Arab Academy for Science, Technology and Maritime Transport

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RISK ASSESSMENT AND ANALYSIS FOR THE CONSTRUCTION OF OFF SHORE PETROLEUM & GAS PROJECTS IN EGYPT

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بسم الله الرحمن الرحيم

﴿ قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا

عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ ﴾

صدق الله العظيم.

سورة البقرة آية رقم (32)

DEDICATION

All Appreciation to My Teacher's

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For Their Precious Advises and Their Continuous Support

And To My

Mother,

Sister,

Wife,

And My kids

for Their Encouragement, Patience and Love

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ABSTRACT

There are many studies concerning risk management all over the world, and also concerning the Oil & Gas projects, but the researches in the area of risk management in the construction phase of petroleum & gas projects in Egypt is extremely under needed.

While there are many construction companies working in this field of oil & gas projects in Egypt expose to face many problems during the execution of such projects due to their ignoring or under estimation of the risks which might face them during project estimation or project execution and also due to their under estimation of the bad effects which might face them caused by the impacts of these risks.

The aim of this research is to identify and analyze associated risks in the construction of Off-Shore Oil & gas projects in Egypt. This analysis may help Contractors in construction of such projects to be confidence in the estimate and allocate appropriate contingencies.

A field survey was conducted through a structure questionnaire to the companies working in that field in Egypt.

Quantitative risk analysis tool "risky project" was used to analyze the data to present statistical measures. Important index and average risk were calculated for Projects. A ranking of risk factors affecting the contractors working in that field was developed for all companies and for each company as well.

A ranking correlation factors between elements of risk factors have been developed and discussed.

It was concluded that the main risk factors affecting the Projects of construction oil & gas in Egypt are:-

- Weather effect.
- Increase in material price.
- Currency fluctuation (foreign exchange rate).
- Delay of tender offer evaluation and purchase order cycle.
- Project duration (schedule is too short for the required activities).
- Client delay in making decision or delay in approval of contractor's submittals.
- Delay in performing inspection &testing by the consultant.
- The conflict between the contractor and the consultant.
- Commitment to the schedule delay due to contactor.

These Factors have been used to identify their effect on project duration, cost and comparing the final result with a validation cases.

There was a delay in duration and increase in cost at the validation cases, the risk factors used by Quantitative risk analysis tools shows the optimum duration and cost which contractor should be considered during Tender Stage To Avoid project Time delay or/and Cost increase.

Another research has achieved different risk factors with another ranking, they studied the risk factors affect the On-Shore Oil & Gas Projects, but in the field of Off-Shore Projects in Egypt it's' extremely under needed.

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CHAPTER (1)

Research Framework

1.1 Overview

In recent years, intensive research and development has been done in the area of project risk management. It is widely recognized as one of the most critical procedures and capability areas in the field of project management**.**

Construction projects are characterized as very complex projects, where uncertainty comes from various sources. Construction projects gather big number of stakeholders, which makes it difficult to study a network as a whole. But at the same time, these projects offer an ideal environment for network and risk management research. Additionally, construction projects are frequently used in management research, and several different tools and techniques have already been developed and especially for the off-shore projects. However, there is a gap between risk management techniques and their practical application by construction contractors.

This Research tries to find out the reasons for this gap and works to fill this gap. Special applications for construction projects are discussed in the literature review.

More over this research is based on the assumption by understanding better both the relationships in a project network and risks related to the network structure, project risk management can be more effective. It has already been recognized that a clear understanding of the risks born by each participant leads to better risk allocation. The objective of the study is to find means of risk management that can be utilized by the network and to make new suggestions on the use of these risk management methods. It is of a particular interest to find the means to manage those risks that are the most effectively managed with the co-operation of several project actors. Initially however, the relationship between the existence of a network and the existence of risks needs to be established.

1.2 Problem Statement

The petroleum and gas projects are examples of those heavy industrial projects are consider quite unique as it needs qualified, specialized and experienced contractor who should possess very high technological and technical capabilities. He should also possess the awareness, understanding and the ability to assess all kinds of risks which he might face during the construction of such projects. A need exists for assessing, analyzing the risks that face the contractors during the construction of such projects in Egypt. This research will handle the risks, their assessment and analysis for off-shore petroleum and gas projects in Egypt from contractor point of view.

1.3 Research Aim

- To identify and analyze associated risks in the construction of Off-Shore Oil & gas projects in Egypt.
- To clarify the important risk factors affecting the construction and exploration companies working in that field in Egypt.
- To investigate the important risk factors according to each company point of view, using a predefined questionnaire.
- To define the most important factors of risks according to the questionnaire
- This analysis may help Contractors in construction of such projects to assist off shore oil & gas contractor in producing appropriate contingencies based on proper risk assessment.

1.4 Research Methodology

The study will be conducted through the following sequence

- A Literature review will be carried out to cover the most important studies in this research area.
- Based on this literature review, a survey will conducted to identify the most important risk factors affecting the Off-Shore projects.
- Data collection and analysis, most probably via a survey questionnaire
- Case Study.
- Conclusion and recommendations.

1.5 Research Structure

The research Work presented according to the following Chapters:-

- **Chapter (2)** Literature Review.
- **Chapter (3)** Project Risk Management.
- **Chapter (4)** Research Implementation.
- **Chapter (5)** Data Analysis and Results.
- **Chapter (6)** Summary, Conclusion and Future Recommendations.
- **References**
- **Annex.**

CHAPTER (2)

LITERATURE REVIEW

2.1 Introduction

This chapter includes a survey of researches and other sources relevant to risk management of construction projects in oil and gas projects.

2.2 Over-Viewing the previous researches in risk factors in construction Projects

Tamer Raafat Mohammed Youssef (2011) studied the main risk factors affecting the contractors whom are working in the construction of Oil & Gas projects in Egypt, These risk factors are summarized as follows:

a) Process Design Risks
b) Schedule risks
c) Cost risks.
d) Contract risks
e) Procurement risks
f) Design quality risks
g) Construction quality risks
h) Construction risks
i) Occupational health and safety risks
j) Environmental risks
k) Operational risks

Yasser Solieman (2009) studied the main risk factors affecting the contractors working in the construction of On-shore Oil & Gas Projects in Egypt, These risk factors are summarized as follows:

a) Increase of material price
b) Loss due to inflation
c) Project Financing (Debt,) (delayed payment on contract)
d) Delay in materials delivery
e) Project Duration (Project Duration Is too short For the Required Activities

f) Delays due Long Period for Tender Evaluation and Purchase Order Cycle
g) Vendor Bid Greater Than Estimate
h) Shortage of Approved For Construction Drawings
i) Low Productivity of Equipment's
j) Cost overrun due to planning estimation

Amir Abousief (2005) studied the main risk factors affecting the construction of power plant in Egypt and he found that the most significant risks relevant to construction of a power plant in Egypt are:

a) Inflation
b) The exchange rate
c) Material cost variation
d) Inaccurate specifications
e) Availability of foreign currency
f) Dispute resolution procedure
g) Change order procedure

Basem Bakarman (2005) concluded that the main risk factors affecting the contractors in Egypt are:-

a) Inflation
b) Devaluation and varying rate exchange
c) Delay in progress payment by the owner.
d) Cash flow problems and difficulties in finance the project by contractor
e) Cost overrun due to planning estimation
f) Cash flow problems faced by the subcontractor
g) Delay in settlement of contractor's claim by the owner
h) Subcontractor's law credibility.
i) Delay of construction project
j) Difficulty in obtaining work permits from the authorities

Orabi (2003) found that the most critical risk factors are financial & economical risks .The most significant risk was:

a) The interest rate
b) Inflation

Fayez (2003) identified the main groups of risks that different parties are exposed to, and studied the factors affecting these risks and ranked them and finally gave recommendations show how to avoid them .he divided the risk factors into 9 groups and he discussed the factors affecting these risks like the client, the project funds the project size and complexity

Another research was made by Amir Wahid (1994) studied the delay problems in construction projects in Egypt. He found that the major causes of delay in construction projects in Egypt are:-

a) Poor contract management and unrealistic scheduling
b) Lack of finance and payment for completed work.
c) design modification during construction
d) Shortage of certain materials
e) Subcontractors and Material supplier's problems.

Substantive research has been done in the field of risk management for construction projects, a significant outcome of which is the identification of many risks that may influence the construction project delivery. Chen et al. (2004) proposed 15 risks concerned with project cost and divided them into three groups:

a) Resources factors.
b) Management factors.
c) Parent factors.

Through a case study on the West Rail Project, Chen found that “price escalation of material” pertaining to resource factors, “inaccurate cost budget” and “supplier or subcontractors’ default” pertaining to management factors, and “excessive interface on project management” pertaining to parent factors are the most significant risks in this particular project.

Other researchers’ work, Shen (1997) identified eight major risks accounting for project delay and ranked them based on a questionnaire survey with industry practitioners. Shen also proposed risk management actions to cope with these risks and validated their effectiveness through individual interview surveys. Tam et al. (2004) conducted a survey to examine the elements of poor construction safety management and as a result, identified the main factors affecting safety performance including:

a) Poor safety awareness of top management.
b) Lack of training.
c) Poor safety awareness of project Managers.
d) Reluctance to input resources to safety.
e) Reckless operation.

While the above research studied the diverse risks influencing the project objectives in terms of cost, time and safety, other research examined the risks or risk management in different phases of a project. Thomas Uher and Ray Toakley (1999) investigated various structural and cultural factors concerned with the implementation of risk management in the conceptual phase of a project life cycle and found that while most industry practitioners were familiar with risk management, its application in the conceptual phase was relatively low.

2.3 Other Techniques being used in the research field

No construction project is risk-free. Risk is manageable diminishable, transferable or acceptable but not ignorable (Latham, 1994).

Rahman and Kumaraswamy, (2002) identified 41 risks in construction projects. Risk management is thus an important tool to cope with such substantial risks in construction industry according to (Edwards, 1998) by the following steps:

a) Assessing and ascertaining project viability.
b) Analyzing and controlling the risks in order to minimize loss.
c) Alleviating risks by proper planning.
d) Avoiding dissatisfactory projects and thus enhancing profit margins.

Thompson and Perry (1992) The construction industry is subject to more risk and uncertainty than many other industries it has a poor reputation for coping with risks, many projects failing to meet deadlines and cost targets. Clients, contractors, the public and others have suffered as a result.

Chapter (2)

The process of taking a project from initial investment appraisal to completion and into use is complex, generally bespoke, and entails time-consuming design and production processes. It requires a multitude of people with different skills and interests and the co-ordination of a wide range of disparate, yet interrelated activities. Such complexity moreover, is compounded by many external, uncontrollable factors Flanagan and Norman (1993).

