi ve etki belirlenir.

Yanıt verenlerden toplanan verilere dayanarak, tanımlanan riskleri deęerlendirmek ve sıralamak için risk matrisleri geliştirilir; bununla birlikte, ilişkili risk yanıtları burada en yüksek on faktör için önerilmektedir. Toplanan yanıtların istatistiksel analizi için SPSS ve Microsoft Excel programları kullanılmış ve verilerin tutarlılığı Cronbach's Alpha güvenilirlik katsayısı kullanılarak doğrulanmıştır. Sonuçlar, projelerin başarısını dolaylı olarak etkileyebilecek en önemli risk unsurlarının, 'Küresel petrol ve gaz fiyatlarında istikrarsızlık' ve 'işgücüne yapılan ödemelerde gecikme' olduğuna işaret ediyor.

Anahtar Kelimeler: Risk Deęerlendirmesi, Petrol ve Gaz Alanları, Risk Tepki Stratejisi, Yapım Yönetimi.

*To my beloved family*

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## LIST OF ABBREVIATIONS

Std. Dev.	Standard Deviation
SPSS	Statistical Package for the Social Sciences
Mean I	Mean Impact
Mean P	Mean Probability
RS	Risk Score
BP	British Petroleum
FST	Fuzzy Sets Theory
NPV	Net Present Value
EMV	Expected Money Value

## CHAPTER 1

### INTRODUCTION

Oil and gas are among of the most important economic resources and are considered the main artery of natural reserves in Iraq. Companies and institutions involved in construction of processing facilities associated with such reserves have a pivotal role in the global economy. On the other hand, Iraq's capital budget highly depends on the proportion of oil revenues [1]. Many researchers studied in this field to develop it by identifying and analyzing the existing risks and developing appropriate methods and practical plans to address them or eliminate them and reduce them to achieve balance in the project's main objectives (i.e., time, cost, and quality) [2].

According to British Petroleum (BP), the need for energy supply will increase because the world population increase, the population will reach 8.8 billion by the year 2035, hydrocarbon will remain still the main source in 2035 fueling the world economy, with the middle east and north Africa [3]. For this reason, we chose this field in our risk management study.

There are many risks in oil and gas, including increase in the cost and time to complete, increase in the price of work materials, accidents, and different risk categories like social, political, contractual, legal, physical, design errors, engineering negligence, quality, and environment [4]. Completion of the work is affected by the risks that directly affect the basic objectives of the project, namely, time, cost, and quality. So, we must identify and analyze the risks as accurately as possible to minimize their effects on the success of the project. Risk management is one of the most important undertakings that can help achieve project objectives successfully. It helps workflow without delays and support for decision-makers, managers, and consultants; besides,

it helps increase understanding and integration between all the contractual parties. However, Risk management is the process of identifying, assessing and controlling threats to an organization's capital and earnings. These threats, or risks, could stem from a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents and natural disasters. IT security threats and data-related risks, and the risk management strategies to alleviate them, have become a top priority for digitized companies. As a result, a risk management plan increasingly includes companies' processes for identifying and controlling threats to its digital assets, including proprietary corporate data, a customer's personally identifiable information (PII) [5].

### **1.1 Justification of the Study**

Given the importance of oil and gas projects and their impact on Iraq's and global economy, any failure to overcome them may cause a major crisis and a significant impact on the economy. A recent global investigation summarized by one of the four well-known auditing firms on the performance of 365 oil and gas projects, Ernst and Young [6]. The study showed that many of these projects did not achieve the project's objectives of time and cost. The study also found that the success of the project's implementation decreases compared to long-term industry expectations. The study reached the idea that inappropriate management of the project is the cause of failure, especially in the face of risks, or there is risk management, but without experience. The application of project management tools and techniques, including risk management, can improve project performance and reduce the risk of project delays and cost losses. On the other hand, Merrow [7], the founder of the project analysis company, stated that 78% of oil and gas projects suffer from failure to achieve their time and cost objectives. The researchers concluded that project management practices contribute to reducing both time and cost of the project. On the other hand, in the previous studies that have been carried out in Iraq, it has been clearly indicated that there is either a lack of risk management or insufficient assessments of risks is practiced in oil companies and the institutions that work in this field [8]. For this very reason, this study aims to perform an inclusive assessment of the risk in Iraq's oil and gas processing facility construction projects.

## **1.2 Research Objectives**

Research objectives of this thesis can be listed as follows:

1. To provide a critical review of the concept and importance of risk assessment practices in construction in the oil and gas sector.
2. To provide appropriate assessment of risk management in construction projects in the oil and gas sector.
3. To calculate the most important risk items or risk categories that obstruct achieving oil and gas construction projects' objectives.
4. To propose recommendations like risk mitigation, risk transfer, accepting the risk, etc. to support the risk management in the field of construction of oil and gas.

## **1.3 Research Significance**

The importance of this research is threefold:

1. It provides a comprehensive overview to learn about possibly all of the risk factors that can affect the project and to recognize the seriousness of each item.
2. It presents significant amount of information gathered from considerable number of experts and authorities which also enables making risk analysis and finding the highest-risk categories and factors threatening project's success, with the aim of eliminating them.
3. Make an appropriate risk management/contingency plan to supports decision-makers in achieving the project objectives in the oil and gas construction projects in Iraq.

## **1.4 Research Methodology**

An in-depth literature survey is done to identify and explain the risk items that can negatively affect construction projects in oil and gas sector. Thence, findings of the literature review are used to develop an online questionnaire including 70 risk items grouped under eight main risk categories, which are widely referred to in the scientific

arena. The questionnaire is then used to collect empirical data from academia, professionals, and decision-making authorities. Participants are chosen from different governmental and non-governmental institutions and/or companies, namely, Iraq's Ministry of Oil, Kuwait Energy, faculty members at the oil department of University of Baghdad, a consortium of four South Korean companies (Kerbala refinery), and Al-Dorra refinery. Responses of 143 experts are compiled using a five-point Likert scale and the risks are assessed by using Statistical Package for the Social Sciences (SPSS) program as well as risk matrices to rank the risk items. Eventually, risk responses are proposed for the ten highest-ranked factors. In addition, the consistency of the data is validated by using Cronbach's Alpha reliability coefficient.

### **1.5 Organization of the Thesis**

The thesis is organized into five chapters as follows. chapter 2 covers a literature review on the related previous studies as well as the historical background of risk management. Chapter 3 includes explanations for different concepts and terminologies used within risk management domain. Chapter 4 provides information on questionnaire design. Chapter 5 summarizes the risk analyses, risk rankings, and risk responses proposed in this thesis. Finally, chapter 6 includes the conclusions.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Chapter Overview

Iraq is among one of the countries depending entirely on oil and gas in its economy. The oil and gas industry in Iraq is related to the whole world, with many international companies working in this field [9]. Through observations in these types of projects, the oil and gas field's construction projects are found to be exposed to several risks due to large financial expenses and high number of project participants of contractors, investors, etc. Such projects also entail significant social and environmental impacts [10].

Most oil and gas construction projects in Iraq have failed to meet the project's objectives of time, cost, and/or quality [11]. Because risk departments are incapable of providing quick solution methods to identify the risks as well as their probable time of occurrence, or guidelines as to how should they be dealt with. Lack of a systematic approach for managing the risk for this type of construction will affect the project and as a result Iraq's economy negatively. Any project failure resulting from a risk item could be avoided if the risk is identified and is prepared for in a timely manner. This can be made possible with the help of a thorough investigation on the risks pertaining to this sector. As a result, this thesis aims at studying the risks in Iraq's oil and gas field in to minimize their effects and to keep Iraq's economy stable and alive.

At first, the definitions for risk and uncertainty should be clarified. Risk is the statement of what may arise from that lack of knowledge. Risk can also be regarded as the gaps in knowledge which people consider can constitute a threat. Uncertainty, on the other hand, is the intangible measure of what we do not know. It is a gap in people's knowledge that they may not even be aware of [12]. Differing terminologies are used to describe the concept of risk. Although certain meanings indicate that risk may have negative and positive connotations, the negative aspect of risk is mainly focused per most of the definitions. This fact is apparent in the definitions made for different risk items such as, hazard, problem, threat, injury, etc.

As an instance of the risk, Iraq's oil and gas infrastructure was severely harmed in the aftermath of the Iran-Iraq war, the implementation of foreign sanctions, and the 2003 military invasion. Output had fallen to less than 1.5 million barrels per day through 2004. As a consequence, oil and gas revenues of the Iraqi government – the most significant source of finance – had decreased precipitously [13]. For such situations, there should be a contingency plan or any solution to manage uncertainty and minimize its effect which can be done through risk management [14].

## **2.2 Historical Background of Risk Management**

After World War II, many researchers started to study risk management. The study initially focused on insurance to protect companies and investors from various economic and other risks. Then other forms of risk management, alternatives to insurance appeared on the market. The principle of derivatives was introduced as a risk management method during the last quarter of the last century and expanded rapidly after 1980 when companies needed to manage financial risk [1]. During 1990, the study of global risk management began, and financial companies developed internal risk, management models. It presented a study to ensure capital from the unexpected risks of reducing regulatory capital. In the meantime, it became necessary to manage those risks, to create a complete risk management model. At that time, the first person in charge of risk management in the companies was employed. Despite all

of these studies, these risk management models have not been able to stand against the financial crisis that began in 2007.

Modern companies have introduced risk management to track risk management's evolution through the history log of companies. After the 1970s, the concept of risk management has evolved significantly [15]. Large corporations with diversified financial assets began to introduce risk insurance, especially in World War II, where companies effectively covered many companies and individuals against small risks. The importance of financial insurance is to cover an event or loss from an accident or risk [16,17]. Self-insurance, on the other hand, is a simple activity that relies on establishing a fairly liquid reserve of funds to cover losses arising from risks. Due to the importance of self-protection activities, these activities negatively or positively affect the proportion of risks or their costs before they arise.

Mitigating, eliminating, and managing risks are among the most common methods of self-protection. Precautions are a method of protection applied to potential but undetermined risks where the possibilities and financial consequences are unknown. All methods of protection and risk prevention are part of risk management [18]. As a result of the traditional management of insurance companies, these companies became highly suspect in the United States during the period 1980-1990. Companies, banks, insurance companies, and financial and non-financial institutions prioritized financial risk management. These banks and institutions and companies started to concern about the risk management system at the beginning of 1970, especially in companies and financial institutions exposed to the fluctuations of the financial markets and raw materials prices. The need to use risk management began after the large fluctuations in prices, where the price of products and materials became uncertain from day to day.

Frequently at that time, risks of natural disasters were led significantly to a huge loss. For these, derivatives in risk management were used against the growing risk crises. Derivatives are described as contracts that insure their owner against certain risks. The impact of risks and decisions to manage them was significantly correlated to financial

risk and its effect on its value or financial budget. In risk management, major financial risk management products emerged in the early 1970s, where the first models of modern risk management were published. The issue of risk management became a commercial issue at the end of the 1990s. However, construction risk management research's starts in the 1950s, the way to deal with uncertainty and risk was through the Program Evaluation and Review (PERT) technology, although it was considered a planning tool for monitoring and forecasting future activities. Only most of the researchers and executives of companies, then the development in the sixties, led to computers' use to create potential distributions of return rates on investment projects. According to Gupta [19], in the 1980s, risk management began to look differently and modernly as an independent field of project management and new theories also emerged, including Fuzzy Sets Theory (FST). Risk management (risk engineering) was the result of the integration of PERT tools, decision trees through the probability of the events, the project period, and the risk events during which Chapman and Cooper emerge [20]. Their work is followed by the efforts of several researchers succeeded in creating another technique such as Analytical Hierarchy Process (AHP). Of the construction risk management research, Tasmin [21] study aimed at investigating the practice of risk management for enterprises in oil and gas companies and concluded that there is a recommendation to conduct much additional research in this area because this topic is modern in this industry. Saudi Aramco, a dominant controlling company in the oil and gas sector, has also established Saudi Aramco Risk Management for their undertakings.

Since the new millennium's beginning, many attempts to assess the project's risks and its modelling by means of computer has been made available for practitioners. Besides, a statistics program has appeared to analyze the necessary data used from the questionnaire. The Statistical Package for the Social Sciences (SPSS) is a computer program the first version of which appeared in 1968. It is considered as one of the most widely used programs for analyzing statistical information in sociology. Today, researchers in the fields of marketing, finance, government, and education are widely using it for questionnaires analysis, information management, and documenting information purposes.

### **2.3 Risk Management in Construction and Oil and Gas Industry**

This section will conduct an extensive review of previous studies related to the construction project's risk management in construction and oil and gas sector.

Dikmen and Birgonul [22] proposed a combined risk management system that serves employers that work at all levels of risk management which helps estimating the cost in the bidding phase. They provide a hierarchical distribution of risk coding to facilitate a systematic process of identifying risks. The hierarchical distribution is as follows: identify the risks; analyze the risks; classify the risks; respond to risks; review and monitor the risks. Thuyet and Ogunlana [23] presented the risk management in oil and gas construction projects in Vietnam due to the importance of oil and gas projects in Vietnam's economy. They collected the necessary data by using questionnaires and in-depth interviews with managers responsible for risk identification/management. Their findings highlighted that the managers should have full knowledge of local laws and regulations; organizations experienced in design should be preferred; there should be a clear statement of the project requirements by the owners; qualified consultants and staff should be recruited; working collectively should be focused; and that the tenders should be arranged in a fair and transparent manner. This research has contributed to raising awareness and resolve or mitigate the risks in some companies, especially in Vietnam [23].

Dimer and Bostanci [24] aimed to study risk management in a housing project. The research was based on determining the extent of profit and loss of investment by using statistical analysis. Due to the growing importance of the logical and effective use of resources in developing the project, the researcher has established an effective risk management system among companies. The researcher concluded that the correct use of risk management in allocating funding for effective projects is an important element that helps develop the real estate market and contributes to mitigating the risks that may affect the national economy. Rogers [25] studied enterprise risk management in the oil and gas industry; this research was based on a group of the greatest and the most powerful companies in the field of oil and gas (including ExxonMobil, Chevron, ConocoPhillips, Baker Hughes, Valero Energy, and Frontier Oil Corporation) four of

which were ranked among the top ten companies in the Fortune 500 magazine. The study was based on the annual information and reports of these companies in 2009. One of the most important observations focused on the presence or absence of a manager or senior risk management officer. Other observations included the environment, economy, and policy of the countries in which these companies operate. The most important risks were found to be price volatility in the market; inflation; start-up timing; interruption of operations; weather conditions; regulatory changes; geological and political.

Mbanugo [26] studied risk analysis applied to oil exploration and production based on risks such as misconceptions and misunderstandings by oil workers. For this purpose, actual field data was obtained from Devon Exploration and Production. The net present value (NPV) and the expected money value (EMV) were calculated using Excel and Visual Basic to determine the projects' validity. The study argued that they could not estimate all the different types of risks. Fazlali et al. [27] analyzed major challenges to the implementation of oil and gas projects, namely, Petrochemical Projects in Iran. The researchers focused on many previous oil challenges internally and externally and their relationship with foreign companies engineering and contractually in the construction and operation. The research aimed to improve companies' performance in the field of oil, gas, and petrochemicals. Questionnaires were used and interviews were made with experts to find the main risky challenges. Three main components were identified as poor procurement, poor documentation, and poor risk management. The various recommendations collected with questionnaires and interviews suggested remedial solutions for this imbalance.

Osabutey et al. [28] analyzed risk management practices in Ghana's Oil and Gas Industry. The research idea sought the significant risks in Tema Oil Refinery by finding out the real risks by all parties to properly manage the risks to improve performance and increase companies' value and reduce financial problems. The study analyzed the first and secondary data and identified the risks faced by the refinery, including instability in international oil prices and the devaluation of the currency

compared with the dollar and the brain drain and the lack of crude oil and huge debt, as well as other risks, including the failure of employees to comply with the rules of safety [28]. Institute and Faculty of Actuaries [21] used five risks to calculate the financial impact of risk by designing a risk model for oil and gas companies. The modeling relies on a statistical system of typical risks. The main negative effects of the risks and options for mitigating risks are illustrated through the test results. This report's objective is the awareness and perception of risk with strong experience within risk management within the actuarial profession. It is discussed that due to institute's growing demand for risk management, actuaries can contribute to industries other than the traditional business areas.