In 1992 worldwide survey reported that the majority of construction projects fail to achieve the objectives of the schedule (cooper K. G. 1994) even in 2001 one of the industry's longest, oldest and most respected brands was a victim of poor risk management , another survey was conducted by Laufer and Stukhart (1992) of 40 U.S. construction managers and owners indicated that for scope and design objectives only 35% of the projects considered had low uncertainty and the remaining 65% had medium to very high uncertainty at the beginning of construction. The costs of the projects averaged $5,000,000. This finding was confirmed in a more recent report by Laufer and Howell (1993). They concluded that approximately 80% of projects at the beginning of construction possessed a high level of uncertainty. The amount of uncertainty in the internal and external environments of a project is an important factor in determining whether there will be a schedule overrun or cost overrun.

According to Carr and Tah (2001) construction projects have developed into being more complicated and dynamic, which results in a more risky industry than others .It is famous for its great amount of uncertainties

Ng Hwee and Robert Tiong (2002) suggest that all projects are exposed to many uncertainties (risks) through their life cycle, but especially during their construction phase

Jaafari (2001). Believes that risks my result from external factors (commercial and competitive pressure, social and political factors, ethics, norms and shifting requirements of the clients)

Regarding the above mentioned factors interest in risk assessment is growing. With an increasingly complex and rapidly changing business environment, owners and their contractors are being challenged to manage risk while maintaining control and improving performance.

However, some owners are not familiar with the concepts of risk assessment where there is a lack of an accepted method of risk assessment and management among professionals in the construction industry compared with the financial and health professionals. Therefore, the onus must fall on the construction industry to market the concepts of risk assessment.

Risk management is not a discrete activity, but a basic fundamental of the project management. In the global sense, risk management is the process that, when carried out, ensures that all that can be done will be done to achieve the objectives of the project within the constraints of project (Clark, Pledger and Needier 1990).

In the narrow specialized sense, risk management is a part of the overall process. Once a risk is identified and defined, it ceases to be a risk and becomes a management problem. It can be summarized that:

- Risk management needs to be a continuous function of project management.
- Risk management needs to give an objective view of the project from the moment the project starts to the moment it ends.
- Risk management processes the available information into a formal model which supports the decisions.
- Risk management breeds responsive, flexible and planned project management

A risk management process typically comprises establishment of context, risk identification, risk analysis, risk evaluation and risk response (Lyons, 2003).
A risk can be characterized by the risk event, its probability of occurrence and the amount of potential loss or gain. All factors comprising a risk are to be identified, analyzed and evaluated so that response can then be given. Risk response is a process of formulation of a management strategy leading to identifying action owners and the risk management plan

Risk allocation, the definition and division of responsibility associated with a possible future loss or gain, seeks to assign responsibility for a variety of hypothetical circumstances should a project not proceed as planned (Uff J., 1995).
Usually, a tender document of a construction project is prepared by the contracting party, i.e. the owner, who initiates the project.
It is common that the owner tends to contractually pass the responsibility for most of the risks to the contractor under traditional procurement processes (Rutgers and Haley 1996). A contract can thus be considered as a trade-off between the contractor’s prices

for undertaking the work and his willingness to accept both the controllable and uncontrollable risks (Flangan and Norman, 1993).

Whether the party is willing and aware to bear the risk will affect its response to risk (Ward and Chapman, 1991). The cost of improper risk allocation could be seen from the response from contractors such as adding a high contingency (premium) to the bid price or delivering low quality work. During the project, the owner might spend more management resources for the increased work disputes. Upon completion of the works, litigation of contractual claims might come after.

The cost of improper risk allocation could be seen from the response from contractors such as adding a high contingency (premium) to the bid price or delivering low quality work. During the project, the owner might spend more management resources for the increased work disputes. Upon completion of the works, litigation of Contractual claims might come after.

In the worst case, the owner pays for the risks twice including one in bidding contingencies and the other one in court (Fisk, 2000). The allocation of risk is thus one of the important decision-making processes leading to project success. Optimally, the goal of risk management should be to minimize the total cost of risk to a project, not necessarily the costs to each contracting party separately (CII, 1993). The most challenging of the task is to decide what the equitable risk allocation is such that the goal is effectively accomplished.

While model or standard sets of general conditions of contract are available, it is argued that the principles behind the allocations in these documents have not been clearly stated (Thompson and Perry, 1992). Problems can arise using any of them If additional clauses affecting risk are applied to them.

Moreover, the nature and extent of risks tend to be project- specific in today’s high-risk scenarios and multiparty complex projects that adoption of tailor-made contract

Strategies is more desirable (Rahman, Kumar aswamy, (2002).

Various risk allocation principles had been suggested by a number of researchers such as (Casey, 1979), (Kussel, 1979), (Barnes, 1979), (Abrahamson, 1984) and (Thompson and Perry,1992). Adopting these principles as the basis for allocating risks is useful in reaching an equitable decision. It would be ultimately beneficial to both owners and contractors. Like most of the management doctrines, all these risk allocation principles commonly use natural language in the expression, which are nevertheless ambiguous in actual application.

For example, one of the principles mentioned by (Abrahamson, 1984) states that ‘a party should bear a construction risk where it is in his control’. The term ‘‘in his control’’ is difficult to be precisely interpreted as the ‘‘control’’ by a contracting party on a real situation could be ‘partial’. The application of those principles to final decision making thus heavily relies on the qualitative judgment and experiential knowledge of construction experts. The problem of this kind of decision making process is its implicitness. Too often it is difficult to be analyzed and retrieved by others. Human factors such as the attitude of the parties (Barnes, 1983) and bias in personal judgments may impose significant variation on the decision outcome. (Rahman and Kumaraswamy, 2002) had shown that there was a divergence of perception on risk allocation in construction contracts among different groups. It is not surprising that improper risk allocation in construction contracts remains a concern in the construction industry in many countries (CIRC, 2001).

2.4 Risk Management in the Planning Phase for Off-Shore Oil and Gas Projects

Project management is a one-time carefully planned and organized effort to achieve a specific goal.

Project management includes: Developing a project plan, which includes defining project goals and objectives, specifying tasks or how goals will be achieved, what resources are needed, and associating budgets and timelines for completion, implementing the project plan carefully to make sure the plan is being implemented according to plan.

Project management usually includes the following main phases:

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

These phases may be defined as follows:

- **Initiation:** It is the phase where a new project is formally authorized; starting up the project. A project is initiated by defining its reason, business goals and scope. Also it is the phase when the main hierarchy is to be identified, as well as early milestones and early proposed budget. With the above information we can move on and perform an end of Phase study in order to get a GO No GO decision.
- **Design:** It is the phase of formulation of a plan to execute a project with a specified performance goal. It is a multi-step process including the research, conceptualization, feasibility assessment, establishing design requirements, preliminary design, detailed design, production planning and tool design, and finally production.
- **Planning:** Once the project is defined and the project team is assembled, we are ready to enter the in depth the Project planning phase. This involves creating Project Management Plan, in order to guide the team during the project lifetime. We will define the required skills of development team, Non-labor Resources, Risks plan, detailed action items and milestones.
- **Execution:** Includes the processes of coordinating project parties and other resources to carry out the plan in order to perform proper implementation of the project on land as designed and planned for its intended use.
- **Commissioning**: The Commissioning process comprises the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the project, from individual functions, such as instruments and equipment, up to complex amalgamations such as modules, subsystems and systems.
- **Closeout:** Project Closeout involves releasing the final project to the client, handing over project documentation, As-built drawings, and Network layouts. Last remaining step is to undertake a Post Implementation Review to identify the level of project success and note down any lessons learned.

Planning was found to be a critical phase in project management (Pinto and Slevin, 1987; Johnson et al., 2001; Turner, 1999). Project planning specifies a set of decisions concerning the ways that things should be done in the future, in order to execute the design for a desired product or service. The project manager is responsible for completing the project to the satisfaction of all relevant stakeholders. Therefore, he/ she must ensure not only that actions are executed according to plan, but also that the plan is reliable and properly represents stakeholders’ requirements.

Kerzner (2006) finds uncertainty reduction to be one of the basic reasons for planning a project. Meredith and Mantel (2003) identified six planning sequences including:

1- Preliminary coordination.
2- Detailed description of tasks.
3- Adhering to project budget.
4- Adhering to project schedule.
5- Precise description of all status reports
6- Planning the project's termination.

Russell and Taylor (2003) identified seven planning processes defining project objectives, identifying activities, establishing precedence relationships, making time estimates, determining project completion time, comparing project schedule objectives and determining resource requirements to meet objectives.

De Meyer et al. (2002) claim that deciding of the best way of planning the project is influenced by the level of risk, whether it is a ‘‘variation’’, ‘‘foreseen uncertainty’’, ‘‘unforeseen uncertainty’’ or a ‘‘chaos’’ project. Since a project manager has to deal with high uncertainty levels, the subject of risk management has received much attention, being one of the nine knowledge areas of a project (PMI, 2004).

According to Wideman (1992), risks can be divided into five groups:

1- External, unpredictable and uncontrollable risks
2- External, predictable and uncontrollable risks
3- Internal, non-technical and controllable risks
4- Internal, technical and controllable risks and
5- Legal and controllable risks.

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

1- Risks linked to technical performance,
2- Risks linked to budget and
3- Risk linked to schedule.

Risk management deals with identifying and reducing the project's risk level, including risk management planning, monitoring and control processes (PMI,2004).

Risk management planning processes include risk identification, qualitative and quantitative risk analysis and risk response plans. Risk monitoring and control is the last risk management process, which is performed during the project's execution phase. In order to deal with risks, project managers may choose to use several tools from the vast variety of risk management software and tools available, both from finance and project management disciplines, such as planning meetings, risk rating and risk control.

Planning was found to be a critical phase in project management (Pinto and Selvin, 1987; Johnson et al., 2001; Turner, 1999 and others). Project planning specifies a set of decisions concerning the ways that things should be done in the future, in order to execute the design for a desired product or service. The project manager is responsible for completing the project to the satisfaction of all stakeholders. Therefore, he/she must ensure not only that actions are executed according to plan, but also that the plan is reliable and properly represents stakeholders' requirements. A hypothesis was raised by (Zwikael and Sadeh, 2007) that improving the project plan may be an effective tool in order to deal with high-risk projects. This theory which includes the improvement of all planning processes (i.e. schedule planning and quality planning) may replace the traditional approach which focuses only on the improvement of risk management processes. The model proposed is described in Fig. (2-1) below

Fig. 2-1

The Planning Theory

Four hypothesis were introduced

First: that planning contributes to project success;

Second: that project managers and organizations that usually face high-risk projects tend to plan their projects than those who usually face low-risk projects;

Third: Through better preparations, high risk projects do not increase project failure.

Fourth: The quality of planning affects project success at different intensities depending on the level of risk. The quality of planning index introduced in Zwikael and Sadeh (2007) assesses the way in which project plans are being developed in organizations. The QP consists of two parts:

(1) ***Project know-how processes*****:** defined as planning processes executed by the project manager which includes 9 knowledge areas:

- Integration
- Scope
- Time
- Cost
- Quality
- Human Resource
- Communications
- Risk Management
- Procurement

(2) ***Organizational support processes***: defined as the means that the organization places at the disposal of the project manager to enable proper project planning, execution and completion which includes 4 organizational support areas:

- Organizational Systems
- Organizational cultures
- Organizational Structure
- Project Office

2.5 Quantifying Schedule Risk in Construction Projects

Schedules are considered as a key factor to the successful execution of projects. Which, diverse activities of a construction project are difficult to manage (Gould, 2002).

Because risk and uncertainty are inherent in all construction activities (CII, 1989), most schedules are developed in a deterministic manner (Nasir and Hartono, 2003). As a result, schedule delays are common in various construction projects and cause considerable losses to project parties. A widely accepted concept in the field of construction project management is that a construction project schedule plays a key role in project management due to its influence on project success. Therefore, it is important to quantify probabilities of schedule delays when managing a construction project. A need has emerged for the development of practical methods to evaluate the probability of construction time overruns.

2.6 Significant Delay Factors in Construction Projects

Many scientific journals have reviewed and critically appraised the major factors causing delays on construction projects. The most common delay factors of a construction project can be grouped under nine categories adopting the classification in (Assaf, 2006) as follows:

1- Project- related factors
2- Owner- related factors
3- Contractor- related factors
4- Consultant- related factors
5- Design- related factors
6- Material- Related factors
7- Workforce- related factors
8- Equipment- related factors
9- Environment- related factors

Environment-related factors are external factors such as inclement weather, changes in government regulations and laws, traffic control and restriction at jobsite, and slow municipality permits. Project-related factors are factors deriving from the project

Characteristics and the project delivery system. Unrealistic contract duration, ineffective delay penalties, type of project bidding and award, and type of construction contract are typical factors in this category.

Bayesian belief networks (BBNs), referred to as belief networks, were first developed at Stanford University in the 1970s (McCabe B et al, 1998). BBNs describe cause-effect relationships among variables through graphical models. Belief networks consist of nodes, representing variables of the domain, and arcs, representing dependence relationships between the nodes. Fig. 2-2 shows a simple belief network in which the node at the tail of the arrow, referred to as the parent node, directly affects the node at the head of the arrow, referred to as the child node. The cause-effect relationship between the parent node and the child node is often represented by an arrow or an arc referred to as edge. Child nodes are conditionally dependent upon their parent nodes. BBNs are based on conditional probability theory which was developed in the late 1700s by Thomas Bayes. He discovered a basic law of probability which was then called Bayes' theorem (Charles River Analytics, 2007). Bayes' rule may be simply expressed as follows:

P(B/A)= P(A/B)*P(B) / P(A)

Where P(A) is the probability of A, and P(A|B) is the probability of A given that B has occurred.

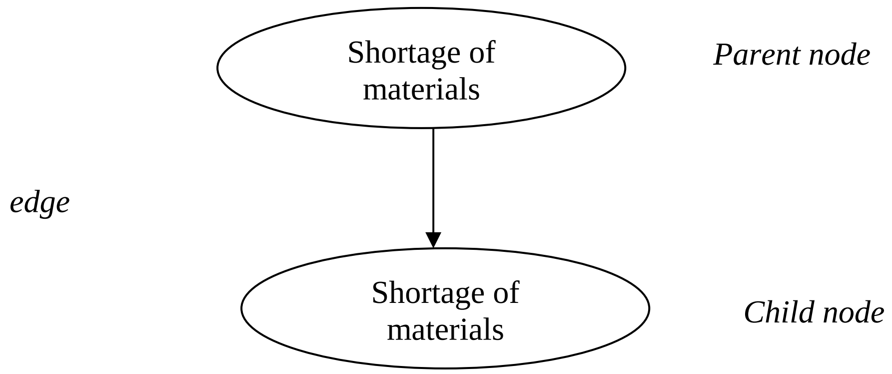


Fig. 2-2
Simple belief network in the construction delay

A research was performed using Bayesian belief networks (BBNs) to quantify schedule risks in construction projects (Van Truong Luu et al, 2009).

The research considered BBNs as the tool for predicting the probability of schedule delay because according to (McCabeB, Goebel R., 1998) belief networks provide great flexibility in their capacity for accepting input and providing output and have the ability to allow the value of a variable to be entered as a known input or to evaluate the likelihood of a variable as an output of the system.

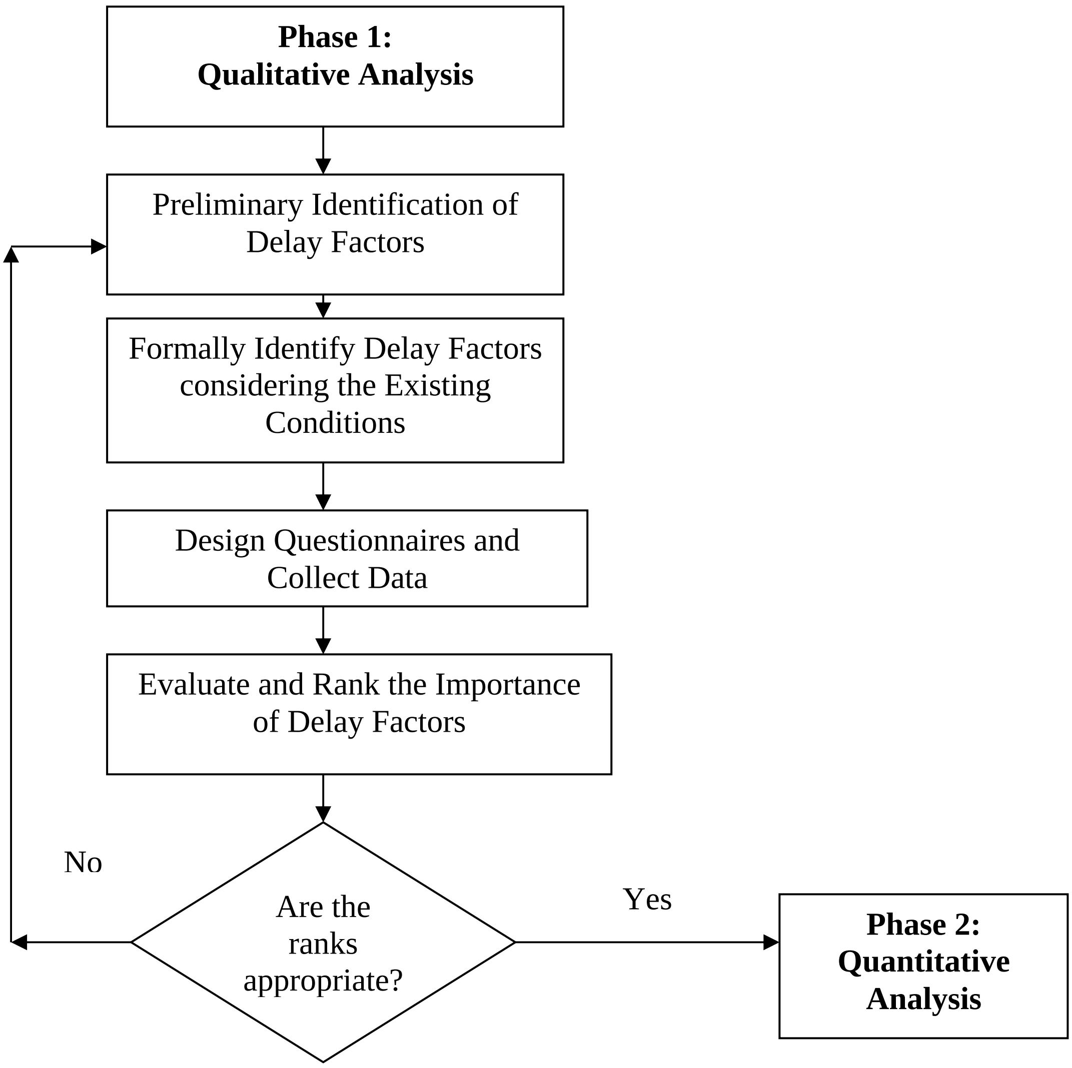


Fig. 2-3

Qualitative Phase in Bayesian Belief Networks

According to (Sahely, 2001), BBNs can readily calculate the probability of events before and after the introduction of evidence and update its diagnosis or prediction.

(McCabeB, Goebel R., 1998) indicated that belief networks may be developed using expert opinion instead of requiring historical data and that belief networks also allow variables to be added or removed without significantly affecting the remainder of the network because modifications to the network may be isolated. BBNs gain insight into relationships among variables of the process due to its graphical display. However, the Bayesian method also has disadvantages that have been elaborated by (Adams, 2006). Fig. (2-3) presents the step-by-step conceptual frame work adopted by (Luu and Kim, 2008)

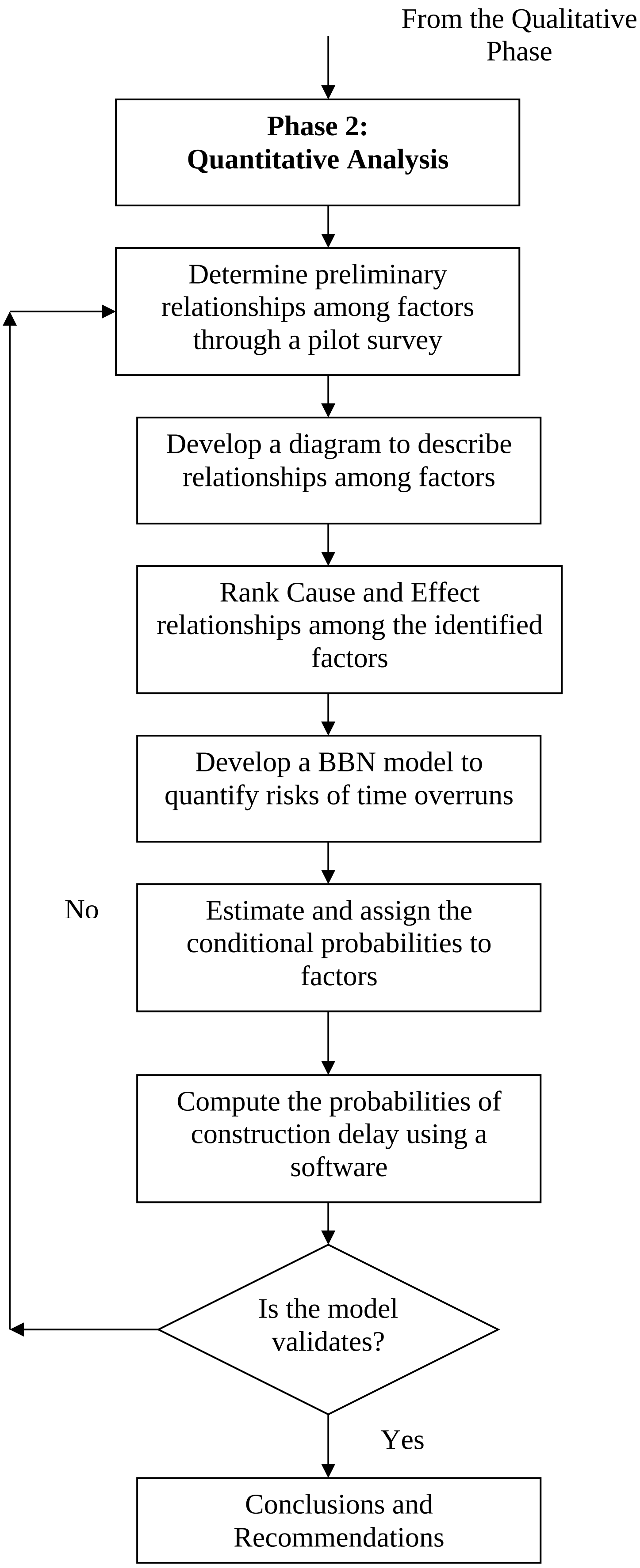


Fig 2-4
Quantitative Phase in Bayesian Belief Networks

The research by (V.T. Luu et al, 2009) consisted of two phases: a qualitative phase and a quantitative phase.