Roberts [29] presented a study on risk management of onshore oil spills. Weak judgment on equipment control and increased operator confidence in the implementation of daily procedures were found to be culprits. It is discussed that oil spills have led to significant environmental pollution and are difficult to estimate. Different ways of calculating them are explained as by adding the costs of cleaning, social losses, the economic and environmental costs. Quintino [30] proposed an integrated risk management model for an oil and gas company. This paper examines the volatility of oil and gas companies' prices, where the researcher explained that oil and gas companies use a separate hedging mechanism to protect them from risks associated with the price volatility. Suda [5] explored and summarized the risks and risk management methods for the oil and gas industry. The study explained the importance of risks and emphasized mismanagement usually leads to the project's failure and needs to be prevented.

Kaplan [31] studied applicability of risk management method of NASA in oil and gas industry. An advanced risk analysis technique was called PRA was used and the risk results were categorized by frequency of occurrence and evaluation. The results were also collected in different ways to provide knowledge on the likelihood of unintended and unexpected risks. This advanced analysis provided a measure of uncertainty about all inputs and outcomes. Since the failure rate and risk are uncertain, it was necessary to provide a set of events and results to help users know the risks' real situation as graphical results. These results gave a clear picture of the higher risks, components,

and systems that contributed to these risks. The author stated that by using this technique, the design variables can be analyzed and future risks and their impacts can be reduced.

Domnikov and Khomenko [32] studied risk and profitability optimization in the oil and gas industry. The researcher dealt with finding the maximum profit rate of oil and gas projects by analyzing the risks associated with profits and their direct impact on revenues. This research included determining the credit quality of the investment project with a probability of default against repayment. The researcher conducted a complete analysis of the investment project based on the Merton-Vasicek model in order to achieve a creditworthiness level of the oil and gas company in the long term. The authors believe that the estimated results would enable the departments of oil and gas companies to make important financial decisions based on this methodology to calculate the projects' profitability with regard to its risk.

Lenkova [33] focused on risk and its management in the oil and gas sector. The researcher identified the main real risks in oil and gas in one of the Russian oil companies. Risks were divided into external and internal in this study. The most important external risks were found to be political, technical, economic, social, and environmental risks, while the internal risks included production and management and activity support risks. Elhoush [34] investigated risk management in the Libyan oil and gas industry. This study relates the importance of the oil and gas field economically in Libya and its relationship with the risks in these projects that may cause failure in completing projects. The researcher analyzed the potential risks by interviewing 13 experts, senior managers, and project engineers. After analyzing the results, the researcher found that awareness of risk management is still very low in Libya, and there is also a lack of general knowledge in people in administrative places. Then, the allocation of responsibilities for implementing the commercial process of risk management and the organization of the sequence of activities among participants was suggested.

## CHAPTER 3

### BACKGROUND OF THE STUDY

Each construction project involves risk in one way or another, which means that there are always things that will not go to the plan. In addition, construction projects are prone to many accidents or injuries. Such eventualities can bear risk to the project as they can cause an increase in the cost and/or the completion time of the project and lead to losses or decreases in profit. In addition to accidents and injuries, the major risk items threatening success of construction projects can be summarized as the increases in material and labor prices, accidents, injuries, changes, engineering errors or negligence, low quality of work performed, etc. These factors too can adversely affect the project. Therefore, risks should be identified and assessed as accurately as possible to avoid or minimize these risks' negative effects. Construction processes involve many uncertainties and all parties of the construction project should become aware of the risks involved to be prepared for both the expected and unexpected risks. Thus, initially the key terms and concepts are defined herein.

#### **3.1 Definition of Risk**

There are several definitions of the term risk; some indicate the potential loss caused by the failure of the project system [35] or the possibility of loss, injury, and damage [36,37]. On the other hand, it is defined as any event that prevents or leads to the failure of project management expectations during implementation [38]. Risks are also defined as the possibility of loss, injury, damage, or delay during the project's implementation, negatively affecting its success [39,40].

### **3.2 Definition Risk Management**

Risk management could be defined as a technique that helps identify elements that can significantly negatively impact a project [1]. The risk management process is a system that enables management to assess the level of risk impact and then develop an emergency plan for its occurrence in order to avoid or minimize this impact [41].

### **3.3 Types of Risk**

There are risks in all projects, and risk management identifies and contains risks to ensure the success of the initiation. The following are some types of risks inherited in most construction projects [42].

#### **3.3.1 Engineering Risks**

They are the risks resulting from the engineer's work, such as engineering errors and omissions resulting from negligence, causing costly change orders or damage to equipment or injury to people and installations. Therefore, this type of risk is the responsibility of the engineer.

#### **3.3.2 Construction Risks**

Most often, the contractor is responsible for most of the risks that occur during the project implementation, and these risks can affect the amount of profit of the contractor or lead to loss sometimes. The contractor's risk can be reduced by the contractor's cognitive ability to directly predict, evaluate, and manage the elements under its direct control. Naturally, the reason for exceeding the cost of construction is due to inaccurate estimation of construction requirements. This inaccurate guesswork results from an insufficient project area; the supervising engineer may be responsible.

#### **3.3.3 Schedule Risks**

Delays in project completion lead to an increase in overall expenses and an increase in construction costs. Delays can result from certain conditions such as poor design or construction management, inaccurate guessing of the schedule or program, strikes or low level of workers, conditions, delay in delivery, or failure of equipment.

### **3.4 Risk Management Process Steps**

Risk management is the definition, measurement, and treatment of exposure to employer, contractor, property, business, and people to risk. This process involves five steps as follows [40,43]:

**I.** Defining and identifying risks is the first step when risks are assessed and can be the most difficult step to accomplish by project management. Failure to identify all potential risks means that management will not capture future unexpected or unknown risks. Project risk identification must begin early from the conceptual stage. The focus should be on identifying risk factors or high risk; otherwise, the project will be difficult to implement or lead to failure;

**II.** The second step after risk identification is measurement of the potential losses due to risks. These measures include determining the likelihood of occurrence, the impact of the risk, and the potential losses that will occur to be realistically reflected to the budget of the project.

**III.** Using different risk management tools and devising response plans is the third step after measurement of the risks. Response strategies include risk avoidance, mitigating, i.e., reducing the chance of loss or reducing its magnitude when it occurs, transferring risk to other events, and holding or taking risks.

**IV.** Project management implements a response strategy after deciding about the best response alternative.

**V.** The results of decision-making and implementation in practice in the first four steps is monitored to evaluate goodness of the decisions made and to evaluate effects of alternative decisions.

### **3.5 Risk Response Plan**

There are several ways to deal with risks and to know how to deal with these risks in

general. Risk response plan is the last step in risk management and include several different approaches discussed in the following sections.

### **3.5.1 Transferring the Risk**

The risks can be partially or totally transferred from one party to another (from owner to contractor). The contractor or the employer may decide to divide the risks through a contractual agreement that enables each party to manage risks in the best way. Different types of contracts divide risks in different ways. For example, in a lump-sum contract, the contractor always assumes all risks when calculating costs and bears the consequences, while the employer assumes the same in a cost-plus contract. Obviously, it is impossible to transfer risks entirely to a party or else, even with a fixed price contract where the contractor takes all the risks, the employer remains exposed to damages or risks such as the project exceeding the specified schedule, or the contractor declares bankruptcy or earthquakes, wars, force majeure, and others events might occur. Transferring risk can be regarded as the transfer of management. Thus, when the employer agrees to the cost-plus contract, it will need careful monitoring and measurement from management to monitor the project implementation [40,44].

### **3.5.2 Avoiding the Risk**

The following procedures may be used to avoid risks:

- Reducing risky activities;
- Reducing complexity;
- Changing contractors;
- Merging procedures.

In most of the cases, it is possible to avoid only some of the risk factors rather than eliminating them all since the whole risk items cannot be eliminated – especially in large and complex projects. The attempt to eliminate risks usually requires countless administrative controls and control systems that increase the complexity of the system and the possibility of introducing new sources of risk. Research projects, innovations, and projects of modern and innovative products are all risky projects, and the risks are inherent to them, but they result in huge profits. Because such projects' potential

profits are proportional to the risk's size, reducing these risks to acceptable levels is better than avoiding them completely [44,45].

### **3.5.3 Mitigating / Reducing the Risk**

Risks can be reduced through many ways that are combined with (i) technical performance, (ii) appropriate scheduling, and (iii) avoiding the specific project cost as described below [44,45]:

i. Reducing risk methods associated with the technical performance:

- Employing a good technical team;
- Organizing decisions on models and simulations of key technical determinants;
- Using appropriate engineering tools for the technical team's needs
- Setting incentives for the work's success;
- Assigning external specialists for critical review and evaluation of the works;
- Conducting experiments and making adjustments accordingly;
- Reducing official complications.

ii. Reducing risk methods associated with appropriate scheduling:

- Creating a realistic program for the project and implementing it properly;
- Scheduling high risk tasks early as possible to give time to deal with potential failures;
- Maintaining a strong focus on the risky and semi-risky events;
- Assigning qualified workers to a risky schedule;
- Providing incentives for overtime;
- Cautious recruitment of the staff.

iii. Reducing risk methods associated with the specific project cost:

- Identifying and monitoring the main costs;
- Designing low cost as an alternative to reviews and evaluations;
- Diversifying system design and performance through examples and assessments;
- Extending the use of already approved technology.

### **3.5.4 Contingency Plans**

Construction are risky attempts with many uncertainties especially in the early stages of project development such as pricing, market conditions, schedule, negligence, errors, etc. Contingencies are the amount of money and time that must be added to the base estimates to stand for such uncertainties. It could explain the amount of money that is added for undertaking difficult work or impossible work. Sometimes the contingency is also added to cover the costs of predictable undertakings with unknown values [46].

### **3.5.5 Accepting the Risk**

Not all effects are severe or fatal, and if the cost of avoiding, minimizing, or transferring risk exceeds the expected earnings, the preferred approach should be taking no actions at all.

## CHAPTER 4

### DESIGN OF QUESTIONNAIRE

#### 4.1 Chapter Overview

As mentioned earlier, this thesis aims to identify the most significant risk items threatening the success of oil and gas projects in Iraq as there exist a scientific necessity and that they greatly impact Iraq's economy. This study also aims to aid decision-makers in identifying and reducing the possibility and/or impact of the risks for the projects in oil and gas industry. To this end, a descriptive-analytical approach is used to analyze the risks associated with implementing oil and gas construction projects in Iraq to help describe the risks and understand their causes. In this regard, a questionnaire is developed in detail of which is explained herein. This chapter explains the research methodology, questionnaire design, questionnaire content. A pilot study is also pointed out as well as the method of data collection and analysis. In order to arrive at a scientific study, the information and data collected by means of the questionnaires are used to address the significant risks and suggestions are made toward establishing a safer environment for the employers and/or contractors.

#### 4.2 Development of Questionnaire

Consequent to an extensive literature survey, 70 major risk items that could negatively affect construction projects in oil and gas sector were identified. They were classified into eight risk categories of 'Job-site and Environmental Risks', 'Legal and Social Risks', 'Financial Risks', 'Logistical and Administrative Risks', 'Technical Risks', 'Design Risks', 'Security and Political Risks', and 'Contractual Risks'. Based on the

identified risks, an initial draft for the questionnaire was designed and prior to its implementation, it was first enhanced and validated through a pilot study details of which is given in section 4.2.1. For each of the risk items, respondents were asked to use Likert-scale to select their perceived rates for both ‘Probability’ and ‘Impact’ values.

#### **4.2.1 Pilot Study**

The questionnaire was first presented to expert engineers with different levels of experience in the construction projects related to oil and gas, and professionals from international oil companies, ministry of oil in Iraq, and academics from College of Petroleum Engineering in Baghdad. The pilot study was conducted to uncover areas of ambiguity in closed and open questions, general information, word choice, the correctness of the information, and proofreading purposes. Ten respondents were selected from the aforementioned institutions to take scientific and technical advice on improving the questionnaire. The initial version was then corrected and modified per the comments and the feedbacks received from the experts which in turn reinforced the validity and correctness of the designed questionnaire. The questionnaire was finalized subsequent to the approval of the experts that took part in the pilot study. Afterwards, the questionnaire was presented for the approval of Board of Ethics. After obtaining the approval of the ethics committee, the final version was also transformed into an online questionnaire in one of the widely used online survey development platforms. The questionnaire used in its final form is presented in the Appendices chapter. As seen in Appendix A, in addition to 70 risk items, in the first part of the questionnaire, 9 general questions about the respondents and the company they work for are included to collect information about the demographic profile of the respondents. In the end, 3 open-ended questions are also contained to allow the respondents to clarify their responses and to let them forward their opinions and suggestions generously.

#### **4.2.2 Overview of the Risk Items Included in the Questionnaire**

As stated earlier, risks were classified into eight main risk categories which will be elucidated in the following sections.

##### **I. Job-site and Environmental Risks**

Control of environmental and worksite risks affecting construction projects in the oil and gas field has become extremely difficult and important issue since any negative impact on the environmental will cause interruptions, to slow-down, or to terminate the works. Environmental risks are classified into several categories, such as the emission of toxic gasses while extracting oil which can present life-threatening danger to the workers on site; the spread of epidemics and infectious diseases that hinders the project and prevents making progresses in construction sites; or heavy rains, high temperatures, Fires, Floods, and presence of groundwater at work sites. Nevertheless, the risk of presence of explosives is ignored and not considered in this study since the experts in Iraq believe their risks can be minimal compared to other factor [23,47,48].

According to the experts engaged in the oil construction sites, many job-site risks can potentially impact the projects some of which can be mentioned as the difficulty in reaching the oil wells; lack of knowledge of the types of soil; intersection of oil pipelines with rivers or road branches; difficulty in reaching the work site; and the wells falling into agricultural lands of farmers. The following 11 risk items belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their ‘Probability’ of occurrence and extent of ‘Impact’:

1. Toxic gas (H<sub>2</sub>S) emissions during good drilling;
2. Pandemic or epidemic spread;
3. They are being exposed to extreme (high) temperature;
4. Fire and explosion;
5. Presence of groundwater in the oilfield;
6. Difficulty in accessing the oil or gas wells;
7. Unforeseen underground/soil conditions, Central Process Facility (CPF), within pipeline, or flow line implementation;

8. The intersection of oil pipelines with major and minor rivers or major and minor roads;
9. Exposure of oil fields to floods or high rain rate in winter or extreme weather conditions;
10. Oil or gas fields are located in remote areas and difficult to reach;
11. Oil or gas pipelines and wellhead passes through farms (problems with farmers).

## **II. Legal and Social Risks**

Initially, more than 10 risk items were included in the questionnaire but the experienced engineers in the oil and gas construction field advised enlisting only the most important and frequently encountered legal and social risks in Iraq that have affected most of the previous projects. As a result, some items such as ‘Personal conflicts among laborers’, ‘Negative attitudes of residents towards a project’, ‘Unemployment problems’, and ‘Legal issues related to land expropriation and house demolition’ [49] were excluded from the revised version. The following 7 risk items belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their ‘Probability’ of occurrence and extent of ‘Impact’:

1. Unofficial holidays;
2. Breach of contract by project parties;
3. Lack of knowledge of arbitration;
4. Improper verification of contract document;
5. Uncertainty and unfairness of court justice;
6. Lack of legal clarity for the work contracts with the general contractors;
7. Legal disputes between the general contractor and governmental oil and gas sector (owner).

## **III. Financial Risks**

In recent years there have been serious delays in the payments made to contractors and/or subcontractors. Frequent problems with payments from contractors to subcontractors or from the Ministry of Oil to contractors as mainly because of the

inadequate fund allocation, client's constraints, client's financial problems, inflation, and monthly payment problems. Through literature review [23,33,50] the related risk items were identified and included in the initial questionnaire; though, after the pilot study some of the items such as 'Lack of cost control', 'Unexpected project expenses', and 'Imprecision in the cost estimates' were found to be inappropriate for the projects in Iraq and thus were excluded. The following 9 risk items belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their 'Probability' of occurrence and extent of 'Impact':

1. The bankruptcy of the contractor;
2. Inadequate insurance coverage;
3. Instability in global oil and gas prices;
4. Changes in bank formalities and regulation;
5. Fluctuation in the exchange rates;
6. The delay in the issuance of advance payments to the general contractor by the employer;
7. Delay or pause in payments to the workforce through project execution due to various reasons;
8. Unexpected funding termination for the general contractor in the oil and gas sector;
9. High prices of materials and equipment required to carry out civil works in the oil and gas field.

#### **IV. Logistical and Administrative Risks**

Similar to previous categories, risk items are identified with regard to the related literature [51,52] and are finalized according to the feedbacks received from the field study, site managers, and project managers. In this respect, some risk items such as 'Sudden shortage of construction materials' and 'Insufficient innovation potential in administration' were found irrelevant to Iraq's sector and were eliminated. The following 16 risk items belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their 'Probability' of occurrence and extent of 'Impact':

1. Improper project feasibility study;
2. Shortage of supplies (electricity, water, fuel, etc.);
3. Inadequate forecast about the market demand;
4. Shortage of skilled workers;
5. Improper project organization structure;
6. Deficient monitoring or follow up of the wells, pipeline, tanks, etc.;
7. Short tendering time;
8. The delay in the arrival of the imported machinery and tools to the oil field promptly (due to customs clearance or other reasons);
9. They are using machines, equipment, and tools without proper training;
10. The difficulty of obtaining licenses and work permits for the general contractor;
11. Poor communication between the general contractor and the owner in the oil and gas field;
12. A change in the management of the oil field throughout the implementing period;  
Lack of knowledge about the team member's actual responsibilities.;
13. Unclear and/or imprecise definition of the work items by the owner in the oil and gas sector;
14. Lack of specialty contractors in oil and gas field works;
15. The absence of a risk-register for the previously completed construction projects in the oil fields.

## **V. Technical Risks**

Technical risks are considered to impact the immediate or future performance of the project which might also be linked to institutional support for the implementation of the task. Technical risks can directly affect the financial aspect of the project and/or its time of execution. For instance, in case of any failure in the equipment, delays will occur in the works [47,51]. The following 7 risk items belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their 'Probability' of occurrence and extent of 'Impact':

1. Lack of pollution prevention equipment;

2. Shortage of new technologies;
3. Equipment failure;
4. Poor quality of building materials;
5. Difficulty in following government standard codes and practices;
6. Accidents that occur due to the lack of safety in the oil and gas fields;
7. Changes in the quantities of the work items during the implementation stage without documentation.

## **VI. Design Risks**

The importance of design and its direct relation with a successful implementation cannot be overlooked. Repeated design errors, delays in preparation of the required drawings, inadequate inspections can cause a project to come to a full stop. Design risks are considered to be of great importance in this study since they are encountered frequently in oil and gas companies in Iraq [53]. According to the recommendations of the experts in this field, two of the risk items including 'Unclear/unsuitable specifications' and 'Insufficient client involvement' have been discarded from the final questionnaire. The following 5 risk items belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their 'Probability' of occurrence and extent of 'Impact':

1. Design changes;
2. Poor design;
3. The complexity of project design;
4. The mismatch between the designs and the actual implementation of the work item;
5. Delay in approval of design documents.

## **VII. Security and Political Risks**

Political instability of Iraq and the problems with the nationwide security, especially in the southern region of Iraq where oil projects are located constitute significant risks. Foreign and Iraqi companies rely on strict armed guards and are officially authorized.

The army and the police guard only some parts of the country while trained staff of some private companies are hired for full protection. On the other hand, the main reason for corruption and bribery in Iraq is observed to originate from the corrupt relationships between politicians and decision-makers in most of the organizations and companies in Iraq's oil and gas construction sector [33]. Some other risk items consisting of 'Country's internal political situation', 'Breach of the contract due to the authorities' actions in which the counterparty is located', and 'Modification of regulatory norms' are removed from the final questionnaire based on the judgements of the experts. The following 5 risk items belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their 'Probability' of occurrence and extent of 'Impact':

1. Terrorist attacks targeting oil and gas structures during implementation;
2. Cost increases due to changes in government policies;
3. Losses incurred due to corruption and bribery;
4. Difficulties due to security situations in Iraq;
5. Instability in the political system in Iraq and political discordant.

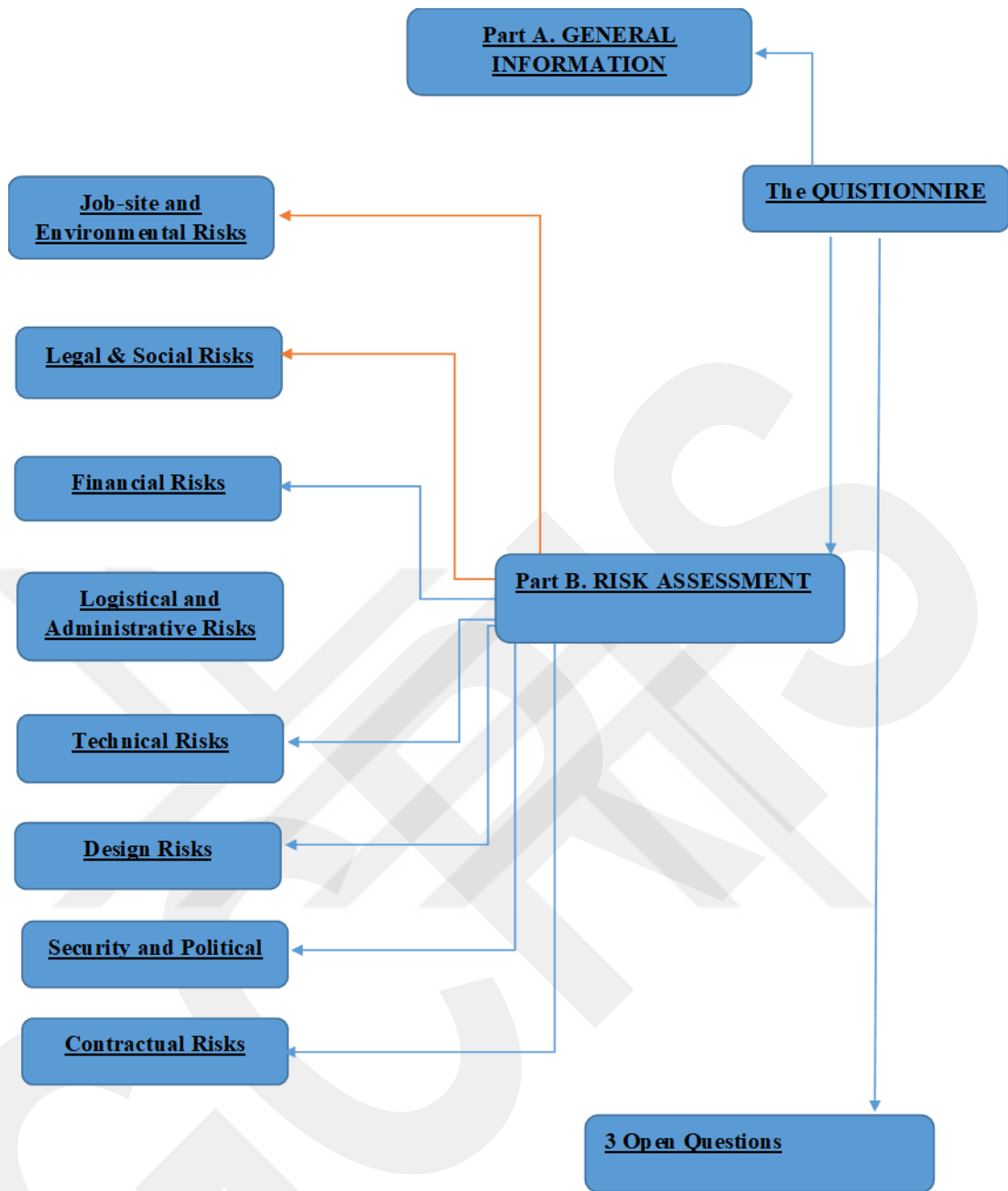
### **VIII. Contractual Risks**

In large-scale project like the oil and gas constructions, risks and responsibilities should be shared fairly among project participants through contractual arrangements. To prevent the risk of unexpected conflicts over implementation of different aspects of a project, international contractors must pay close attention to local project characteristics and contract practices. On the other hand, as mentioned earlier, of the critical success factors of any construction project comes its timely completions which may only be facilitated by an adequate schedule. Thus, this risk category also encompasses the risks that could negatively impact the durations and/or schedule of the oil and gas construction projects. The following 10 risk items [33,49,54] belonging to this category were considered and included in the questionnaire and the experts were asked to rate them both with respect to their 'Probability' of occurrence and extent of 'Impact':

1. Lack of formal and written contingency plan from contractor or the owner;

2. Very limited duration in the original contract;
3. Inadequate definition of substantial completion;
4. Ineffective delay penalties and/or bonus payments;
5. Delay to furnish and deliver the site to the contractor by the owner;
6. Type of project bidding and contract award mechanism (negotiation, lowest bid, etc.);
7. Problems with permits and the difficulty of issuing them for foreign companies in a contract;
8. Lack of technical experience and/or know-how of the contractor;
9. Inadequate financial capacity of the general contractor or the owner;
10. Construction contract type (lump-sum, cost-plus, unit price, etc.).

Figure 4.1 given below illustrates the structure of the designed questionnaire. It consists of two main parts, the first part covering the general information of the participants without giving room for exposure of any confidential information of the respondents, and the second part including the questions related to the eight different risk categories followed by three open-ended questions.



**Figure 4.1** Structure of the developed questionnaire

## **CHAPTER 5**

### **RISK ASSESSMENTS AND RESPONSE STRATEGIES**

#### **5.1 Chapter Overview**

This chapter focuses on assessment of the risk items based on the data collected from 143 respondents. Subsequent to the pilot studies described in section 4.2.1 and obtaining the approval of the ethics committee, the final version of the questionnaire was also transformed into an online questionnaire in one of the widely used online survey development platforms. Both the online version and the prints were used to collect data from the expert project managers involved in oil and gas field or working on construction projects in oil and gas industry. The designed questionnaire was used to gather information and then to analyze the effect of identified risks on the progress of the oil and gas constructions projects. Risk matrices were developed to evaluate seriousness of each risk item as well as Statistics Package for Social Sciences (SPSS) version 25 together with Microsoft Excel programs were employed to analyze the collected data. Significant risks are determined and suggestions are made toward establishing a safer environment by raising awareness of the risks involved for the employers and/or contractors operating in the oil and gas sector.

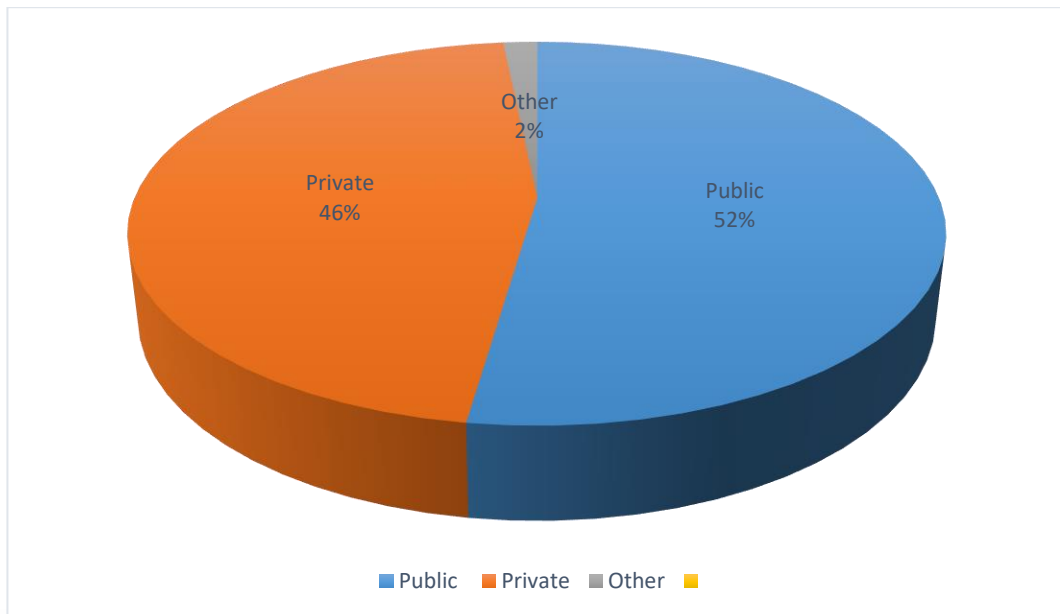
#### **5.2 Demographic Profile of the Respondents**

Empirical data are collected from academia, professionals, and decision-making authorities. Participants are chosen from different governmental and non-governmental institutions and/or companies enrolled as the owner, management office,

or designer in the oil and gas field or construction projects related to the oil and gas industry. The respondents were selected through stratified random sampling to avoid bias in selection by providing equal opportunities for all the qualified individuals from each of the strata (with each institution/company considered as a stratum). Respondents were selected from namely, Iraq's Ministry of Oil, Kuwait Energy, University of Baghdad, a consortium of four South Korean companies (Kerbala refinery), and Al-Dorra refinery. To this end, initially a meeting was arranged with the Iraq's Ministry of Oil for the purpose of obtaining the necessary permission to fill-in the electronic questionnaires. Engineers and academics from College of Petroleum Engineering of the University of Baghdad who were involved in Siba gas field – an oil and gas field located in the south of Iraq affiliated with Kuwait Energy Petrojet Company – participated in completing the questionnaire. Furthermore, experts from Kerbala oil refinery – four-company consortium of South Korean companies – and Al-Dorra refinery also participated in the questionnaire survey. First part of the questionnaire was designed to include 9 general questions about the respondents and the company they work for. Based on the first 9 questions of the questionnaire, the demographic profile of the respondents is summarized in the following sections.

### **5.2.1 Type of Organization**

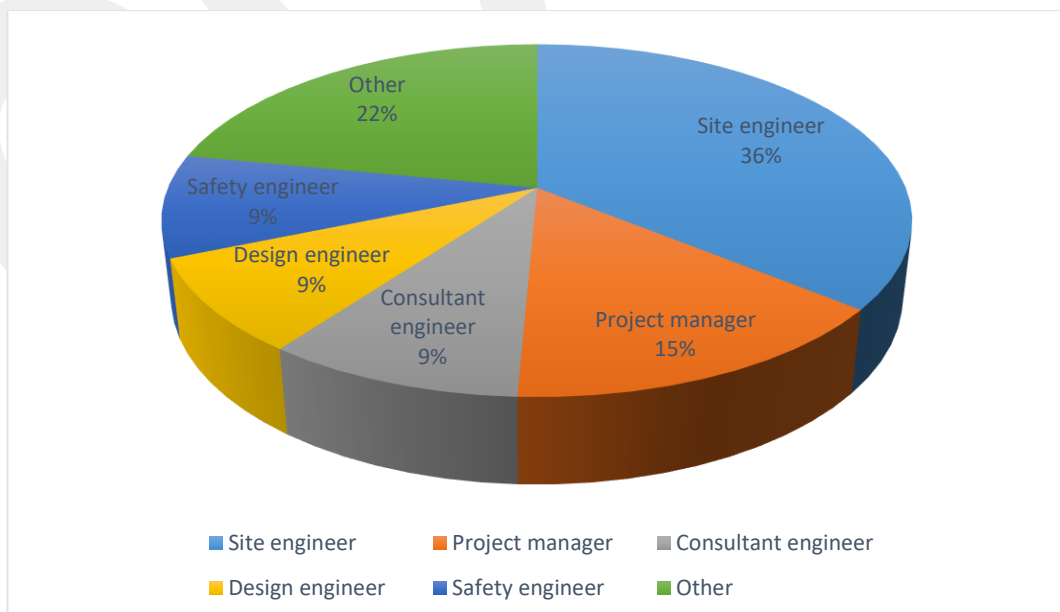
Given the importance of the collected data related to the institution's type and system in which the respondents work. Government institutions are the most reliable places for gathering information due to the great expertise and the size of the work assigned to them. As seen in Figure 5.1, experts working within the public (government) sectors constitute a larger portion of the respondents.



**Figure 5.1** Type of organization

### 5.2.2 Job Description

As shown in Figure 5.2, it was found that a large number of the respondents worked at the construction site constituting over 45% of the participants. This high percentage indicates that the respondents were well aware of the risks involved because of their practical experiences.



**Figure 5.2** Job description

### 5.2.3 Professional Experience

Results of the questionnaire showed that there is a large percentage of respondents, more than 50% (Figure 5.3), with professional experience ranging 6-15 years which signals dependability of the collected data.