The purpose of the research was to identify significant delay factors being applicable to the context of construction projects. Delay was defined in the research according to (Assaf et al, 2006) as the time-overrun beyond the completion date specified in the contract for a construction project. Sixteen factors were identified as the main delay factors in a construction project which was grouped into five categories as risk variables for the conceptual BBN-based model. The categories are:

1- Category 1: Materials
2- Category 2: Consultants
3- Category 3: Contractors
4- Category 4: Owners
5- Category 5: Construction environment

The relationships developed among factors identified were used to develop the BBN-based model, and to estimate the probability of delays in construction The top main causes of delay in building and industrial construction projects indicated by (V.T. Luu et al, 2009) included owner's financial difficulties, inadequate experience and financial difficulties of contractors, shortage of materials, slow site handover, inappropriate construction methods, defective works and reworks, and lack of management capacity by owners/ project managers.

2.7 Risk Management and Cost-Estimating Processes

Early in the risk analysis process, the cost elements of a project are organized into a suitable structure. The objective of this step is to generate a structure that contains sufficient detail for adequate analysis, but is not so detailed that large amounts of resources and time would be required (Dale Cooper and Stephen Grey, 2005).

The cost structure contained 24 base costs, representing the main activities and equipment items in the project, as shown below:

a) Preliminary Works
b) Concrete Structures
c) Fill Structures

d) Electrical and Mechanical Equipment
e) Indirect Costs
f) Engineering, Management and Owner's Costs
g) Reservoir Cleaning
h) Reservoir Seepage Control
i) Global Risks
j) Escalation Risks

2.8 Risk Management and Procurement Activities

Project management in the construction industry involves coordination of many tasks and individuals, affected by complexity and uncertainty, which increases the need for efficient cooperation. Procurement is crucial since it sets the basis for cooperation between clients and contractors. This is true whether the project is local, regional or global in scope. Traditionally, procurement procedures are competitive, resulting in conflicts, adversarial relationships and less desirable project results.

To manage costs, increase quality and reduce risk, procurement has become a key part of the planning and coordinating process (Egan J, 1998). Due to increased uncertainty, complexity, time pressure and customization in construction projects, high levels of coordination and cooperation among project participants are required (Olsen B, 2005).

The task of coordinating and managing the many suppliers and their activities is often performed by the main contractor (or Construction Management Company). The

client then has only a single point of contact to ensure that promises and contractual requirements are being met. Traditionally, client–contractor relationships have been characterized as adversarial and maintaining arms-length distance, as a result of competitive procurement procedures.

Recently, clients and main contractors are increasingly coordinating their activities, and often develop close cooperative relationships (typically referred to as partnering)

with each other and share many experiences from project to project (Ngowi, 2007). Such partnering relationships improve coordination and flexibility, which is often beneficial in projects characterized by complexity and uncertainty (Anvuur, Kumaraswamy, 2007). Partnering has received much positive attention in recent research, but some researchers claim that full-fledged partnering is not always suitable (Bresnen, 2007). In fact a suitable balance between cooperation and competition often is most appropriate (Eriksson, 2008).

Notwithstanding the potential shortcomings of partnering most authors agree that increased cooperation is desirable in construction projects characterized by high complexity, customization, time pressures, and uncertainty (Lu S, Yan H, 2007).

Previous research confirms that cooperative relationships are not easily established (Chan A et al, 2003). In fact, most clients realize the importance of cooperative relationships but lack the understanding of how to establish them (Mcintosh G et al, 2000). The movement toward more cooperative relationships is hindered by the traditional type of procurement that encourages competition rather than cooperation (Cheung and Suen, 2003). Hence, it would be useful to identify an alternative type of procurement and increase the understanding of how clients can establish cooperative relationships with contractors through cooperative procurement procedures (Pesama and Eriksson, 2009).

An empirical alternative procurement model was proposed by (Pesama and Eriksson, 2009) and empirically test an alternative procurement model based on cooperative procurement procedures, which facilitates cooperation between clients and contractors in construction projects. The traditional competitive type of procurement in the construction industry involves inviting numerous bidders to prepare lump sum contract proposals based on detailed design documents prepared ex ante by the client and their consultants. In the subsequent bid evaluation the lowest

lump sum price is typically awarded the contract (Eriksson PE, 2008). A principal assumption in this neoclassical view is that price leads to a satisfying decision and that the decision maker(s) is capable of achieving a thorough positive outcome. A process such as this is often referred to as a rational process. One drawback of this type of theoretical reasoning, however, is the assumption that throughout this rational process the decision maker is competent to make the best decision with the greatest value and avoid subjective preferences. Most modern, complex industrialized products contain attributes that make it difficult for the decision maker to assess the quality of the product based only on objective factors and avoid subjective characteristics. A primary reason for this is that environmental laws and related regulations cause difficulties in making completely objective decisions. The rational process in such situations then becomes a process to identify alternatives based on previous experiences (e.g., familiarity), or on reputation, legitimacy, quality standards or some other qualifying factor. The process also eliminates others because of their size, lack of relationships to key suppliers, uncertain reputation, or their overall standards are not consistent with ethical and environmental regulations.

A recent trend is these latter factors appear to play a more important role in the rationale of decision makers throughout the procurement process. As a result, competitive procurement processes increasingly leads to disputes, conflicts and adversarial relationships (Cheung, 2003) and the movement is more toward client–contractor cooperation (Molenaar et al, 2000) because it is more effective and improved procurement procedures are implemented (Briscoe et al, 2004).

At the basic level any theory represents a system of ideas and relationships that can be defined, measured and tested in a representative empirical setting (Hair JF et al, 2006). A Structural equation modeling (SEM) technique to be used by (Pesama and Eriksson, 2009) to develop a procurement model guided by and emerged from the scientific foundations of the SEM techniques process. The model and the hypotheses are shown in Fig. (2-5)

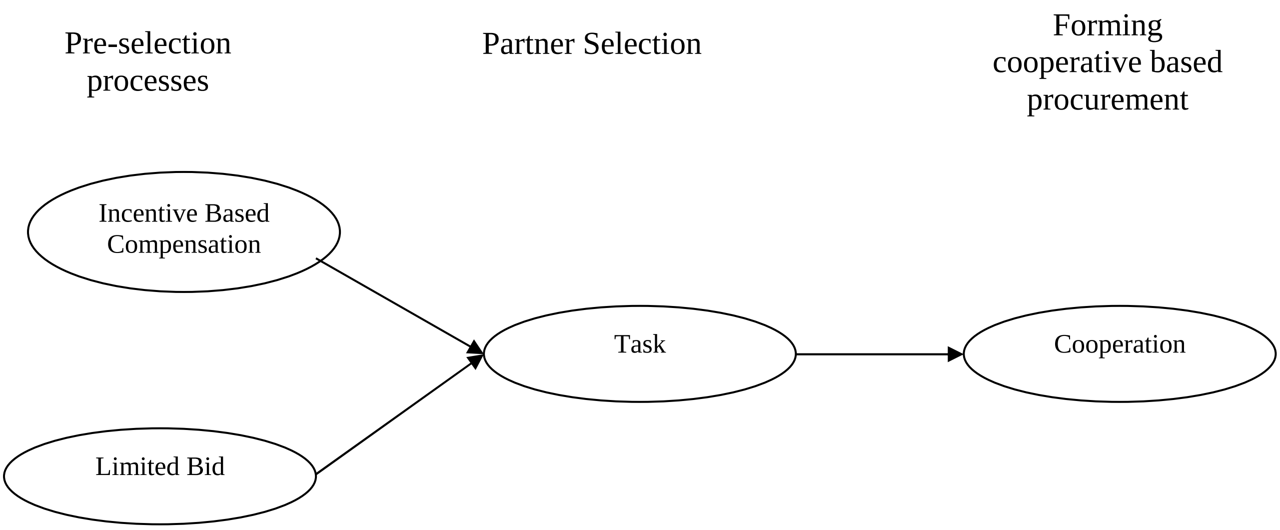


Fig 2-5

Theoretical model of proposed relationships

(Pesama and Eriksson, 2008)

2.9 Managing Quality Risks in Construction Activities

Not all studies required a quantification of construction quality. The authors of some studies did not intend to establish the relationship between the explanatory variables and the dependent variable (quality). Rather, they presumed the factors found would affect construction quality (Abdel Razek, 1998). In such cases, there was no need to quantify quality. Others used some statistical methods to establish the relationship between explanatory variables and dependent variable (quality). The statistical methods typically used were multiple regression, correlation analysis, and mean comparison (Konchar M et al, 1998). Occasionally, a rank correlation approach called Spearman's rho was used. When such statistical methods were used, there was a need to quantify construction quality.

Just like the fact that the questionnaire survey was the most commonly used method of data collection, the subjective evaluation by experts interviewed or surveyed was the most commonly used method of quantifying construction quality. The primary reason was the lack of data. Nearly all studies using statistical methods to identify factors affecting construction quality mentioned above used this method, although one study, (Cooke-Davis, 2002) did not specify the method of quantification. The only notable exception was, who used the Hong Kong Housing Authority's (HKHA) Performance Assessment Scoring System (PASS) scores. Table (2-1) lists the methodologies and data sources of some studies on construction quality:

Attempts were made to quantify project performance. For instance, Menches and Hanna, 2006) proposed an index to quantify project performance, although the paper did not intend to examine factors affecting project performance. However, few attempts were made to quantify quality other than subjective rankings by experts.

The authors believed that the major difficulty in quantifying construction quality is the availability of data. When data was not available, scholars tended to either bypass

Quantifying quality or collect opinions on quality via questionnaire surveys.

It is generally agreed that critical success factors (CSFs) for quality are different at different stages of the building process (Arditi and Gunaydin, 1998). CSFs also differ as project objectives change (Chau et al, 1999). It is also agreed that CSFs for quality are different in different industries (Belassi and Tukel, 1996). Hence, it is very probable that CSFs for quality could be different at different stages of economic development.

Belassi and Tukel (Belassi and Tukel, 1996) recognized the importance of the availability of resources (human, financial, raw materials, and facilities). (Nguyen et al, 2004) also found that one of the CSFs for large construction projects in Vietnam was the ‘‘availability of resources”. In addition, (Ling et al., 2004) found that the ‘‘adequacy of contractor's plant and equipment” (or lack thereof) was one of the most influential factors affecting the quality of building elements in design-build projects. It is self-convincing that the availability of resources could affect construction quality. The reason that management issues were overemphasized in the literature could be that the economies studied were well-developed and boasted ample and mobile resources (including materials, machinery, and labor). Hence, these factors were often taken as granted and not considered to be critical factors affecting construction quality. However, in underdeveloped economies such as China's as recently as a few years ago, both the availability of materials and the mobility of labor could well be matters serious enough to affect construction quality.

Using national level data, (Yung and Lai, 2008) found that per capita machinery owned by contractors affects construction quality. The variables tested were the
‘‘Value of machinery per capita at constant price" and the ‘‘power of machinery per capita". They documented in their research the implementation of mandatory construction supervising arrangements in China
And found that it improved construction quality. It has been argued that the quality of buildings is an attribute borne more by users, who have little control over and little information on the quality of their buildings, than by developers or contractors. Hence, certain institutional arrangements could better affect construction quality than simply leaving the market to price the differentials in quality in the case of positive transaction costs.

In their paper, (Yung and Yip, 2010) defined quality as a percentage of total floor area of completed projects in a particular province in a particular year. ‘‘Good quality projects" here refer to those projects accredited as ‘‘good quality" by the relevant government quality supervision department according to the quality standard prevailing at the time of inspection. The quality standards prevailing during
The study period were those prescribed by the Standards for Assessment of Quality of Construction and Installation Projects (GBJ300-88), in which three categories of quality, namely, good, pass and fail were defined. Essentially, a building is divided into several parts according to the location, for example, the builder's works consist
Of substructure, frame, floors, doors & windows, finishes & roofing. Each part will be further divided into a number of sections according to work trades. The items under each section are further categorized into three categories, namely, guaranteed, fundamental and tolerance-allowed items.

Table 2-1 describes the standards required for accreditation as ‘‘pass” or ‘‘good quality”.

Category	Pass	Good Quality
Sections: guaranteed items	All items shall meet pass standards	All items shall meet good quality standard
Sections: Fundamental items	All sampled items shall meet pass standard	All sampled items shall meet pass standard; and at least 50% of them shall meet good quality standard
Sections: Tolerance allowed parts	At least 70% of tolerance allowed items in builder’s works and 80% in services works shall fall within the maximum allowance tolerance	At least 90% of all tolerance-allowed items shall fall within the maximum allowable tolerance
Parts	All sections shall pass	All sections shall pass, and at least 50% of them will be of good quality
Building	All parts shall pass; and quality assurance documents shall be recorded; and visual quality judgment items shall have an overall mark of at least 70%	All parts shall pass, and at least 50% of them shall be of good quality, and quality assurance documents shall be recorded, and visual quality judgment items shall have an overall mark of at least 85%

Table 2-1

Quality standards in GBJ300-88

The study by (Yung and Yip, 2010) concluded that:

- The availability of resources, including machinery and labor, was particularly important because it affects construction quality in underdeveloped economies; _ the power of machinery per laborer is a better measurement of the impact of equipment on quality than the book value of the machinery per laborer;
- The use of more plants or machinery per m^2 of floor space will increase construction quality, while the use of more laborers per m^2 of floor space will decrease
- Construction quality;
- Construction quality will improve, but at a decreasing rate, as China’s economy develops;
- Properties with larger unit areas tend to be better constructed;
- Construction quality has improved over the years, probably due to the gradually implementation of mandatory construction supervising system;
- State Owned Enterprises (SOE) projects tended to be of better quality than those undertaken by non-SOEs, probably due to the greater availability of construction materials and capital enjoyed by the former; and
- Higher labor productivity tends to be associated with better construction quality.

2.10 Safety Risk Management in Construction Projects

Safety at work is a complex phenomenon, and the subject of safety attitudes and safety performance in the construction industry is even more so. In the construction

Industry the risk of a fatality is five times more likely than in a manufacturing based industry, whilst the risk of a major injury is two and a half time higher (Davis and Tomasin, 1990). A labor workforce is a valuable asset to all industries, and determines a region's productivity and economic growth if the best protection protocols for the workforce are in place (Occupational Safety and Health Council,

2001). the construction industry is a major source of employment and plays a vital role in the local economy. However, the industry also suffers from high accident rates, which results in absenteeism, loss of productivity, permanent disability, and even fatalities (Fung and Tam, 1994; Mohamed, 1999; Occupational Safety and Health Council, 2001a,b; Niza et al., 2008; Mohamed et al., 2009).

Construction work was found to be a high-risk occupational area in modern society (Liao and Perng, 2008; Niza et al., 2008). That was caused by the combination of many reasons, such as high-risk characteristic of construction work and low education level of construction workers. It is well-known that the most effective way to improve safety performance should be preventing accidents and reducing uncertainty before its happens (Cooke, 1997; Gambatese et al., 2008). Thus, safety risk analysis is a foundation upon which safety management is build and risk assessment becomes a critical task which forms a part of safety management systems (Langford et al., 2000; Low and Sua, 2000; Cheng et al., 2004; Jung et al., 2008). To improve safety performance of the industry, safety professionals are the key to carry out assessment on site (Aksorn and Hadikusumo, 2008; Aneziris et al., 2008; Visscher et al., 2008). Therefore, safety professionals' understandings and perceptions of safety risks will affect quality and reliability of risk assessment. A tool was developed by (Cooke et al, 2008) to help construction designers integrate the management of occupational health and safety risk into the design process in Australia.

2.11 Managing Environmental Risks in Construction Projects

The promotion of environmental management and the mission of sustainable development have resulted in pressure demanding the adoption of proper methods to improve environmental performance across all industries including construction. Construction is not by nature an environmentally friendly activity. Existing research suggests that construction activity is a major contributor to environmental pollution. For example, McDonald's research (McDonald, 1996) reports that 14 million tons of wastes are put into landfill in Australia each year, and 44% of this waste is attributed to the construction industry. According to (Zhang et al, 2000) construction contributed environmental pollution has been increasing in China in line with its fast urban development since the early 1980s. The standards of major environmental.

Indicators such as sulfur dioxide (SO2) emissions and total air-suspended particulates (TSP) are far worse than international standards. It has been reported according to (SEPB, 1997) that 72% of the major Chinese cities, including the municipalities and the provincial capitals, have TSP of over 200 mg/m3, whilst the international standard defined by the World Health Organization is 90 mg/m3 (World Bank, 1998). Construction activity is one of the major contributors to the environmental impacts, which are typically classified as air pollution, waste pollution, noise pollution and water pollution (EPD, 1999). (Poon, 2000) reported that the waste generated by the building and demolition of construction projects assumes a large proportion of environmental waste in Hong Kong. (Uher, 1999) suggested that construction activities have a significant impact on the environment across a broad spectrum of off-site, onsite and operational activities. Off-site activities concern the mining and manufacturing of materials and components, the transportation of materials and components, land acquisition, and project design. On-site construction.

Activities relate to the construction of a physical facility, resulting in air pollution, water pollution, traffic problems, and the generation of construction wastage.

(March, 1992) observed the construction industry's environmental impacts under the categories of ecology, landscape, traffic, water, energy, timber consumption, noise, dust, sewage, and health and safety hazards.

(Shen et al, 2000) classified construction environmental impacts as the extraction of environmental resources such as fossil fuels and minerals (; extending consumption of generic resources, namely, land, water, air, and energy; the production of waste that require the consumption of land for disposal; and pollution of the living environment with noise, odors, dust, vibrations, chemical and particulate emissions, and solid and sanitary waste. (Hendrickson and Horvath, 2000) considered the five largest

Toxic air emissions from construction, including sulfur dioxide (SO2), nitric dioxide (NO2), volatile organic compounds (VOC), toxic releases to air, and hazardous waste generated. They estimated these environmental emissions for the four largest construction sectors in the United States, namely, highway, bridge, and other horizontal construction; industrial facilities and commercial and office buildings; residential one unit buildings and other construction such as towers, sewer and irrigation

systems, and railroads. Nevertheless, their findings suggest that construction in the USA makes a smaller contribution to hazardous waste generation than its share of GDP might suggest. This probably demonstrates that the US Environmental
Protection Agency moves to regulate these environmental emissions more closely.
In pursuing the mission of sustainable development, efforts towards practicing environmental management in the construction business have been growing rapidly.

The environmental management system (EMS) defined in the standard ISO 14000 is promoted as a vehicle for organizations to develop environmentally friendly practices.
The system provides a standard framework that includes environmental policy, planning, implementation and operation, checking and corrective action, and
Measurement review and improvement (Baccarini, 1999). It was developed to assist organizations to improve their environmental performance on a voluntary basis through coherent allocation of resources, assignment of responsibilities, and continuing evaluation of practice. The findings from a recent survey show that the number of firms who have obtained ISO 14000 certification is increasing, mainly in the fields of electrical and optical equipment, basic metal and fabricated metal products, machinery and equipment, construction, and wholesale and retail trade. Improvements in environmental performance in construction are on the increase, particularly in reducing the production of wastes and improving the techniques that could have harmful effects on the environment. This development, however, involves investing resources and thus presents challenges, particularly to contractors' profits-making. It appears that concern related to investment in environmental management has largely overtaken the understanding of the benefits gained by engaging in environmentally friendly construction practice.