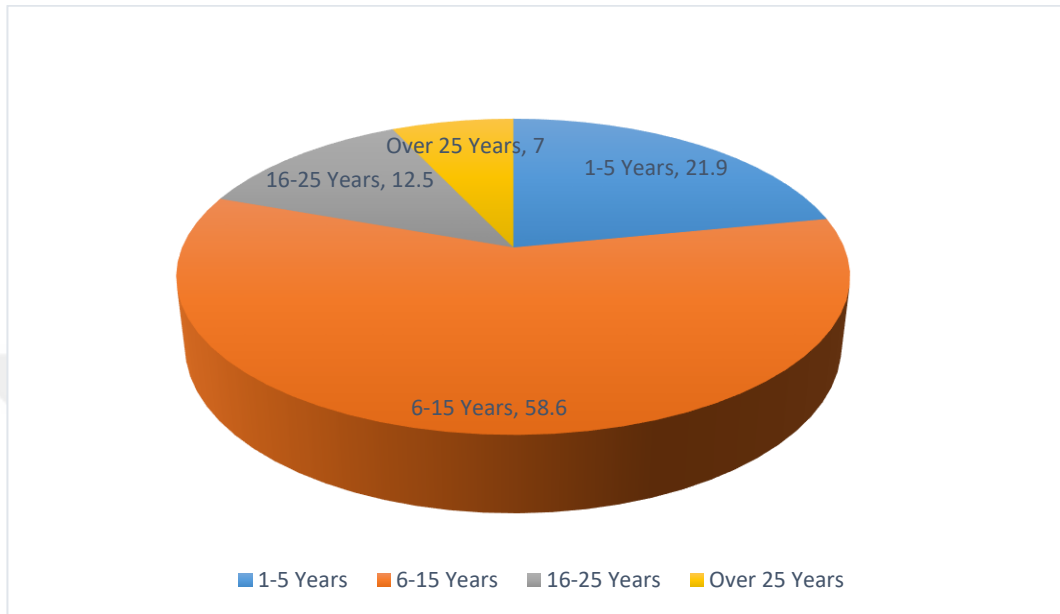
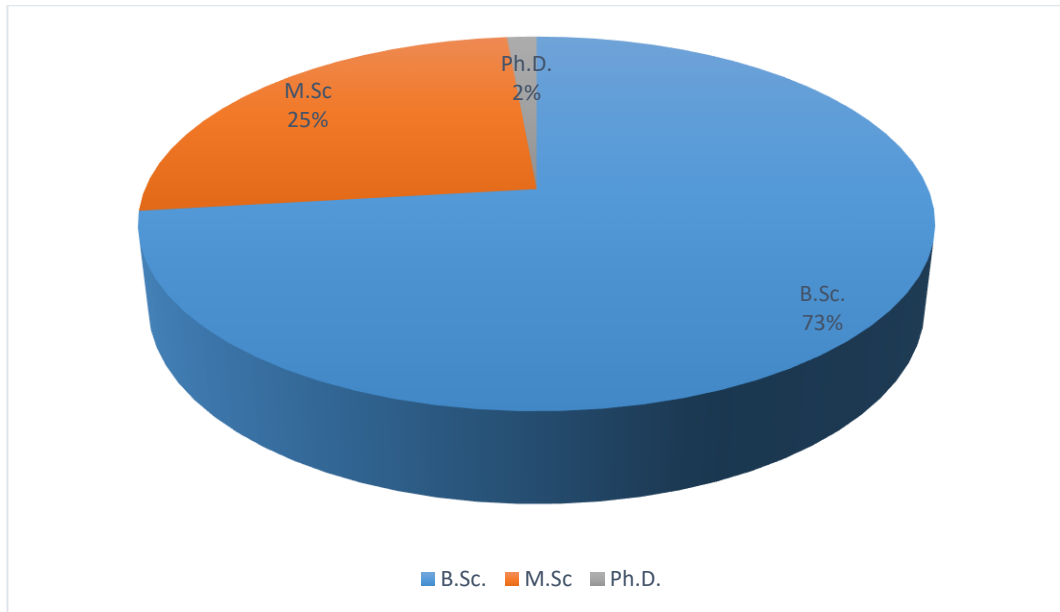


Figure 5.3 Professional experience

### 5.2.4 Level of Education

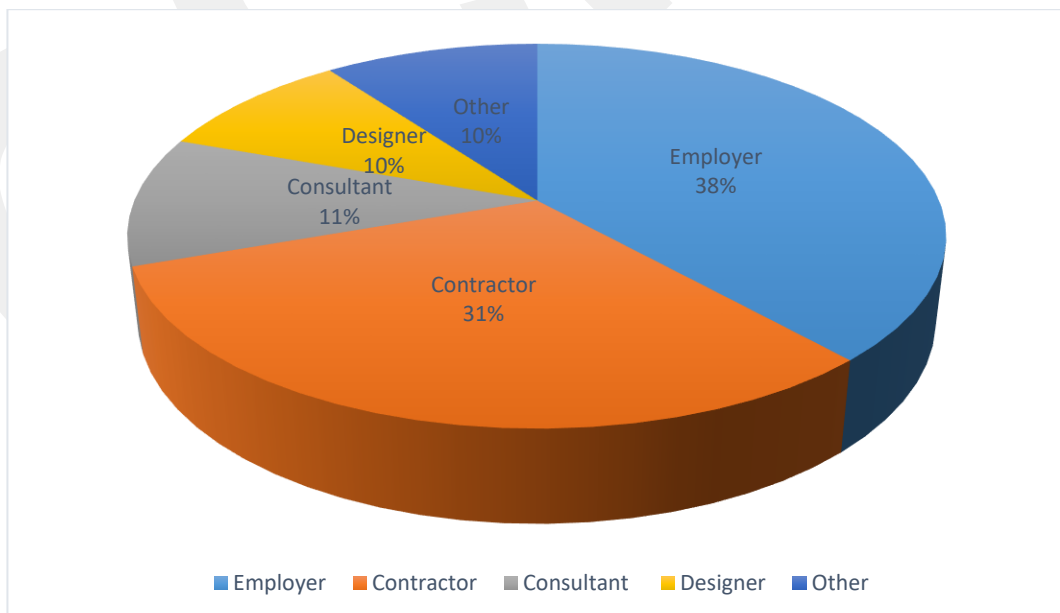
As given in Figure 5.4, engineers with a bachelor's degree represent 73% of the respondents while a high percentage of 27% describe engineers with higher levels of education.



**Figure 5.4** Level of education

### 5.2.5 Type of Company

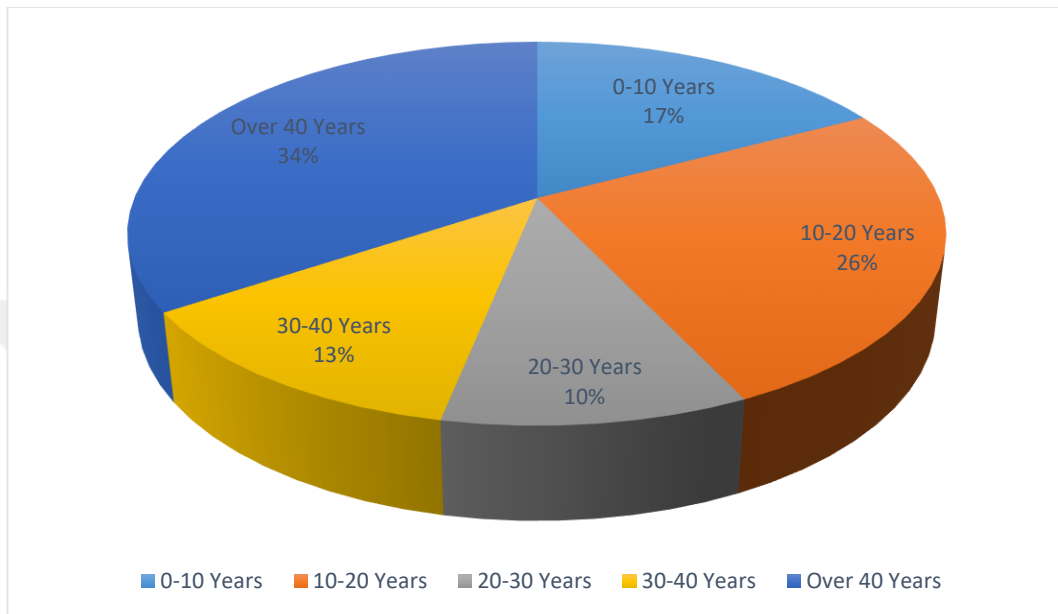
Figure 5.5 demonstrates the distribution of parties that had representative experts in this study's questionnaire survey. A significant percentage of the respondents referred to the type of company they worked in as either employer or contractor, followed by consultants and designers.



**Figure 5.5** Type of company

### 5.2.6 Age of the Company

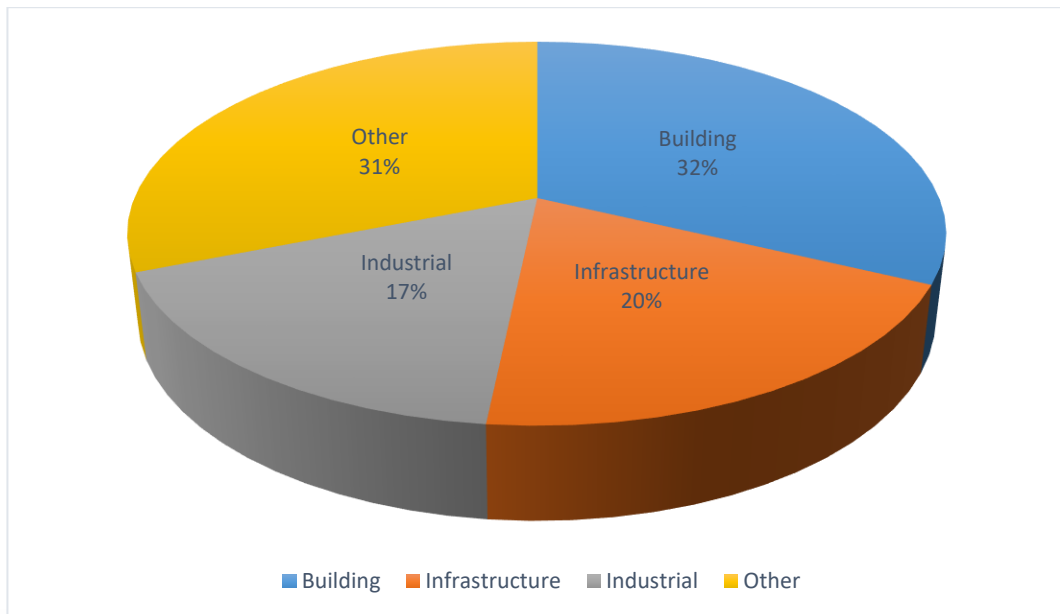
One of the important observations that the questionnaire brought to light was that the percentage of respondents working in institutions over 40 years of operation was 34% (Figure 5.6). Yet again this further increases the expected reliability of the results due to experiences of the companies accumulated over the many years of performance.



**Figure 5.6** Age of company

### 5.2.7 Field of Activity of the Company

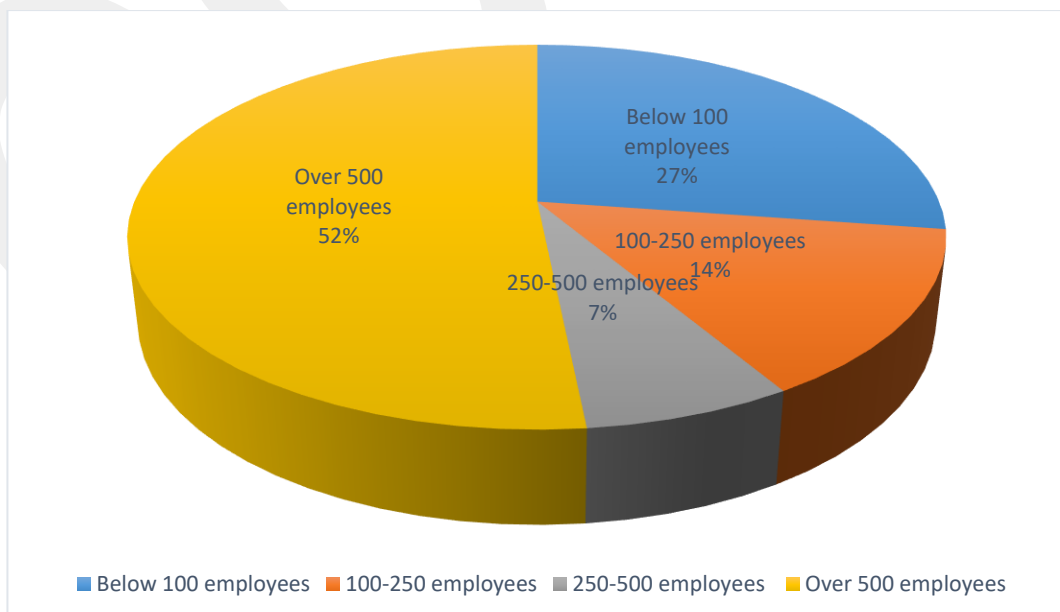
A major percentage of the companies that the respondents work for are found to operate in either infrastructure, industrial, or building sector (Figure 5.7). Since oil and gas fields incorporate numerous facilities and buildings, almost all the Iraqi companies operating in oil and gas fields are associated with the building and industry activity areas. Therefore, these two areas combined roughly stand for 50% of the companies performing in oil and gas industry in Iraq.



**Figure 5.7** Field of activity of the company

### 5.2.8 Size of Organization

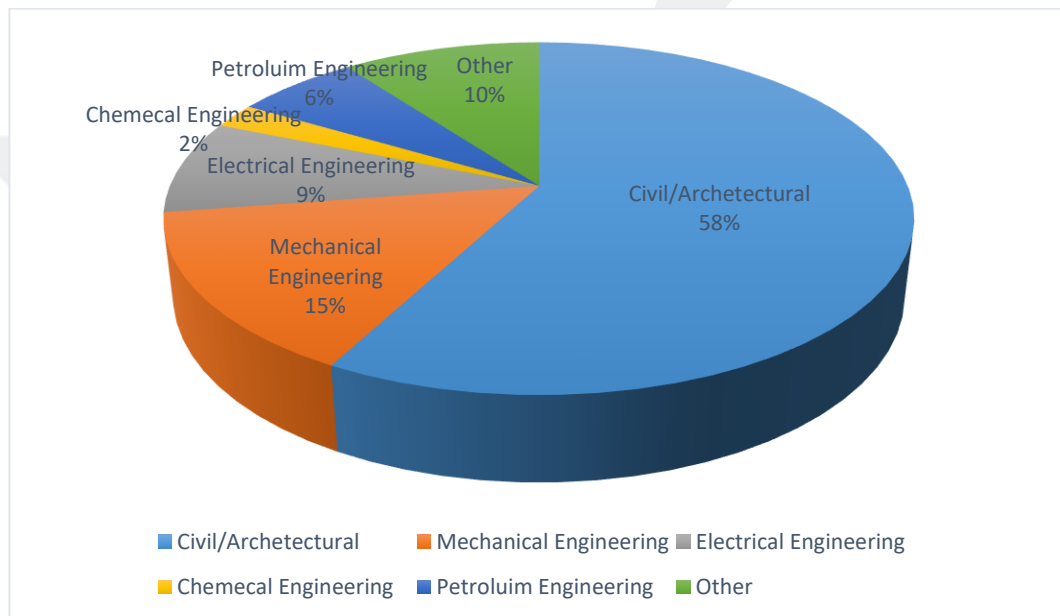
Figure 5.8 shows that 50% of respondents who participated in this questionnaire belongs to an organization that includes more than 500 employees. This percentage reflects individuals from the key players in oil and gas market has responded to the questions in the survey.



**Figure 5.8** Size of Organization

### 5.2.9 Major Field of Expertise

Expert engineers with a wide range of expertise have been included in this questionnaire. As seen in Figure 5.9, the largest number of respondents belong to civil engineers with approximate 58%. Obviously, this specialization is an essential expertise sought after in oil and gas projects, in that, such projects engage a plenty of construction works required for oil extractions. In addition, civil engineering is more closely related to the administrative risks and executive risks of the projects compared to the rest of the related engineering disciplines.