Performance of a project has always been an important issue in the construction industry. There have been many past studies on project success and factors affecting
Project success. (Sayles and Chandler, 1971) listed five critical success factors for a project. These are project manager's competence, scheduling of activities, control
Systems and responsibilities, monitoring of project and continual involvement in the project. (Martin, 1976) identified eight success factors in a project). These are defined
Goals, organizational philosophy, management support, proper delegation of duties, selection of team, proper allocation of resources, information mechanism and
Planning reviews. (Morris and Hough, 1987) found nine success factors of a project. These are clear project objectives, technical uncertainty innovation, politics, community involvement, schedule

duration urgency, finance, legal agreement, contracting and solving of problems. These studies provided invaluable knowledge on factors which are vital to project success. There have been widespread research studies of personal managerial skills of a project manager affecting the performance of a project. These research studies allowed the client to have a better understanding of project managers, thus enabling him to select the appropriate project manager for his proposed project. (Fryer, 1985) listed social skills, decision making skills, problem handling skills, opportunities recognizing skills and management of changes as personal attributes affecting project success.

Despite this, a project may still under-perform. An understanding of project success factors and attributes of project managers alone proved to be insufficient for project success. There is a lack of understanding of the importance of the working environment and its impact on the success of a project. Working environment refers
to the perception of the work environment and can differ from project to project. Few studies have been done to specifically examine how the working environment can affect the effectiveness of a project manager.

In view of the important role the working environment plays in ensuring project success, The study by (Low and Quek, 2005) was conducted to examine the working environment affecting the performance of project managers. The study aimed to enable practitioners to understand the type of working environment which undermines the performance of project managers and understand the causes of failures. This is important not only for determining the success of a proposed project, but also in ensuring the continual good performance of project managers.

There are obvious benefits to the community from implementing environmental management in construction activities, such as reducing the production of Wastes, and reducing the use of materials and techniques that could have harmful effects on the environment. The benefits to contractors can be in a number of ways, for example, cost savings due to the reduction of fines associated with convictions as a result of complying with environmental legislation. Existing publications.
have identified a number of beneficial factors (BF) in implementing environmental management in construction (Shen, 2000) and (Hendrickson, 2000).

2.12 Summary

As a conclusion from the literature review, it has been found that problems in risk management were derived from a narrow perspective.

All researches and studies illustrate the increasing importance of the probability of risk and its impact. The Petroleum & Gas Projects in Egypt are evolving and there are no enough studies describing and defining them.

The research of Tamer Raafat Mohammed (2011) and Yasser Solieman (2009), both of them had studied the risk factors in On-Shore Oil & Gas projects in Egypt, they had assessment and analysis these risk factors (As shown in page 4), these research have achieved different risk factors (As shown in page 85) in comparison with their researches according to the different environmental conditions, this research had matching in some risk factors and not matching in other factors, constructing a project in a stable environmental is totally different as constructing a project in Un-stable environmental.

Therefore the objectives of the current work are:

1. To study the Factors which may effect in the construction phases of off-shore petroleum projects to analyze and identify associated risks.

2. Identify the important risk factors affecting the construction companies working in that field in Egypt.

3. Investigate the important risk factors according to each company point of view, Using a pre-define questionnaire.

4. Define the most important factor of risks according to the questionnaire.

CHAPTER (3)

Project Risk Management

3.1 Introduction

Risk management is generally a part of other management system such as quality management, environmental management system …etc. So risk management must be implemented during the project process. The Off-Shore construction projects are characterized as very complex which have planning and design complexity, resource availability, different roles of parties, political environment, economic environment etc. For all of these reasons, a very careful risk management is needed to ensure that the construction work can be successfully implemented.

The off-Shore projects in Egypt contain many risks. That is the reason why, conducting a good risk management in off-Shore project management is highly needed.

3.2 Risk Definitions

- Uncertain event or condition that, if it occurs, has an effect (impact) on any of the project objectives (Time, Cost, Quality, Scope), Impact could be +ve (opportunity) or –ve (threat) (PMBOK® Guide P436)
- Webster's dictionary defines risk as ''the possibility of loss, injury, disadvantage, or destruction.''
- The Health and Safety Commission defines risk as ''the likelihood that harm will occur'' Health and Safety Commission 1995.
- The Random House College Dictionary defines risk as ''exposure to the chance of injury or loss' (Hertz and Thomas 1983).
- Hertz and Thomas (1983) determined the relationships between risk and uncertainty. They stated that, if someone is inheriting from a relative but is not sure how much he will get after state taxes and lawyer fees, he is definitely in a state of uncertainty. But, in no way, can it be said that he is facing risk. Risk would have to involve some kind of damage or loss. Symbolically, this can be written as

$$\text{Risk} = \text{Uncertainty} + \text{Damage}$$

They added that risk is a broad concept with many dimensions, and only through the ability to structure the decision problem can a meaningful assessment of risk be obtained. A clear understanding of these dimensions and the structuring of the problem is therefore very important.

- Hillebrandt (1974) stated that risk arises when the assessment of the probability of a certain event is statistically possible, while uncertainty arise when the probability of occurrence or nonoccurrence of an event is indeterminate.
- Erikson and o'onnocr (1979) produce a working definition of risk as "an exposure to possible loss or gain arising from involvement in the construction process "they described characteristics of risks include:
    - Frequency of losses or gains.
    - Severity of losses or gains.
    - variability of losses or gains
- Lifson and Shaifer (1982) defined the risk as "the uncertainty associated with estimates of outcomes of decision". He further said that the definition means there is a chance that results could be better than expected as well as worse than the expected and probability is being used to measure risk.
- R.M Wideman (1986) defines risk as:" the chance of certain occurrences adversely affecting the project objective" it neglects the positive effects. So Chapman modified it to "an event which should it occur, would have a positive or negative effect on the achievement of a project's objective." He doesn't consider Risk and uncertainties as synonyms
- Al-Bahar and Crandell (1990) defined the risk as the "exposure to the chance of occurrences of events adversely or favorably affecting project objectives as a consequence of uncertainty "with this definition they characterized risk by the following components:
    - The risk events: what might happen to detriment or in favor of the project?
    - The uncertainty of the event: how likely the event is to occur. i.e the chance of the event occurring
- Barrier and Paulson (1992) expressed the risk as an exposure to economic loss or gain arising from involvement in the construction process.
- PMBOK (2000) defined the risk is an uncertain event or condition that if it occurs, has a positive or negative effect on project objective .a risk has a cause may be requiring a permit or having limited personal assigned to the project.

- Kartam (2001) defined the risk as the probability of occurrence of some uncertain, unpredictable and even undesirable event that would change the prospects for the profitability on a given investment.
- Jaafri (2001) gave two separate definitions to risk is the exposure to loss/gain, or the probability of occurrence of loss/gain multiplied by its respective magnitude and uncertainty, which is the probability that the objective function will reach its planned target value.
- Hillson (2002) took a step further by defining project risk as “an uncertain event or condition that if it occurs, has a positive or negative effect on the project objective… project risk includes both threats to the project's objectives and opportunities to improve on those objectives”.
- Dr. William J. Bender, Pe (2004) used a common definition of risk as a pair of the probability of occurrence (likelihood) of an event, and the consequence (outcome) associated with the event's occurrence. This pairing can be represented by the following equation:

$$\text{Risk} = [(P1, C1), (P2, C2)\ldots, (PX, Cx)]$$

In this equation PX is the occurrence probability of event x, and Cx is the occurrence consequences or outcomes of the event. This definition is used because of its Application to the project management field. The term probability is used because it frequently is used to express the likelihood of an occurrence in project.

3.3 Risk Management

- Risk management is defined as a procedure to control the level of risk and to mitigate its effects (Toakley 1989).
- Risk management is not a discrete activity, but a basic fundamental of the project management. In the global sense, risk management is the process that, when carried out, ensures that all that can be done will be done to achieve the objectives of the project within the constraints of the project (Clark, Pledger and Needier 1990).

In the narrow specialized sense, risk management is a part of the overall process. Once a risk is identified and defined, it ceases to be a risk and becomes a management problem. It can be summarized that:

- Risk management needs to be a continuous function of project management.

- Risk management needs to give an objective view of the project from the moment the project starts to the moment it ends.
- Risk management processes the available information into a formal model which supports the decisions.
- Risk management breeds responsive, flexible and planned project management.
- The Project Management Institute (2004: 237-268) covers project risk management (PRM). The objectives of PRM are to increase the probability and impact of positive events, and to decrease the probability and impact of events adverse to the project. The risk identification process, which usually leads to the qualitative risk analysis process, is an iterative process of determining which risks might affect the project and documents and their characteristics. The PMBOK guide also outlines inputs, tools, and techniques that may be used to identify and quantify risks. According to the guide, PRM includes the processes concerned with conducting: Risk Management Planning (deciding how to approach, plan and execute the risk management activities of the project); Risk Identification (determining which risks might affect the project and documenting their characteristics); Risk Analysis (see below); Risk Response Planning (developing options and actions to enhance opportunities, and to reduce threats to project objectives); and Risk Monitoring and Control (tracking identified risks, monitoring residual risks, identifying new risks, executing risk response plans, and evaluating their effectiveness throughout the project life cycle). The primary outputs from a risk identification exercise may be entered into a risk register, which typically contains: a list of identified risks; list of potential responses; root causes of risk; and updated risk categories.
- Risk management Plan : is the process of defining how to conduct risk management activities for a project, process allows the work when it is done:
    - To be completed faster.
    - Easier.
    - And more effectively.
    - Continuous improvement: plan, do, check, act.
    - Less likely to miss something important.

3.4 Risk Management Modeling

Risk management modeling provides an effective systematic framework for identifying, evaluating and responding to risks in the different types of project in order to cope with the problems or consequences that may arise in the construction or/and operation stages.

3.5 Risk in Construction

- Construction risk is generally perceived as events that influence project objectives of cost, time and quality (Akintoye and Macleod 1997).
- The construction industry has had a poor reputation for coping with risks, many projects failing to meet deadlines and cost targets. Clients, contractors, the public and others have suffered as a result (Thompson and Perry 1992).
- The construction industry is subject to more risk and uncertainty than many other industries. The process of taking a project from initial investment appraisal to completion and into use is complex, generally bespoke, and entails time-consuming design and production processes. It requires a multitude of people with different skills and interests and the co-ordination of a wide range of disparate, yet interrelated activities. Such complexity moreover, is compounded by many external, uncontrollable factors (Flanagan and Norman 1993).
- The construction industry has many unknowns and things rarely go according to plan. We need to be more aware of WHIF “What Happens If” analysis. People should be encouraged to have brainstorms of destructive thinking, where wild idea can be thrown up about the things which might go wrong, even though there is no precedent. The ideas need to be collected into a risk management system where analysis can be undertaken (Flanagan and Norman 1993).
- Risks in construction have been classified in different ways (see for example, Edwards and Bowen’s (1998: 341-344) comprehensive review of risk literature (1960-1997) in construction). However, they significantly have the same meaning in that authors generally agree that some risks can be controlled whereas others cannot. Murdoch and Hughes (2008: 81) classified risks affecting construction projects under physical works, delay and disputes, direction and supervision, damage and injury to persons and property, external factors, payment, and law and arbitration. Erikson (1979: 6) classified risks in construction as contractual risk (caused by lack of clarity, absence of communication between parties, problems of timeliness in contract administration) and construction risk (inherent in the work itself). In developing a fuzzy model for contractor’s risk assessment at the tender stage, Tah et al. (1993: 282) categorized project

risks into external and internal risks (see below). This is similar to the classification in the finance literature where portfolio theory and capital-market theory divides risk into systematic risk (external – overall market risk including unanticipated increases in inflation or interest rates, labor shortages, and economic downturn or recession) and unsystematic risk (internal – independent of any economic, political, or social factors which affect the market in a systematic way, including the risks mentioned by Park.

3.6 Characteristics of construction risk

In the practice of construction risk management, Perry and Hays (1985) stated characteristics of construction risk as:

- Risk and uncertainties are associated with specific events or activities that can be individually identified.
- A risk event implies that there is a range of outcomes of each event and each outcome has a probability of occurrence.
- Some risks offer only the prospect of adverse consequence (loss) a bankruptcy, war, sea or flood damage , these may be low or high probability but of high impact.
- Many common construction risks offer the prospect of either loss or gain as productivity of labor and plant; these are typically of high probability and may be of low or high impact.
- Subjective judgment is usually required to calculate the probability of occurrence of specific outcomes of risk event.
- B.Mulholland and J.christian (1999) stated that one reason for failure in construction projects has been caused by the selection of the contracting format that did not fit the risk characteristics of the project. For example the use of lump-sum contract on a fast track project can lead to many contract disputes and diversion of management s attention from the critical field work issues. Poor management practices also create problems .the effectiveness of the project management function significantly influence whether the planning project schedule duration will be achieved successfully.

Successful projects	Unsuccessful projects
Well defined scope	No defined scope
Early , extensive planning	Poor planning
Good leader ship and supervision Involved , positive owner relationships	Poor management and control
Good communications and relationships	Poor communication between disciplines
Quick response to changes	Poor personnel quality
Engineering concerned with total project.	Excessive changes

Table 3.1 the characteristics of successful and unsuccessful project

Knowledge gained from formal education, training, and substantial planning experience is required. However, the valuable knowledge and experience that is acquired during the construction of a facility often are:

Not available for the construction of the next similar facility. A number of factors have contributed to the shortage in recording past project experiences. The following are four of the principal reasons:

- The project team assumes each project is unique; therefore old records are often considered of little value, and the records are not maintained or are discarded (Sanvido and Medeiros 1990).
- At the end of the project there is a lack of interest or funding to conduct post project reviews.
- A formal or convenient process does not exist to capture and transfer readily knowledge to subsequent projects.
- At the end of a project often there is not a similar project in progress to which the professional and trades personnel can be transferred.

3.7 Construction Risk Management System (CRMS)

This model presented by Al-bahar (1988), provides an effective systematic framework for quantitatively identifying, evaluating, and responding to risks in construction projects. According to CRMS, it is suggested that risk management must be seen as managing responses rather than responding to risk events after they happen. Hence, the theme of risk management approach is to act instead of react to project risks. Many contractors think of risk management as insurance management where the main objective is to find the optimal economic insurance coverage for the insurable risks but actually it is a scientific systematic approach of managing risks faced by contractor, and it deal with both insurable as well as uninsurable risks and the choice of the appropriate technique or techniques for treating those risks.

Figure 3.1 shows the functions of the CRMS model, the proposed CRMS model consists of the following four processes:

- Risk identification
- Risk analysis and evaluation
- Response management
- System administration

These four processes are arranged in a logical and sequential order that progress clockwise. By following this model, the contractor is assured of a systematic way of managing risks. The linkage between the four processes provides a closed feedback loop to update the information in the system and to capture the interaction between these processes.

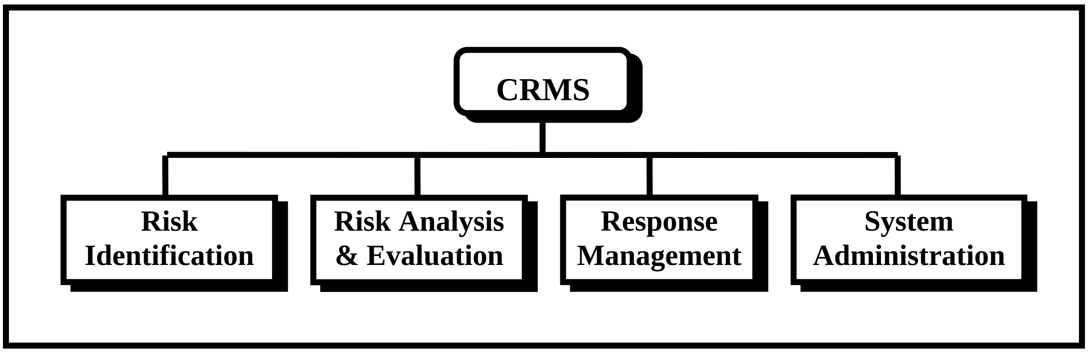


Fig.3.1 The four functions of the CRMS Model by Al-bahar (1988)

3.8 The Risk Breakdown Structure (RBS)

David Hillson, defined RBS as “A source-oriented grouping of project risks that organizes and defines the total risk exposure of the project , Where the RBS can be used as a prompt list to ensure complete coverage during the risk identification phase. This is accomplished by using the RBS to structure which ever risk identification method is being used. For example, a risk identification workshop or brainstorm might work through the risk identification checklist can also be developed based on the RBS, by taking each of the lowest RBS levels and identifying a number of generic risks in each area based on previous experience

The most obvious demonstration of the value of structuring within project management is the Work Breakdown Structure (WBS), which is recognized as a major tool for the project manager because it provides a means to structure the work to be manageable and definable packages to provide a basis for project planning, communication, reporting, and accountability. In the same way, risk data can be organized and structured to provide a standard presentation of project risks that facilitates understanding, communication and management

Some authors and practitioners have gone further in structuring risk than simply listing types of risk faced by a project. These have produced hierarchical structures under various names to describe sources of risk, or risk categories or types, though these are usually focused on a particular project type or application area.

In another paper Tumala and Burchett (1999) used: high level of work breakdown structure to properly identify cost centers, to be able to categorize them. He identified 6 types of risk Financial, political, environmental design, site construction, physical and act of god) they used certain checklist figures to collect required information. After gathering all necessary inputs, it is tie to employ the recommended tools and techniques of risk identification.

3.9 Risks Identification

Many managers believe that the principal benefits of risk management come from the identification rather than analysis stage. For them, great benefit comes from the discipline of thinking through the project, understanding the potential risks, and considering possible responses. Rigorous, analytical analysis is often reserved for the larger, more complex projects (Hayes, Perry, Thompson, and Willmer, 1987).

In according to mentioned statement, many professionals (e.g. (Bajaj, Oluwoye, and Lenard, 1997) also agreed with. According to Hayes, Perry, Thompson, and Willmer (1987) research, they also suggested the way to identify the risks by asking key question that ‘What are the discrete features of the project (risk sources) which might cause following failure?. The most serious effects of risks are:

- Failure to keep within the cost estimate
- Failure to achieve the required completion date
- Failure to achieve the required quality and operational

Victor O. (2000) The first step in controlling risk is the identification of risk. Just as the design professional identifies design parameters in a programming process, the design professional must identify the risk parameters of a specific project. There are many generators or influences of risk. At a minimum, firms should always be aware of:

• The nature of the project (aspects such as sufficiency of scope, site, budget, and schedule; community sensitivity or opposition; unusual regulatory requirements; or a history of a high incidence of litigation.

• The firm's capabilities and experience (the appropriate design expertise and ability to spend the time necessary on the project.)

• Specific client attributes (client attitude, funding, understanding of the nature of professional services, and sophistication.)

• Construction industry factors (the influences on the delivery of a project such as the type of contractor selection process; the inclusion of other parties in the design and construction process; the state of the local construction economy.)

• Constraints on time and cost (the compensation for design services, the project budget, and scheduling constraints.)

• Forces external to design and construction (the general economic climate and the attitude of the community and the government to new projects; the overall political situation and laws, rules, and regulations that might be forthcoming.)

- Elkington and Smallman (2002) argue risk identification requires rigorous thinking in different directions on the part of the project manager and his team during different stages of the project.
- Chapman and word (1997) agree on the importance of risk identification and argue that through it is considered a difficult step it requires creativity and imagination and that it could be more efficient if it carried or checklists . Another author argues that this process could be a well structured process that starts with setting a proper context, prospective for analysis and finally classify risks according to their causes.
- Chapman (2002) carried out a study related to the design of projects. He Believes the project team should acquaint with certain aspects before starting the identification process. Information related to the process shall be introduced; he also believes that the process shall be iterative; as more new

information is introduced earlier step should be "revisited ". Under the supervision of any analyst, the following steps should be implemented:

- Knowledge acquisition.
- Selection of representatives.
- Presentation of the idea to the team.
- Measurement criteria.
- Understanding probability.
- Culture conditions.
- Identification.

3.9.1 Risk Identification Techniques

Some techniques have been used to identify Risk shown as follow:

1- Delphi Technique: Is a way to reach a consensus of experts.

- Anonymous: no bias/no influence from individual person on the outcome.
- Written questionnaire.
- Responses are summarized and recirculated to the experts for further comments.
- Two or more rounds to reach consensus.

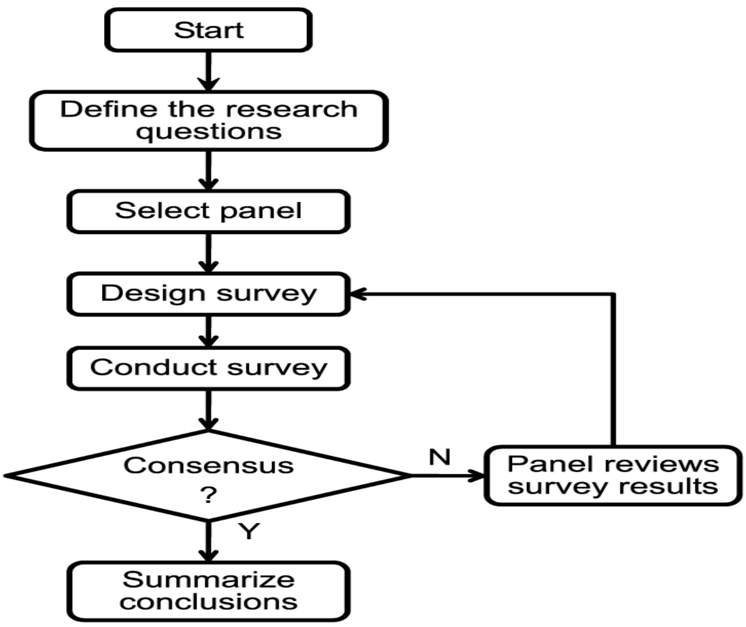


Fig. 3.2 Delphi Technique Diagram PMBOK® Guide 2013 5th Edition, PMI.