**Figure 5.9** Major field of expertise

### 5.3 Risk Assessment

Neither Iraq's Ministry of Oil nor oil companies in Iraq have risk register or contingency plans. The data collected using the questionnaires are used to analyze the risks associated with implementing oil and gas construction projects in Iraq and to find significant risk items with the greatest degree of seriousness that could negatively affect achieving project objectives. Risk assessment and analysis are carried out once by regarding the information collected from the first part of the questionnaire and only by using the probably and impact values assigned to the 70 risk items included. These analyses are detailed in section 5.3.1. Then, analyses are carried out by incorporating

the data obtained from the second part of the questionnaire in which respondents were asked to rank the 8 different risk categories. As a result, weighted risk magnitudes are calculated, result of which are described in section 5.3.2.

### 5.3.1 Prioritizing Risks using Risk Matrices

Responses are used to develop risk matrices to assess the risks and rank them thereof. Risk assessments are done based on the values assigned for likelihood and magnitude of each risk item. For a single respondent the severity of each factor can be determined as the product of probability and impact (Eq. 5.1). But in the case of numerous respondents, Eqs. (5.2) to (5.4) should be used.

$$Risk\ Magnitude = Probability \times Impact \quad (5.1)$$

$$Mean\ P = \frac{\sum_{i=1}^N Probability_i}{N} \quad (5.2)$$

$$Mean\ I = \frac{\sum_{i=1}^N Impact_i}{N} \quad (5.3)$$

$$RS = Mean\ P \times Mean\ I \quad (5.4)$$

where;  $N$  stands for the number of respondents;  $Mean\ P$  denotes the average probability value;  $Mean\ I$  denotes average impact value; and  $RS$  denotes risk score or the overall magnitude based on multiple responses. In order to adopt the abovementioned equations, respondents were asked to use the grading scale given in Table 5.1 to assign values for probability and impact of the risk items.

**Table 5.1** Grading scale for probability and impact

Value	Probability	Impact
1	Rare (Not occurred before)	Insignificant (Negligible effect)
2	Unlikely (Rarely occurs)	Minor (Minimal effect)
3	Feasible (Possible but not common)	Moderate (Rather a significant effect)
4	Likely (Occurred before and will again)	Major (Considerable effect)
5	Almost Certain (Occurs frequently)	Critical (Catastrophic effect)

As mentioned earlier, Eq. (5.1) is used to calculate the risk magnitude. Based on the values found, and the mapping provided in Tables 5.2 and 5.3, risks will be classified into three levels of significance of high, moderate, and low.

**Table 5.2** Risks classification chart

Risk Significance	Magnitude Range
High	11-25
Moderate	5-10
Low	1-4

**Table 5.3** Risk classification matrix

Probability	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
	Impact					

Using the equation and the charts discussed above, risk magnitudes are measured for all the items following the same procedure. The first risk item included in the questionnaire, i.e., ‘Toxic gas (H<sub>2</sub>S) emissions during well drilling’, is taken as an example to illustrate the procedure applied for calculation of the overall magnitude of each risk item – denoted as *RS* (Risk Score) – based on the responses of 143 participants. The probability and impact values assigned by each of the 143 respondents for this risk item are tabulated in Table 5.4.

**Table 5.4** Probability and impact values assigned for ‘Toxic gas (H2S) emissions during well drilling’ risk item

<b>No.</b>	<b>Prob.</b>	<b>Impact</b>	<b>No.</b>	<b>Prob.</b>	<b>Impact</b>	<b>No.</b>	<b>Prob.</b>	<b>Impact</b>
1	1	5	19	5	5	37	3	2
2	4	1	20	1	1	38	3	3
3	3	3	21	1	4	39	4	3
4	3	4	22	1	5	40	5	5
5	1	5	23	4	4	41	3	3
6	3	4	24	4	3	42	2	2
7	3	2	25	1	2	43	1	5
8	3	5	26	2	3	44	3	4
9	4	5	27	4	4	45	4	3
10	4	5	28	1	2	46	4	4
11	4	4	29	3	3	47	3	5
12	2	4	30	3	1	48	1	2
13	4	4	31	5	5	49	5	5
14	2	3	32	3	3	50	4	4
15	2	2	33	3	3	51	5	4
16	1	1	34	3	3	52	4	5
17	3	3	35	4	5	53	3	2
18	1	1	36	3	2	54	2	1
55	4	4	77	1	2	99	2	5
56	5	4	78	3	3	100	3	3
57	1	5	79	5	5	101	3	4
58	1	2	80	3	3	102	4	4
59	1	2	81	1	5	103	3	4
60	2	5	82	3	2	104	4	3
61	1	1	83	4	2	105	3	4
62	1	1	84	5	1	106	3	5
63	4	4	85	1	5	107	4	3
64	1	1	86	2	4	108	4	5
65	5	4	87	4	2	109	5	5
66	4	3	88	4	2	110	5	5
67	2	5	89	2	5	111	4	3
68	1	3	90	5	4	112	3	3
69	5	5	91	4	2	113	4	4
70	1	1	92	3	4	114	2	3

**Table 5.4** Probability and impact values assigned for ‘Toxic gas (H2S) emissions during well drilling’ risk item (cont’d)

No.	Prob.	Impact	No.	Prob.	Impact	No.	Prob.	Impact
71	1	4	93	2	3	115	2	3
72	4	3	94	3	4	116	2	3
73	2	5	95	2	3	117	4	4
74	4	4	96	2	3	118	4	5
75	4	5	97	1	1	119	3	4
76	1	5	98	3	2	120	3	5
121	3	5	129	4	5	137	3	2
122	4	4	130	4	5	138	2	1
123	1	5	131	4	5	139	2	4
124	2	4	132	5	4	140	4	5
125	4	3	133	3	3	141	3	4
126	3	4	134	3	4	142	2	4
127	4	3	135	4	5	143	2	4
128	4	3	136	5	5	<b>Sum.</b>	<b>423</b>	<b>499</b>

As shown in table 5.4, summation of all the impact and probability values are equal to 423 and 499, respectively. These values are used as described in Eqs. (5.5) to (5.7) to find *RS* of ‘Toxic gas (H2S) emissions during well drilling’ risk item. The same procedure is applied to the rest of the risk items as well.

$$Mean P = \frac{\sum_{i=1}^N Probability_i}{N} = \frac{423}{143} = 2.95 \quad (5.5)$$

$$Mean I = \frac{\sum_{i=1}^N Impact_i}{N} = \frac{499}{143} = 3.48 \quad (5.6)$$

$$RS = Mean P \times Mean I = 2.95 \times 3.48 = 10.32 \quad (5.7)$$

The abovementioned procedure is applied to all the risk items using SPSS program and the obtained results are summarized in Table 5.5. In addition to *RS*s, standard deviation amounts are also calculated to measure the spread of the probability and the impact values. The first column in Table 5.5 denotes the order of the risk item on the questionnaire shown in Appendix A, e.g., ‘1’ stands for ‘Toxic gas (H2S) emissions during well drilling’ item.

**Table 5.5** *RS* values calculated based on responses of all participants

<b>No.</b>	<b>Mean <i>P</i></b>	<b>Mean <i>I</i></b>	<b>Std. Deviation</b>	<b><i>RS</i></b>
1	2.95		1.27	10.32
		3.48	1.27	
2	2.36		1.28	7.40
		3.13	1.28	
3	3.45		1.10	11.11
		3.21	0.97	
4	2.67		1.28	10.03
		3.74	1.29	
5	3.09		1.18	8.77
		2.83	1.09	
6	2.67		1.14	7.79
		2.90	1.08	
7	2.79		1.11	8.56
		3.06	1.12	
8	3.10		1.18	9.68
		3.11	1.13	
9	2.62		1.12	8.06
		3.07	1.13	
10	2.95		1.26	8.21
		2.77	1.06	
11	3.24		1.13	11.07
		3.41	1.11	
12	2.95		1.24	7.59
		2.56	1.12	
13	2.47		1.11	8.29
		3.34	1.21	
14	2.60		1.06	8.55
		3.27	1.21	
15	2.67		1.14	8.76
		3.27	1.21	
16	2.60		1.21	8.77
		3.36	1.34	
17	2.60		1.09	8.60
		3.30	1.13	
18	2.79		1.17	9.46
		3.38	1.08	
19	2.64		1.124	9.39
		3.55	1.19	
20	2.83		1.138	9.88
		3.48	1.08	
21	3.37		1.13	12.99
		3.84	1.12	

**Table 5.5** *RS* values calculated based on responses of all participants (cont'd)

<b>No.</b>	<b>Mean <i>P</i></b>	<b>Mean <i>I</i></b>	<b>Std. Deviation</b>	<b><i>RS</i></b>
22	2.37		0.94	6.94
		2.92	1.11	
23	2.75		1.16	8.13
		2.95	1.05	
24	3.09		1.08	10.55
		3.40	1.00	
25	3.22		1.17	11.13
		3.45	1.09	
26	2.57		1.02	9.53
		3.70	1.18	
27	3.03		0.99	9.59
		3.16	1.03	
28	2.73		1.10	9.61
		3.51	1.17	
29	2.79		1.17	9.58
		3.42	1.12	
30	2.59		1.07	8.16
		3.14	1.10	
31	2.88		0.99	10.17
		3.53	1.10	
32	2.67		1.01	8.66
		3.24	1.17	
33	2.58		1.07	8.37
		3.23	1.25	
34	2.74		1.08	8.95
		3.26	1.09	
35	3.13		1.02	11.50
		3.66	1.01	
36	2.99		1.09	11.03
		3.68	1.00	
37	2.74		1.02	8.66
		3.15	1.05	
38	2.57		1.12	8.36
		3.25	1.14	
39	2.74		1.01	8.24
		3.0	1.08	
40	2.69		1.03	8.90
		3.30	1.10	
41	2.65		1.00	8.26
		3.11	0.96	
42	2.60		1.14	8.67
		3.33	1.19	
43	2.77		1.18	8.98
		3.23	1.18	

**Table 5.5** *RS* values calculated based on responses of all participants (cont'd)

<b>No.</b>	<b>Mean <i>P</i></b>	<b>Mean <i>I</i></b>	<b>Std. Deviation</b>	<b><i>RS</i></b>
44	2.93		1.19	10.55
		3.60	1.09	
45	2.89		1.09	9.37
		3.23	1.04	
46	2.83		1.12	10.04
		3.53	1.11	
47	2.65		1.02	9.38
		3.53	1.16	
48	2.55		1.20	8.05
		3.14	1.19	
49	2.75		1.25	9.86
		3.58	1.13	
50	2.66		1.16	8.57
		3.21	1.04	
51	3.11		1.09	10.64
		3.41	1.04	
52	2.75		1.12	10.01
		3.63	1.13	
53	2.83		1.02	8.89
		3.13	1.01	
54	2.70		1.14	9.40
		3.47	1.06	
55	3.18		1.13	11.01
		3.45	1.09	
56	2.38		1.23	9.27
		3.88	1.37	
57	2.53		1.05	8.62
		3.39	1.06	
58	3.02		1.18	11.11
		3.67	0.98	
59	3.24		1.13	12.57
		3.87	0.90	
60	3.32		1.19	11.77
		3.53	1.20	
61	2.77		1.05	9.49
		3.41	1.01	
62	2.70		1.00	8.72
		3.22	1.01	
63	2.53		0.91	7.79
		3.06	0.96	
64	2.81		1.04	9.23
		3.28	0.94	
65	2.86		1.01	9.10
		3.17	1.04	

**Table 5.5** *RS* values calculated based on responses of all participants (cont'd)

No.	<i>Mean P</i>	<i>Mean I</i>	Std. Deviation	<i>RS</i>
66	3.04		1.02	9.70
		3.18	1.04	
67	2.67		1.03	8.65
		3.23	1.05	
68	2.65		0.99	9.08
		3.42	1.12	
69	2.62		1.02	9.40
		3.58	1.16	
70	3.06		1.10	9.61
		3.13	1.15	

Table 5.6 given below demonstrates the same data covered in Table 5.4, but here the entries are sorted in descending order with respect to the associated risk item's significance, i.e., *RS* value. As seen in Table 5.6, 'Instability in global oil and gas prices', 'Difficulties due to security situations in Iraq', 'Instability in the political system in Iraq and political discordant', 'The delay in the arrival of the imported machinery and tools to the oil field promptly (due to customs clearance or other reasons)', 'Delay or pause in payments to the workforce through project execution due to various reasons', 'Losses incurred due to corruption and bribery', 'Being exposed to extreme (high) temperature', 'Oil or gas pipelines and wellhead passes through farms (problems with farmers)', 'Using machines, equipment, and tools without proper training', and 'Delay in approval of design documents' risk items with the greatest significance of beyond 11 *RS* are highlighted in accord with the charts specified in Tables 5.2 and 5.3.

**Table 5.6** *RS* values calculated based on responses of all participants in descending order

No.	Risk Item	Probability	Impact	<i>RS</i>
21	Instability in global oil and gas prices	3.38	3.85	12.99
59	Difficulties due to security situations in Iraq	3.24	3.87	12.57
60	Instability in the political system in Iraq and political discordant	3.33	3.54	11.78
35	The delay in the arrival of the imported machinery and tools to the oil field promptly (due to customs clearance or other reasons)	3.14	3.66	11.51

**Table 5.6** *RS* values calculated based on responses of all participants in descending order (cont'd)

No.	Risk Item	Probability	Impact	<i>RS</i>
25	Delay or pause in payments to the workforce through project execution due to various reasons	3.22	3.45	11.14
58	Losses incurred due to corruption and bribery	3.03	3.67	11.12
3	Being exposed to extreme (high) temperature	3.45	3.22	11.11
11	Oil or gas pipelines and wellhead passes through farms (problems with farmers)	3.24	3.41	11.07
36	Using machines, equipment, and tools without proper training	2.99	3.69	11.03
55	Delay in approval of design documents	3.19	3.45	11.02
51	Design changes	3.12	3.41	10.64
44	Lack of pollution prevention equipment	2.93	3.6	10.55
24	The delay in the issuance of advance payments to the general contractor by the employer	3.1	3.41	10.55
1	Toxic gas (H <sub>2</sub> S) emissions during well drilling	2.96	3.49	10.32
31	Shortage of skilled workers	2.88	3.53	10.17
46	Equipment failure	2.84	3.54	10.05
4	Fire and explosion	2.68	3.75	10.04
52	Poor design	2.76	3.64	10.02
20	Inadequate insurance coverage	2.83	3.49	9.88
49	Accidents that occur due to the lack of safety in the oil and gas fields	2.76	3.58	9.86
66	Type of project bidding and contract award mechanism (negotiation, lowest bid, etc.)	3.04	3.19	9.7
8	The intersection of oil pipelines with major and minor rivers or major and minor roads	3.1	3.12	9.68
28	Improper project feasibility study	2.73	3.52	9.62
70	Construction contract type (lump-sum, cost-plus, unit price, etc.)	3.06	3.14	9.62
27	High prices of materials and equipment required to carry out civil works in the oil and gas field	3.03	3.16	9.59
29	Shortage of supplies (electricity, water, fuel, etc.)	2.8	3.43	9.58
26	Unexpected funding termination for the general contractor in the oil and gas sector	2.57	3.71	9.54
61	Lack of formal and written contingency plan from the contractor or the owner	2.78	3.42	9.49
18	Legal disputes between the general contractor and governmental oil and gas sector (owner)	2.8	3.38	9.47

**Table 5.6** *RS* values calculated based on responses of all participants in descending order (cont'd)

No.	Risk Item	Probability	Impact	<i>RS</i>
69	Inadequate financial capacity of the general contractor or the owner	2.62	3.59	9.41
54	The mismatch between the designs and the actual implementation of the work item	2.71	3.48	9.41
19	The bankruptcy of the contractor	2.64	3.55	9.39
47	Low quality of building materials	2.66	3.53	9.38
45	Shortage of new technologies	2.9	3.24	9.37
56	Terrorist attacks were targeting oil and gas structures during implementation	2.38	3.89	9.27
64	Ineffective delay penalties and bonus payments	2.81	3.29	9.24
65	Delay to furnish and deliver the site to the contractor by the owner	2.87	3.17	9.1
68	Lack of technical experience or know-how of the contractor	2.65	3.43	9.08
43	The absence of a risk-register for the previously completed construction projects in the oil fields	2.78	3.24	8.99
34	Short tendering time	2.74	3.27	8.95
40	Lack of knowledge about the team members' actual responsibilities	2.69	3.31	8.91
53	The complexity of project design	2.83	3.14	8.89
5	Presence of groundwater in the oilfield	3.1	2.83	8.77
16	Uncertainty and unfairness of court justice	2.61	3.36	8.77
15	Improper verification of contract document	2.68	3.27	8.77
62	Minimal duration in the original contract	2.71	3.22	8.72
42	Lack of specialty contractors in oil and gas field works	2.6	3.34	8.68
32	Improper project organization structure	2.67	3.24	8.67
37	The difficulty of obtaining licenses and work permits for the general contractor	2.75	3.15	8.67
67	Problems with permits and the difficulty of issuing them for foreign companies in a contract	2.68	3.23	8.65
57	Cost increases due to changes in government policies	2.54	3.4	8.63
17	Lack of legal clarity for the work contracts with the general contractors	2.61	3.3	8.61
50	Changes in the quantities of the work items during the implementation stage without documentation	2.66	3.22	8.57
7	Unforeseen underground/soil conditions, Central Process Facility (CPF), within pipeline, or flow line implementation	2.79	3.07	8.57
14	Lack of knowledge of arbitration	2.61	3.28	8.55
33	Deficient monitoring or follow up of the wells, pipelines, tanks, etc.	2.59	3.24	8.38

**Table 5.6** *RS* values calculated based on responses of all participants in descending order (cont'd)

No.	Risk Item	Probability	Impact	<i>RS</i>
38	Poor communication between the general contractor and the owner in the oil and gas field	2.57	3.25	8.37
13	Breach of contract by project parties	2.48	3.35	8.29
41	Unclear or imprecise definition of the work items by the owner in the oil and gas sector	2.65	3.12	8.27
39	A change in the management of the oil field throughout the implementation period	2.74	3.01	8.24
10	Oil or gas fields are located in remote areas and difficult to reach	2.96	2.78	8.21
30	Inadequate forecast on the market demand	2.59	3.15	8.16
23	Fluctuation in the exchange rates	2.76	2.95	8.13
9	Exposure of oil fields to floods or high rain rate in winter or extreme weather conditions	2.62	3.08	8.07
48	Difficulty in following government standard codes and practices	2.56	3.15	8.05
63	Inadequate definition of substantial completion	2.54	3.07	7.79
6	Difficulty in accessing the oil or gas wells	2.68	2.91	7.79
12	Unofficial holidays	2.96	2.57	7.59
2	Pandemic or epidemic spread	2.36	3.13	7.4
22	Changes in bank formalities and regulations	2.38	2.92	6.95

According to the highest-ranked risk items shown in Table 5.6, it can be observed that ‘Financial Risks’, ‘Security and Political Risks’ and ‘Logistical and Administrative Risks’ categories account for the greatest number of significant items.

### 5.3.1.1 Cronbach’s Alpha ( $\alpha$ ) Reliability Analysis

Alpha was developed by Lee Cronbach in 1951 [55] to provide a measure of the internal consistency of a test or scale which is expressed as a number between 0 and 1. Cronbach’s Alpha is the most common measure of reliability (internal consistency) and is generally used when multiple Likert questions are included in a questionnaire survey [56,57]. It demonstrates the extent to which the items measure the same concept; thus, it is connected to the inter-relatedness of the items in the survey. That is, a low value of alpha could be due to poor inter-relatedness among the items and indicates some should be discarded or revised. In addition, a low value of alpha could

also indicate that the participants have not responded to the items consistently [58]. A rule of thumb for interpreting  $\alpha$  for Likert scale questions is given in Table 5.7.

**Table 5.7** Acceptability of Alpha Values

<b>Cronbach's Alpha</b>	<b>Reliability</b>
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

SPSS program was used to measure reliability ( $\alpha$  values) for the 70 risk items grouped under the eight risk categories. Results of the analyses are summarized in Table 5.8 which suggest that the items have relatively high internal consistency since all values for  $\alpha$  lie within either the 'Acceptable' or 'Good' range as per the ranges given in Table 5.7. That is, the items in the questionnaire are highly correlated and that participants have responded consistently to the risk items.

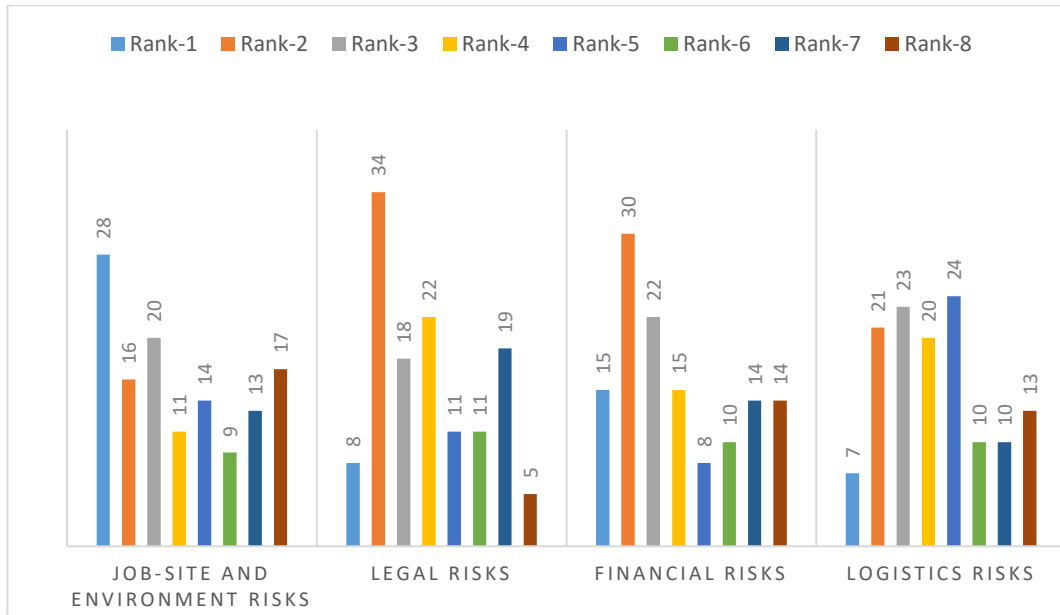
**Table 5.8** Reliability Cronbach's Alpha and Data Validity

<b>Risk Item</b>	<b>No. of items</b>	<b>Reliability (Cronbach's Alpha)</b>
Job-site and Environmental Risks	22	0.83
Legal and Social Risks	14	0.87
Financial Risks	18	0.88
Logistical and Administrative Risks	32	0.92
Technical Risks	14	0.86
Design	10	0.82
Security and Political	10	0.79
Contractual Risks	20	0.89

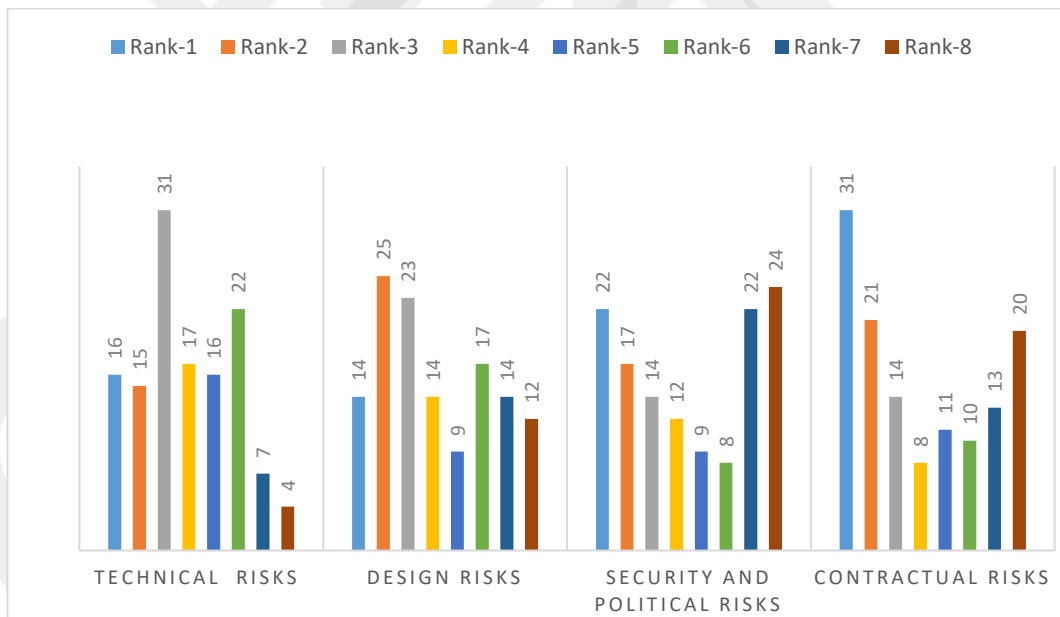
### 5.3.2 Prioritizing Risks by Incorporating the Ranks of the Risk Categories

As stated earlier, in the second part of the questionnaire, some open-ended questions were contained to allow the respondents to clarify their responses and to let them forward their opinions and suggestions generously. In one of these questions ('Q. 72') the experts, based on their past experiences, were asked to sort the 8 risk categories of 'Job-site and Environmental Risks', 'Legal and Social Risks', 'Financial Risks', 'Logistical and Administrative Risks', 'Technical Risks', 'Design Risks', 'Security and Political Risks', and 'Contractual Risks' in a descending order with respect to their significance. Despite 143 responses from 143 individuals were collected, 15 of them provided ambiguous or incomplete information for 'Q. 72'. Therefore, those 15 responses were discarded and not included in the evaluations. Consequently, for this question only the responses of 128 respondents were explored.

The information gathered for this question is abstracted in Figures 5.10 and 5.11. Figure 5.10 compiles the rankings for 'Job-site and Environmental Risks', 'Legal and Social Risks', 'Financial Risks', and 'Logistical and Administrative Risks' categories while the arrangements for 'Technical Risks', 'Design Risks', 'Security and Political Risks', and 'Contractual Risks' categories are summarized in Figure 5.11. In both the figures, for any specific category, Rank-1 bar represents the number of the respondents that have pointed out this category to be the most significant one; Rank-2 bar shows the number of experts referring this category as the second most significant one; and so forth. For instance, for 'Security and Political Risks' category shown in Figure 5.11, 22 experts indicate this category to be the most critical, 17 experts rank it the second critical, 14 experts rank it as the third significant category, and etc.



**Figure 5.10** Significance of risk categories according to engineers' experiences (1/2)



**Figure 5.11** Significance of risk categories according to engineers' experiences (2/2)

The values depicted in Figures 5.10 and 5.11 are used to calculate a uniform rank for the risk categories whereby the associated weights are also determined. To this end, Eqs. 5.8 to 5.11 are used as follows.

$$Magnitude_i = \frac{\sum_{j=1}^c ((c+1)-j) \times r_{ij}}{c(c+1)/2} \quad (5.8)$$

$$\sum_{j=1}^c r_{ij} = N \quad (5.9)$$

$$c = |Ctg| \quad (5.10)$$

$$\forall i \in Ctg = \{Category-1, \dots, Category-c\} \quad (5.11)$$

where;  $i$  denotes risk category;  $j$  stands for rank number;  $Ctg$  is a set holding all the risk categories;  $c$  denotes cardinality of set  $Ctg$ ;  $r_{ij}$  denotes the number of respondents that have appointed  $j$ th rank to  $i$ th category; and  $N$  denotes number of respondents. Afterwards, categories are ranked in descending order with respect to *Magnitude* values found by means of Eq. (5.8). Resultantly, for the  $i$ th risk category with  $Rank_i$ , the associated weight is measured using Eq. (5.12).

$$w_i = (c + 1) - Rank_i \quad (5.12)$$

For example, for ‘Job-site and Environmental Risks’ category shown in Figure 5.10, the associated rank and weight are calculated as shown in Eqs. (5.13) and (5.14). Similar procedure is applied for all the categories and the results are provided in Table 5.9.

$$Magnitude_1 = \frac{\sum_{j=1}^8 ((8+1)-j) \times r_{1j}}{8(8+1)/2} \quad (5.13)$$

$$Magnitude_1 = \frac{(8 \times 28) + (7 \times 16) + \dots + (1 \times 17)}{36} = 17.69 \quad (5.14)$$

**Table 5.9** Rank and weight of each risk category according to ‘Q. 72’

Risk Category	Magnitude	Rank	Weight
1. Job-site and Environmental Risks	17.69	5	4
2. Legal and Social Risks	17.77	3	6
3. Financial Risks	17.80	2	7
4. Logistical and Administrative Risks	16.66	8	1
5. Technical Risks	18.11	1	8
6. Design Risks	17.27	6	3
7. Security and Political Risks	16.00	7	2
8. Contractual Risks	17.75	4	5

With regard to the results provided in Table 5.9, ‘Technical Risks’, ‘Financial Risks’, and ‘Legal and Social Risks’ are found to be the first three critical categories. Eventually, category weights listed in the last column of Table 5.9 are used to determine the weighted *RSs*, i.e., weighted significance, for every risk item (Table 5.10) by multiplying the *RSs* shown in Tables 5.5 and 5.6 by the weight of their corresponding risk category. Subsequently, as highlighted in Table 5.10, ‘Instability in global oil and gas prices’, ‘Lack of pollution prevention equipment’, ‘Equipment failure’, ‘Accidents that occur due to the lack of safety in the oil and gas fields’, ‘Delay or pause in payments to the workforce through project execution due to various reasons’, ‘Poor quality of building materials’, ‘Shortage of new technologies’, ‘The delay in the issuance of advance payments to the general contractor by the employer’, ‘Inadequate insurance coverage’, and ‘Changes in the quantities of the work items during the implementation stage without documentation’ risk items with the greatest weighted *RSs* are found to be the first ten most critical risk items.

**Table 5.10** Weighted *RS* values calculated based on responses to ‘Q. 72’

No.	Risk Item	<i>RS</i>	Category Weight	Weighted <i>RS</i>
<b>I</b>	<b>Job-site and Environmental Risks</b>			
1	Toxic gas (H <sub>2</sub> S) emissions during well drilling.	10.32	4	41.28
2	Pandemic or epidemic spread.	7.40		29.61
3	Being exposed to extreme (high) temperature.	11.11		44.44
4	Fire and explosion.	10.03		40.15
5	Presence of groundwater in the oilfield.	8.77		35.09
6	Difficulty in accessing the oil or gas wells.	7.79		31.16
7	Unforeseen underground/soil conditions, Central Process Facility (CPF), within pipeline, or flow line implementation.	8.56		34.26
8	The intersection of oil pipelines with major and minor rivers or major and minor roads.	9.68		38.73

**Table 5.10** Weighted *RS* values calculated based on responses to ‘Q. 72’ (cont’d)

No.	Risk Item	<i>RS</i>	Category Weight	Weighted <i>RS</i>
9	Exposure of oil fields to floods or high rain rate in winter or extreme weather conditions.	8.06		32.27
10	Oil or gas fields are located in remote areas and difficult to reach.	8.21		32.84
11	Oil or gas pipelines and wellhead passes through farms (problems with farmers).	11.07		44.29
<b>II</b>	<b>Legal and Social Risks</b>			
12	Unofficial holidays.	7.59	6	45.54
13	Breach of contract by project parties.	8.29		49.75
14	Lack of knowledge of arbitration.	8.55		51.32
15	Improper verification of contract document.	8.76		52.59
16	Uncertainty and unfairness of court justice.	8.77		52.63
17	Lack of legal clarity for the work contracts with the general contractors.	8.60		51.65
18	Legal disputes between the general contractor and governmental oil and gas sector (owner).	9.46		56.80
<b>III</b>	<b>Financial Risks</b>			
19	The bankruptcy of the contractor.	9.39	7	65.73
20	Inadequate insurance coverage.	9.88		69.17
21	Instability in global oil and gas prices.	12.99		90.93
22	Changes in bank formalities and regulations.	6.94		48.64
23	Fluctuation in the exchange rates.	8.13		56.91
24	The delay in the issuance of advance payments to the general contractor by the employer.	10.55		73.85
25	Delay or pause in payments to the workforce through project execution due to various reasons.	11.13		77.95
26	Unexpected funding termination for the general contractor in the oil and gas sector.	9.53		66.75
27	High prices of materials and equipment required to carry out civil works in the oil and gas field.	9.59		67.15
<b>IV</b>	<b>Logistical and Administrative Risks</b>			

**Table 5.10** Weighted *RS* values calculated based on responses to ‘Q. 72’ (cont’d)

No.	Risk Item	<i>RS</i>	Category Weight	Weighted <i>RS</i>
28	Improper project feasibility study.	9.61	1	9.61
29	Shortage of supplies (electricity, water, fuel, etc.).	9.58		9.58
30	Inadequate forecast on the market demand.	8.16		8.16
31	Shortage of skilled workers.	10.17		10.17
32	Improper project organization structure.	8.66		8.66
33	Deficient monitoring or follow up of the wells, pipelines, tanks, etc.	8.37		8.37
34	Short tendering time.	8.95		8.95
35	The delay in the arrival of the imported machinery and tools to the oil field on time (due to customs clearance or other reasons).	11.50		11.50
36	Using machines, equipment, and tools without proper training.	11.03		11.03
37	The difficulty of obtaining licenses and work permits for the general contractor.	8.667		8.667
38	Poor communication between the general contractor and the owner in the oil and gas field.	8.368		8.368
39	A change in the management of the oil field throughout the implementation period.	8.24		8.24
40	Lack of knowledge about the team members’ actual responsibilities.	8.90		8.90
41	Unclear and/or imprecise definition of the work items by the oil and gas sector owner.	8.26		8.26
42	Lack of specialty contractors in oil and gas field works.	8.67		8.67
43	The absence of a risk-register for the previously completed construction projects in the oil fields.	8.98	8.98	
<b>V</b>	<b>Technical Risks</b>			
44	Lack of pollution prevention equipment.	10.55	8	84.41
45	Shortage of new technologies.	9.37		74.98
46	Equipment failure.	10.04		80.36
47	Poor quality of building materials.	9.38		75.07

**Table 5.10** Weighted *RS* values calculated based on responses to ‘Q. 72’ (cont’d)

No.	Risk Item	<i>RS</i>	Category Weight	Weighted <i>RS</i>
48	Difficulty in following government standard codes and practices.	8.05		64.43
49	Accidents that occur due to the lack of safety in the oil and gas fields.	9.86		78.91
50	Changes in the quantities of the work items during the implementation stage without documentation.	8.57		68.56
<b>VI</b>	<b>Design Risks</b>			
51	Design changes.	10.64	3	31.92
52	Poor design.	10.01		30.05
53	The complexity of project design.	8.89		26.67
54	The mismatch between the designs and the actual implementation of the work item.	9.40		28.21
55	Delay in approval of design documents.	11.01		33.04
<b>VII</b>	<b>Security and Political Risks</b>			
56	Terrorist attacks were targeting oil and gas structures during implementation.	9.27	2	18.54
57	Cost increases due to changes in government policies.	8.62		17.25
58	Losses incurred due to corruption and bribery.	11.11		22.23
59	Difficulties due to security situations in Iraq.	12.57		25.14
60	Instability in the political system in Iraq and political discordant.	11.77		23.55
<b>VIII</b>	<b>Contractual Risks</b>			
61	Lack of formal and written contingency plan from a contractor or the owner.	9.49	5	47.46
62	Very limited duration in the original contract.	8.72		43.62
63	Inadequate definition of substantial completion.	7.79		38.96
64	Ineffective delay penalties and/or bonus payments.	9.23		46.19
65	Delay to furnish and deliver the site to the contractor by the owner.	9.10		45.51

**Table 5.10** Weighted *RS* values calculated based on responses to ‘Q. 72’ (cont’d)

No.	Risk Item	<i>RS</i>	Category Weight	Weighted <i>RS</i>
66	Type of project bidding and contract award mechanism (negotiation, lowest bid, etc.).	9.70		48.50
67	Problems with permits and the difficulty of issuing them for foreign companies in a contract.	8.65		43.26
68	Lack of technical experience and/or know-how of the contractor.	9.08		45.40
69	Inadequate financial capacity of the general contractor or the owner.	9.40		47.03
70	Construction contract type (lump-sum, cost-plus, unit price, etc.).	9.61		48.08

### 5.3.3 Discussion of the Results

Two complementary risk rankings are illustrated in this thesis. Initially, risks are ranked only with respect to the results of risk matrices (as discussed in section 5.3.1). Afterwards, the weights of the corresponding risk categories are also incorporated in the ranking of the risk items (as discussed in section 5.3.2). With respect to the first ranking, ‘Instability in global oil and gas prices’, ‘Difficulties due to security situations in Iraq’, ‘Instability in the political system in Iraq and political discordant’, ‘The delay in the arrival of the imported machinery and tools to the oil field promptly (due to customs clearance or other reasons)’, ‘Delay or pause in payments to the workforce through project execution due to various reasons’, ‘Losses incurred due to corruption and bribery’, ‘Being exposed to extreme (high) temperature’, ‘Oil or gas pipelines and wellhead passes through farms (problems with farmers)’, ‘Using machines, equipment, and tools without proper training’, and ‘Delay in approval of design documents’ risk items are found to be of the greatest significance. On the other hand, with regard to the second ranking scheme, ‘Instability in global oil and gas prices’, ‘Lack of pollution prevention equipment’, ‘Equipment failure’, ‘Accidents that occur due to the lack of safety in the oil and gas fields’, ‘Delay or pause in payments to the workforce through project execution due to various reasons’, ‘Poor quality of building materials’, ‘Shortage of new technologies’, ‘The delay in the issuance of advance

payments to the general contractor by the employer’, ‘Inadequate insurance coverage’, and ‘Changes in the quantities of the work items during the implementation stage without documentation’ risk items are discovered to show the greatest weighted significance. When both the rankings are considered, it is observed that the two risk items of ‘Instability in global oil and gas prices’ and ‘Delay or pause in payments to the workforce through project execution due to various reasons’ are the items that appear within the ten highest-ranked risks per both the ranking schemes. In account of this, the two risk items appear to pose the greatest threat to the success of oil and gas construction projects in Iraq and should be dealt with utmost care. Nonetheless, despite the fact that the foregoing risks can dramatically threaten the success of the project, they certainly cannot be regarded as project risk items with direct impacts on projects success; though, they can only threaten project in an indirect manner. That is, owner’s income cannot be regarded as the project risk; in other terms, success of an oil and gas construction project cannot directly rely on the oil prices. Thus, if managed well and in case of a proper financial planning, these items would not pose any threat to the project success factors.

In addition, it was previously stated in section 5.3.1 that the highest-ranked risk items belonged to ‘Financial Risks’, ‘Security and Political Risks’ and ‘Logistical and Administrative Risks’ risk categories. Later, in section 5.3.2, risk categories were ranked based on responses to an open-ended question included in the second part of questionnaire, results of which indicated ‘Technical Risks’, ‘Financial Risks’, and ‘Legal and Social Risks’ categories to be the first three critical categories. In the following section (section 5.4) risk response strategies are proposed based on the information given in section 3.5. Distinct response plans are suggested for the top ten risk items per both the abovementioned ranking schemes.

#### **5.4 Proposed Risk Response Plan**

During interviews with the experts, their lack of knowledge was noticed as no clear or effective strategies were set to deal with the risk items under investigation. Though they unanimously agreed that most of the risk items could be managed, and they suggested that the best solution is, in general, to mitigate risks which is also in line

with the recommendations of various scholars who have contributed to the existing literature. In a study carried out by Lyons and Skitmore [59], the risk reduction was the type of action most often chosen against risks. Grabowski et al. [60] suggested the mitigation of the risk items in the virtual organization. Besides Hallowell et al. [61] discovered mitigation of construction safety and health risks to be the project's best risk plan. Grabowski et al. [62] also studied risk mitigation techniques in large-scale systems. In this respect, this thesis study also proposes some risk response plans for the more critical risk items in order to reduce their negative impact on the project's success. Based on the strategies discussed in section 3.5, risk responses are proposed for the first ten risk items with the highest *RS* values (section 5.4.1) in addition to the first ten items with the largest weighted *RS*s (section 5.4.2).

#### **5.4.1 Responses for High-Priority Risks identified using Risk Matrices**

##### **5.4.1.1 Instability in global oil and gas prices**

**Mitigate risk:** Fix Price with Economic Price Adjustment (FPEPA) type of payment is recommended as the risk of changes in the prices is unknown for both the parties and this type of payment will provide flexibility with regard to the economic situations. As per this type of agreement, should the profit of the owner surpass a certain limit, the two parties will negotiate for a new price according to terms agreed in the contract [63] to hedge the oil and gas prices risk.

##### **5.4.1.2 Difficulties due to security situations in Iraq**

**Transfer risk:** A 3rd party can be assigned to maintain security and thus the risk will be transferred to this party. In fact, since 2003 it has become a common practice for most of the companies working in the oil and gas field in Iraq to hire security companies.

**Transfer risk:** Another risk transfer strategy that is widely used in Iraq is taking out insurances.

#### **5.4.1.3 Instability in the political system in Iraq and political discordant**

**Avoid risk:** A clause shall be added to the contract that preserves the company's right and is legally reviewed to protect it in general from external interference due to political fluctuations or the termination of the contract, or forcing a new political party the company for taking a Percent of profits, the period of establishing the project, the number of workers and methods of implementation [64].

**Mitigate risk:** Being involved with legitimate lobbying activities and/or improving relationships with the important citizens.

**Mitigate risk:** Forming a partnership with a local firm can be recommended.

#### **5.4.1.4 The delay in the arrival of the imported machinery and tools to the oil field in a timely manner (due to customs clearance or other reasons)**

**Transfer risk:** Customs clearance agencies should be hired. Especially if the agreement is based on Incoterms (or International Commercial Terms, which are a series of pre-defined commercial terms published by the International Chamber of Commerce (ICC)), they either will be kept responsible only for releasing the imported machinery and tools or they will also deliver them to the construction site [65,66].

**Transfer risk:** An agreement can be initiated so that the seller bears all risks from shipping until the arrival and unloading of goods to the port or airport or land transport at the borders. This under DAT - delivery occurs at the terminal (named station at the port or place of destination) [67].

#### **5.4.1.5 Delay or pause in payments to the workforce through project execution due to various reasons**

**Mitigate risk:** A payment guarantee or bond should be provided by the owner.

**Mitigate risk:** The contractor should be given the rights to either suspend or reduce the rate of the works.

**Mitigate risk:** Financial management can be implemented against cash-flow problems.

**Avoid risk:** Due payments should be received before handing over the project to the owner.

#### **5.4.1.6 Losses incurred due to corruption and bribery**

**Mitigate risk:** Electronic governance – linking government departments together with each other electronically in a way that allows citizens and employees to communicate electronically – can be instrumented to ensure transparency and speed, with more control to reduce corruption.

**Mitigate risk:** Reinforce the Federal Board of Supreme Audit (FBSA) – Iraq’s primary audit institution that has the role of reporting corruption to the Parliament; it is an administratively and financially independent institution.

**Mitigate risk:** Random inspection by establishing general inspectors in all ministries and providing them with protection.

**Mitigate risk:** Train and support to increase the experience of individuals in the Anti-Corruption Commission (Integrity Commission).

#### **5.4.1.7 Being exposed to extreme (high) temperature**

**Mitigate risk:** Follow-up cases of the direct influence of workers through the Safety Department which continuously raises awareness of staying hydrated and keeping away from the sun by placing shaded places for work, adding a medical unit close to work sites at high temperatures, taking into consideration giving a vacation when the temperature reaches 50 degrees Celsius. In addition, to stop pouring concrete in days hour, night shift can be added instead of the dayshifts.

#### **5.4.1.8 Oil or gas pipelines and wellhead passes through farms (problems with farmers)**

All agricultural land belongs to the Ministry of Agriculture in the first place. Farmers may only lease the land and not own it. That is, farmers’ contracts with the government are not open-ended. Thus, it is a fixed-term contract. With respect to this situation, the following strategies can be recommended:

**Accept risk:** Compensation can be made for only the exploited agricultural places.

**Mitigate risk:** Performing underground work when the ground is uncultivated (in the case of work by laying pipes only underground).

**Transfer risk:** Inclusion of a clause in the contract that keeps the owner responsible for raising the subject matter to the landowner, i.e., Ministry of Agriculture.

#### **5.4.1.9 Using machines, equipment, and tools without proper training**

**Mitigate risk:** Preparation of trained staff in addition to strict procedures for operation of the machinery requires a safety certificate as well as a certificate of driving and experience.

#### **5.4.1.10 Delay in approval of design documents**

**Accept risk:** Estimating the time it takes for the approval of the design and reflecting it in the schedule as a contingency.

**Transfer risk:** Transferring such risks to an appropriate subcontractor. This party will have the responsibility for administering the design approvals. Besides, an authorized decision-maker who is part of the project board needs to be identified before the project starts, and the sign-off points need to be communicated upfront.

### **5.4.2 Responses for High-Priority Risks identified by Incorporating the Ranks of the Risk Categories**

#### **5.4.2.1 Instability in global oil and gas prices**

Response strategy recommended for this item is covered in section 5.4.1.1.

#### **5.4.2.2 Lack of pollution prevention equipment [68]**

**Mitigate risk:** Risks can be mitigated using the guidelines provided below [69]:

- Testing of substances and reactions to monitor physical hazards for the workers;

- Hazard analysis studies to review the chemical and engineering practices of the process, including thermodynamics and kinetics;
- Examination of preventive maintenance and mechanical integrity of equipment and facilities used in the process;
- Worker training for urgent response in presence or absence the equipment that include special masks for gases, gases emission alarm and etc.
- Preparing and developing operating instructions and emergency response procedures.

#### **5.4.2.3 Equipment failure**

**Mitigate risk:** Regular maintenance of the necessary parts in equipment.

**Mitigate risk:** Recruiting only trained operators for the equipment or providing some training/educating sessions.

**Mitigate risk:** Provision of suitable and safe place for the equipment.

#### **5.4.2.4 Accidents that occur due to the lack of safety in the oil and gas fields**

**Mitigate risk:** In order to mitigate the risk associated with accidents in the work fields the following protocols can be recommended [70]:

- Reduce the depending on the human in the works that have high possibility in cause error by using auto-machine.
- Monitor the sites by high quality cameras with system alarms to prevent the accidents.
- Prevent the workers access without safety equipment for the sites with high risks and accidents.
- Employing trainer staff that have the ability to deals with accidents.

#### **5.4.2.5 Delay or pause in payments to the workforce through project execution due to various reasons**

Response strategy recommended for this item is covered in section 5.4.1.5.

#### **5.4.2.6 Poor quality of building materials**

**Mitigate risk:** Trusted vendors/suppliers should be shortlisted. Building materials should be procured from the shortlisted vendors/suppliers that implement Quality assurance and Quality control procedures.

**Mitigate risk:** Quality team have to monitor all technical specifications and doing material test according to the quality plan and Inspection test plan with the transparency.

#### **5.4.2.7 Shortage of new technologies**

**Mitigate risk:** Training workers on the mechanisms and modern methods of implementation in developed countries.

**Mitigate risk:** Facilitating transfer of technology by involving foreign parties in the project by forming partnerships or by hiring foreign experts so that they can share their experience with the local engineers and/or administrative staff.

#### **5.4.2.8 The delay in the issuance of advance payments to the general contractor by the employer**

**Mitigate risk:** The project manager should be directly monitoring this item.

**Mitigate risk:** Inclusion of clauses in the contract that entitles the contractor for suspension of works in case of non-payment by the owner.

#### **5.4.2.9 Inadequate insurance coverage**

**Mitigate risk:** Adopting simple, understandable tools and avoiding complexity in drafting insurance contracts.

In all works field the following insurances should be available [71]:

- Health coverage for workers should be reviewed annually to follow the new kinds of accidents.

- Buildings insurance should depend on the whole cost of the building and the age of building.
- Pipes and equipment insurance.

#### **5.4.2.10 Changes in the quantities of the work items during the implementation stage without documentation**

**Mitigate risk:** Adopting effective quantity control systems to accurately measure and document the amount of work involved in the project that are required by different departments.

**Mitigate risk:** Contract type should be Unit-price which will facilitate reflecting the actual quantities [72].

## CHAPTER 6

### CONCLUSIONS

Oil and gas are among of the most important economic resources and are considered the main artery of natural reserves in the Republic of Iraq. Iraq is one of the few countries whose economy entirely depends on oil and gas production rates, prices, and reserves. Companies and institutions involved in construction of processing facilities associated with such reserves have a pivotal role in the global economy since the oil and gas industry in Iraq is a global market with many international actors. On the other hand, Iraq's capital budget highly depends on the proportion of oil revenues. The oil and gas field's construction projects are found to be exposed to several risks due to large financial expenses and high number of project participants of contractors, investors, etc. Such projects also entail significant social and environmental impacts. Most oil and gas construction projects in Iraq have failed to meet the project's objectives mainly because of incapability of the companies in providing quick solution methods to identify risks as well as their probable time of occurrence, or presence of any guidelines as to how should they be dealt with. Due to the lack of knowledge of risk management principles, most Iraqi constructions projects in oil and gas field have suffered from delays and significant losses. Lack of a systematic approach for managing the risk in this sector not only affects the project but also Iraq's economy negatively. Any project failure resulting from a risk item could be avoided if the risk is identified and is prepared for promptly. This can be made possible with the help of a thorough investigation on the risks pertaining to this sector.

Respectively, this thesis study has attempted to identify and analyze the risks pertinent to construction projects related to oil and gas processing facilities and proposes various methods and practical plans for eliminating or reducing them for achieving a desired

balance in the project's critical success factors of time, cost, and quality. A descriptive-analytical approach is used to analyze the risks associated with implementing oil and gas construction projects in Iraq to help describe the risks and to understand the underlying causes. To this end, the risks threatening the desired balance between the main objectives of construction projects in oil and gas sector of Iraq are identified. Risk identification is performed with regard to the findings of an exhaustive literature review accompanied with opinions of the experts. Ensuingly, in order for collection of empirical data from academia, professionals, and decision-making authorities, 70 risk items widely referred to in the scientific arena are used to develop a questionnaire. The initial draft of the questionnaire is first presented to select expert engineers and is enhanced – by discarding the immaterial and inclusion of the lacking risk items – and validated through a pilot study. Subsequent to the pilot study and obtaining the approval of the ethics committee, the final version of the questionnaire is transformed into an online questionnaire in one of the widely used online survey development platforms. Both the online version and the prints are used to collect data from participants.

The participants for the questionnaire survey are chosen from different governmental and non-governmental institutions and/or companies, namely, Iraq's Ministry of Oil, Kuwait Energy, faculty members at the oil department of University of Baghdad, a consortium of four South Korean companies (Kerbala refinery), and Al-Dorra refinery. General information related to 143 experts are compiled and the respondents are asked to rate probability and impact values per each risk item classified into eight risk categories – of 'Job-site and Environmental Risks', 'Legal and Social Risks', 'Financial Risks', 'Logistical and Administrative Risks', 'Technical Risks', 'Design Risks', 'Security and Political Risks', and 'Contractual Risks' – by using a five-point Likert scale. The experts are asked to rate the risk items with respect to their 'Probability' of occurrence and extent of 'Impact' on the project success. Thereby, by using Statistical Package for the Social Sciences (SPSS) program as well as risk matrices risk items are assessed and analyzed. In order to arrive at a scientific and practical conclusion, the information and data collected by means of the questionnaires are used to address the significant risks and suggestions are made toward establishing a safer environment by raising awareness of the risks involved for the employers and/or contractors operating

in the oil and gas sector. Eventually, risk responses, as counter-measures, are proposed for the ten highest-ranked factors. In addition, the consistency of the data is validated by using Cronbach's Alpha reliability coefficient.

Two complementary risk rankings are illustrated in this thesis. Initially, risks are ranked only with respect to the results of risk matrices. Afterwards, the weights of the corresponding risk categories are also incorporated in the ranking of the risk items. With respect to the first ranking, 'Instability in global oil and gas prices', 'Difficulties due to security situations in Iraq', 'Instability in the political system in Iraq and political discordant', 'The delay in the arrival of the imported machinery and tools to the oil field promptly (due to customs clearance or other reasons)', 'Delay or pause in payments to the workforce through project execution due to various reasons', 'Losses incurred due to corruption and bribery', 'Being exposed to extreme (high) temperature', 'Oil or gas pipelines and wellhead passes through farms (problems with farmers)', 'Using machines, equipment, and tools without proper training', and 'Delay in approval of design documents' risk items are found to be of the greatest significance. On the other hand, with regard to the second ranking scheme, 'Instability in global oil and gas prices', 'Lack of pollution prevention equipment', 'Equipment failure', 'Accidents that occur due to the lack of safety in the oil and gas fields', 'Delay or pause in payments to the workforce through project execution due to various reasons', 'Poor quality of building materials', 'Shortage of new technologies', 'The delay in the issuance of advance payments to the general contractor by the employer', 'Inadequate insurance coverage', and 'Changes in the quantities of the work items during the implementation stage without documentation' risk items are discovered to show the greatest weighted significance. When both the rankings are considered, it is observed that the two risk items of 'Instability in global oil and gas prices' and 'Delay in payments to the workforce' are the items that appear within the ten highest-ranked risks per both the ranking schemes. In account of this, the two risk items appear to pose the greatest threat to the success of oil and gas construction projects in Iraq and should be dealt with utmost care. Nonetheless, despite the fact that the foregoing risks can dramatically threaten the success of the project, they certainly cannot be regarded as project risk items with direct impacts on projects success; though, they can only threaten project in an indirect

manner. That is, owner's income cannot be regarded as the project risk; in other terms, success of an oil and gas construction project cannot directly rely on the oil prices. Thus, if managed well and in case of a proper financial planning, these items would not pose any threat to the project success factors.

Ultimately, distinct risk responses plans are proposed for the first ten risk items per both the abovementioned ranking schemes, i.e., once with respect to the highest risk score values and then with regard to the largest weighted risk scores. Strategies include actions to respond to risks either by avoiding, mitigating, transferring, or accepting them in order for maintaining the project objectives despite the presence of risks.

## **6.1 Concluding Remarks**

In addition to what has been previously reported, the following inferences were also drawn:

- When risks are ranked with respect to the results of the risk matrices, 'Difficulties due to security situations in Iraq' is found to be the second most significant item. This is believed to be linked with the security and political conditions that have emerged after the military invasion and the collapse of the previous government in 2003.
- Lack of risk register and dearth of independent departments established exclusively for risk management are among the struggles noticed in most of Iraq's construction projects.
- Iraqi Engineers Association, construction establishments in oil and gas projects, and/or the Ministry of Oil in Iraq must provide comprehensive training programs that increase risk awareness of the parties involved in this industry.
- In addition to the involvement of more foreign experts in the oil and gas industry, their contribution and participation in training programs can also contribute to the development of more effective risk response strategies.
- This study mainly focused on risk assessment of onshore oil and gas construction project. There remains a necessity for analyzing the risks associated with the offshore oil and gas construction projects in the Republic of Iraq.

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## **APPENDICES**

### **APPENDIX A**

#### **OIL AND GAS CONSTRUCTION PROJECT DATA QUESTIONNAIRE**

**Atılım University**

**Department of Civil Engineering**

**Questionnaire for Risk Assessment of Oil and Gas Construction  
Projects in IRAQ**

**STUDY TITLE:** Risk Assessment of Oil and Gas Construction Projects in IRAQ

**INTRODUCTION:** You are invited to take part in a study conducted by Muhanned Dawood (M.Sc. Student) Dr. Saman Aminbakhsh (Assistant Professor and Thesis Supervisor), and Dr. Thair Alfatlawi (Professor and Thesis Co-Supervisor) from the Department of Civil Engineering.

This questionnaire survey is a part of an ongoing graduate thesis studies on risk management in oil and gas construction projects in Iraq and aims to study the sources of risk and the state of risk management within this sector. This study aims to assess the Probability, Impact, and thereby the Magnitude of risk items threatening the success of Oil and Gas Construction Projects in Iraq. In this study Probability refers to likelihood of occurrence of a negative event. On the other hand, impact designates significance of the effect of a negative event. There are 9 demographical and 73 technical questions in this survey. In the technical part respondents will be asked to assess 70 risk items classified under 8 risk categories and at the end of the survey, they

will be asked to share their insight by answering 3 open-ended questions. Completing the survey should take 20-25 minutes.

**PARTICIPATION:** Participation in the survey is voluntary. Respondents may refuse to take part in, or exit the survey at any time without penalty. We appreciate completing the survey in one sitting.

**BENEFITS AND RISKS:** Respondents will receive no direct benefits from their participation. However, their inputs are important to us. They may help us learn more about the ranks of the risk items. There are no foreseeable risks in participating in the study.

**CONFIDENTIALITY:** The online survey will store the responses in a password protected format. Data will later be encrypted and stored in the researcher's computer. Respondents will remain anonymous. This means that no identifying information such as name, IP address, etc. will be collected, nor will the identity of the respondents be connected to the information gathered. The information gathered by means of this questionnaire will only be used for academic purposes on academic platforms. At the conclusion of this study, we intend to share findings with scientific communities in publications.

**CONTACT:** This study has been approved by Atilim University Review Board. For questions about participant rights or the study please contact Muhanned Dawood at dawood.mohanned@student.atilim.edu.tr or +964 771 734 8998. Thank you for sharing your expertise with us.

**CONSENT:** Please select your choice below. If you are taking the survey physically in the field, you will be given a hard-copy of this form. In case you are entering this survey online, you may print a copy of this consent form for your records. Clicking on the "Agree" button indicates that,

- You have read the above information.
- You voluntarily agree to participate.
- You are 18 years of age or older.

AGREE

DISAGREE

Date: ...../...../.....

**Part A. GENERAL INFORMATION ABOUT THE COMPANY AND THE RESPONDENT**

*(Please check the relevant box)*

**1-What type of organization do you work for?**

Public  Private  Other.....

**2-What is your job description?**

Site engineer  Project manager  Consultant engineer

Design engineer  Safety engineer

Technical Manager  Technician  Other.....

**3- Professional Experience:**

1-5 years  6-15 years  16-25 years  Over 25 years

**4-Level of Education:**

B.Sc.  M.Sc.  Ph.D.

**5-The type of the company you are working at:**

Employer  Contractor  Consultant

Designer  Other.....

**6-The age of the company you are working at:**

0-10 years  10-20 years  20-30 years  30-40 year  Over 40 years

**7-Field of activity of the company:**

Building  Infrastructure  Industrial  Other.....

**8-What is the size of your organization?**

Below 100 employees  100-250 employees

250-500 employees  Over 500 employees

**9-What is your major field of expertise?**

Civil/Architectural  Mechanical Engineering  Electrical Engineering

Chemical Engineering  Petroleum Engineering  Other.....

## **Part B. RISK ASSESSMENT**

Please rank the risk factors under the following eight risk categories according to your past experiences by using the rating scale given below:

### **For the probability of occurrence:**

1. Rare (Not occurred before).
2. Unlikely (Rarely occurs).
3. Feasible (Possible but not common).
4. Likely (Occurred before and will again).
5. Almost Certain (Occurs frequently).

### **For impact:**

1. Insignificant (Negligible effect).
2. Minor (Minimal effect).
3. Moderate (Rather a significant effect).
4. Major (Considerable effect).
5. Critical (Catastrophic effect).

No.	Risk Item	Probability	Impact
<b>I</b>	<b><u>Job-site and Environmental Risks</u></b>		
1	Toxic gas (H <sub>2</sub> S) emissions during well drilling.		
2	Pandemic or epidemic spread.		
3	Being exposed to extreme (high) temperature.		
4	Fire and explosion.		
5	Presence of groundwater in the oilfield.		
6	<b>Difficulty in accessing the oil or gas wells.</b>		
7	<b>Unforeseen underground/soil conditions, Central Process Facility (CPF), within pipeline, or flow line implementation.</b>		
8	The intersection of oil pipeline with major and minor rivers or major and minor roads.		
9	Exposure of oil fields to floods or high rain rate in winter or extreme weather conditions.		

<b>No.</b>	<b>Risk Item</b>	<b>Probability</b>	<b>Impact</b>
10	Oil or gas field located in a remote area and difficult to reach.		
11	Oil or gas pipelines and wellhead passes through farms (problems with farmers).		
<b><u>II</u></b>	<b><u>Legal and Social Risks</u></b>		
12	Unofficial holidays.		
13	Breach of contract by project parties.		
14	Lack of knowledge of arbitration.		
15	Improper verification of contract document.		
16	Uncertainty and unfairness of court justice.		
17	Lack of legal clarity for the work contracts with the general contractors.		
18	Legal disputes between the general contractor and governmental oil and gas sector (owner).		
<b><u>III</u></b>	<b><u>Financial Risks</u></b>		
19	The bankruptcy of the contractor.		
20	Inadequate insurance coverage.		
21	Instability in global oil and gas prices.		
22	Changes in bank formalities and regulations.		
23	Fluctuation in the exchange rates.		
24	The delay in the issuance of advance payments to the general contractor by the employer.		
25	Delay or pause in payments to the workforce through project execution due to various reasons.		
26	Unexpected funding termination for the general contractor in the oil and gas sector.		
27	High prices of materials and equipment required to carry out civil works in the oil and gas field.		
<b><u>IV</u></b>	<b><u>Logistical and Administrative Risks</u></b>		
28	Improper project feasibility study.		
29	Shortage in supplies (electricity, water, fuel, etc.).		
30	Inadequate forecast on the market demand.		
31	Shortage of skilled workers.		

<b>No.</b>	<b>Risk Item</b>	<b>Probability</b>	<b>Impact</b>
32	Improper project organization structure.		
33	Deficient monitoring or follow up of the wells, pipelines, tanks, etc.		
34	Short tendering time.		
35	The delay in the arrival of the imported machinery and tools to the oil field in a timely manner (due to customs clearance or other reasons).		
36	Using machines, equipment, and tools without proper training.		
37	The difficulty of obtaining licenses and work permits for the general contractor.		
38	Poor communication between the general contractor and the owner in the oil and gas field.		
39	A change in the management of the oil field throughout the implementation period.		
40	Lack of knowledge about the team members' actual responsibilities.		
41	Unclear and/or imprecise definition of the work items by the owner in the oil and gas sector.		
42	Lack of specialty contractors in oil and gas field works.		
43	The absence of a risk-register for the previously completed construction projects in the oil fields.		
<b><u>V</u></b>	<b><u>Technical Risks</u></b>		
44	Lack of pollution prevention equipment.		
45	Shortage of new technologies.		
46	Equipment failure.		
47	Poor quality of building materials.		
48	Difficulty in following government standard codes and practices.		
49	Accidents that occur due to the lack of safety in the oil and gas fields.		
50	Changes in the quantities of the work items during the implementation stage without documentation.		
<b><u>VI</u></b>	<b><u>Design Risks</u></b>		
51	Design changes.		
52	Poor design.		

<b>No.</b>	<b>Risk Item</b>	<b>Probability</b>	<b>Impact</b>
53	The complexity of project design.		
54	The mismatch between the designs and the actual implementation of the work item.		
55	Delay in approval of design documents.		
<b><u>VII</u></b>	<b><u>Security and Political</u></b>		
56	Terrorist attacks targeting oil and gas structures during implementation.		
57	Cost increase due to changes in government policies.		
58	Losses incurred due to corruption and bribery.		
59	Difficulties due to security situations in Iraq.		
60	Instability in the political system in Iraq and political discordant.		
<b><u>VIII</u></b>	<b><u>Contractual Risks</u></b>		
61	Lack of formal and written contingency plan from contractor or the owner.		
62	Very limited duration in the original contract.		
63	Inadequate definition of substantial completion.		
64	Ineffective delay penalties and/or bonus payments.		
65	Delay to furnish and deliver the site to the contractor by the owner.		
66	Type of project bidding and contract award mechanism (negotiation, lowest bid, etc.).		
67	Problems with permits and the difficulty of issuing them for foreign companies in a contract.		
68	Lack of technical experience and/or know-how of the contractor.		
69	Inadequate financial capacity of the general contractor or the owner.		
70	Construction contract type (lump-sum, cost-plus, unit price, etc.).		



**73-Does the questionnaire cover all/most of the risk factors in the oil and gas field?  
Please comment.**

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**As we develop our report, we may find it helpful to reach out for you (for follow up questions or requesting for more clarifications). Would you be willing to be contacted in case it is required? If so, please provide your contact information:**

**1. Email address:**

**2. Phone:**

**How long did it take to finish the survey? ..... minutes.**

**YOUR VALUABLE TIME AND EFFORT IS GREATLY APPRECIATED.**