2- **SWOT** Analysis of strengths, weaknesses, opportunities and threats of an organization, project or option.

Internal:

Strengths: Build upon it to offset threats and exploit opportunities.

Weaknesses: Avoid by building capacities

External:

Opportunities: Positive Risks

Threats: Negative Risks

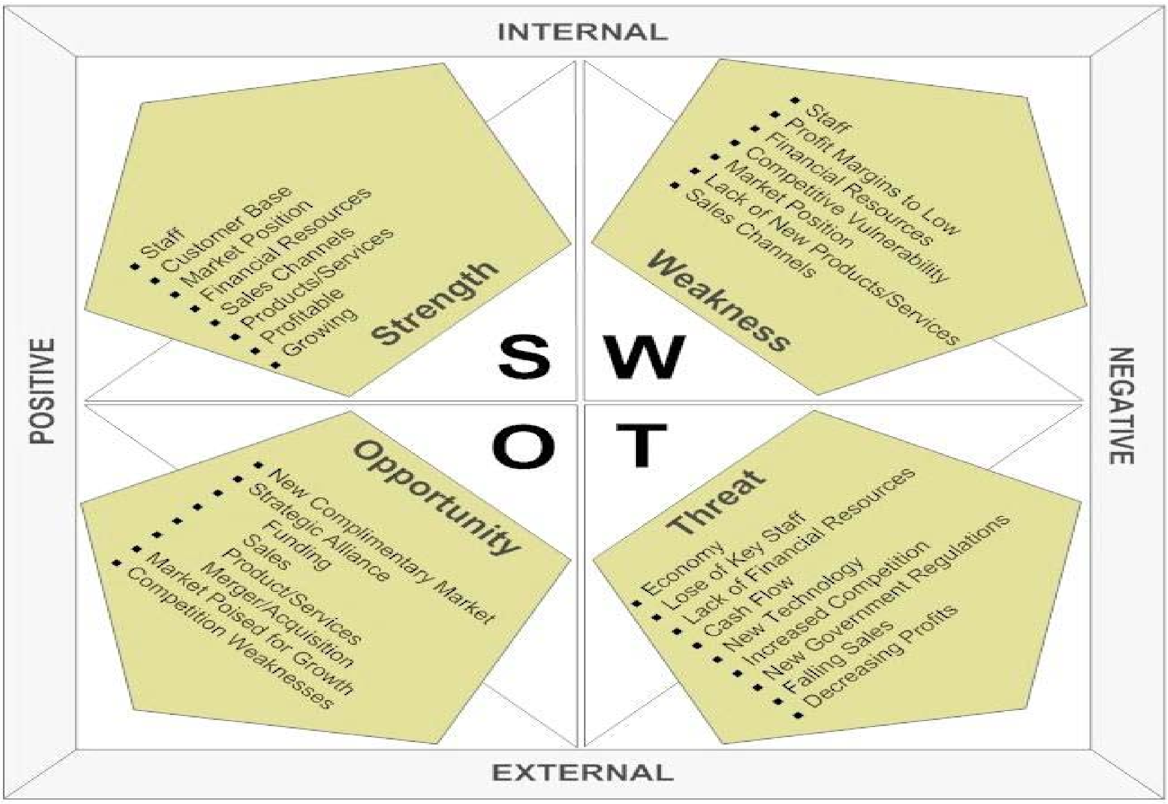


Fig. 3.3 SWOT Analysis Technique PMBOK® Guide 2013 5th Edition, PMI.

3- **Ishikawa diagrams**: are causal diagrams created by Kaoru Ishikawa (1968) that show the causes of a specific event. Common uses of the Ishikawa diagram are product design and quality defect prevention, to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation. The categories typically include:

- People: Anyone involved with the process

- Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations and laws
- Machines: Any equipment, computers, tools, etc. required to accomplish the job
- Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
- Measurements: Data generated from the process that are used to evaluate its quality
- Environment: The conditions, such as location, time, temperature, and culture in which the process operates

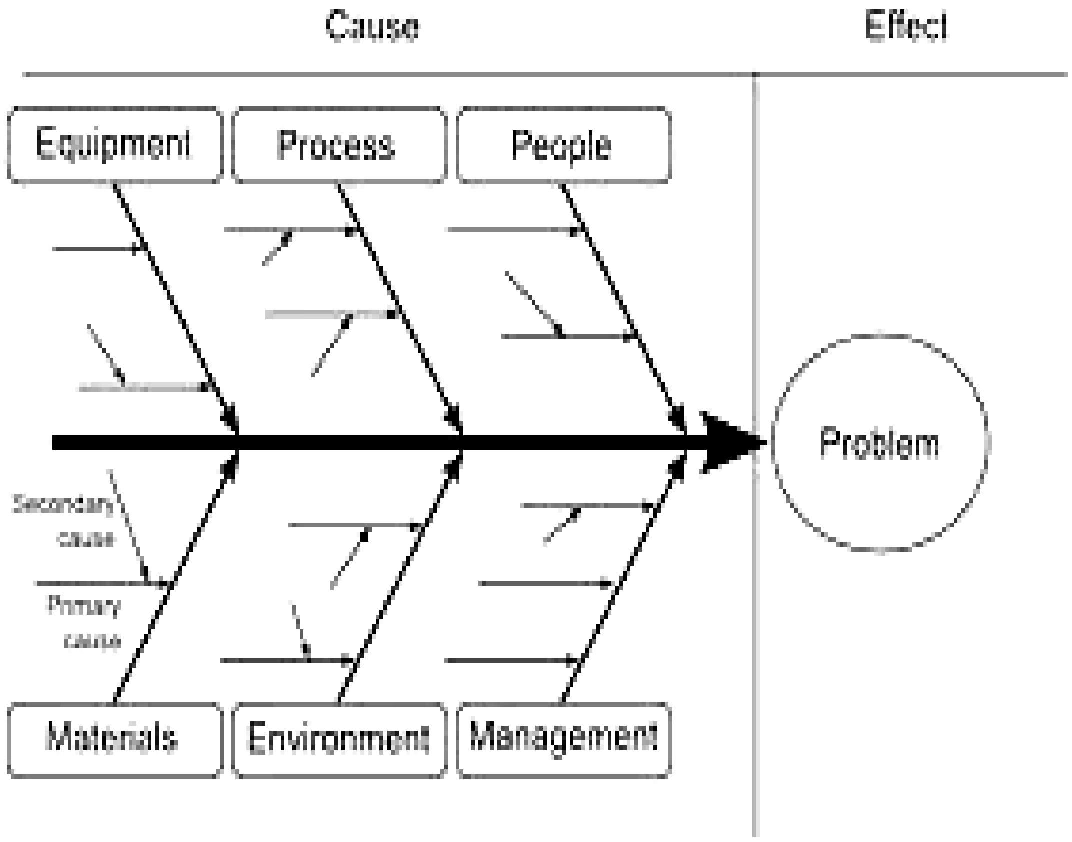


Fig. 3.4 Ishikawa diagrams PMBOK® Guide 2013 5th Edition, PMI.

4- **Root cause analysis:** Identify problem, discover causes and develop preventive action.
5- **Checklist Analysis:** developed based on historical information and knowledge, the lowest level of RBS can be used as a risk checklist.
6- **Assumptions Analysis:** explores the validity of assumptions (hypotheses, scenarios), identifies risk from inaccuracy, inconsistency or incompleteness of assumptions

3.10 Risk Register

It is a tool (spreadsheet or database) containing all the risks identified for a project, along with the description of each risk and a documentation of information relevant to the ownership, assessment and response for each risk.

3.11 Risk Assessment

Risk assessment is the process of identifying and evaluating areas of risk in anther words it is process to determine the importance and potential impact of the risk which is conducted by the use of historical data and past experience and mostly by means of educated guess. Another definition of the risk assessment is a technique that aims to identify and estimate risks to personnel and property impacted upon by a project. This approach goes beyond the application of a compliance system such as that of the Occupational Safety and Health Act ~OSHA!. It is to consider both individual and generic risks in work activities.

Many studies concerned with the assessment of risk in construction due to the complex characteristics of major industrial and construction projects have created the need for improving management support techniques, and tools. Many companies have recognized that need and are drawing from their past experience when developing project organizations, where managers need to know how much risk is involved in an activity to decide how to go about it.

Project teams generally are too preoccupied with solving current problems involved with getting work done and therefore have insufficient time to think about, much less carry out, a formal risk assessment program (Oglesby et al. 1989).

Although it is important to assess risk, a precise estimate of risk may not be required. It would be extremely time consuming in practice, and usually a lack of data makes it impossible. What is needed is a reliable tool that measures the extent of the potential risk. Perhaps a model that determines the value of risk would help contractors identify the high risk of major construction activities and would enable them to allocate safety precautions in a more efficient manner.

The problem arise since most of the results are given in terms of probability of high, medium, and low chances of occurrence and no accurate results .the assessment of the impact was accompanied by fewer recommendations, and suggested that assessment should be qualitative and the process should be iterative .in anther research , Chapman and Ward (1997) suggest that assessment could be carried out by an incremental method for both the occurrence and impact of risk: by identifying the maximum and minimum impacts and identifying incremental steps to reach a decision on the impact, then same steps are used for the probability assignment.

Quantitative evaluations of risk have been used in many fields. For example, Fine (1975) Developed a general loss prevention method to measure risks due to hazards. His technique, which indicates the relative potential seriousness of all hazards, has been used at the Naval Ordnance Laboratory, Silver Spring, Maryland. Krasner and Wiener (973) conducted a quantitative effort on loss prevention in fire. They studied the feasibility of quantitatively analyzing investments in loss prevention activities. Glennon (1974) developed a probabilistic transportation hazards index model. Based on the economic return, the model calculates relative quantitative measures of various types of roadside safety improvement. Grose (1990) stated the importance of numerical assessment of risk. He said that numbers held the promise of simplifying complexity, reducing infinite variables to a manageable few, and even granting certainty within a universe of chance. Indicated that construction risks could be identified by presenting all the operations of the construction company and evaluating all activities within those operations. The New York State Division of Industrial Safety Services Knab (1978) adopted one technique that correlates the degree of risk of various construction activities and the workmen’s compensation insurance rates. It was concluded that higher insurance rates indicate higher risk. Knab (1978) Modified the technique Adopted by the New York State Division of Industrial Safety Services and developed a model that determines a risk score for various workmen’s compensation classifications. The model is based on the total insurance premium paid by the contractor for each classification per unit of time.

Although the risk assessment process may involve a detailed risk analysis, it might not be of great importance to an organization to know a precise estimate of risk for their various activities. This would be too time consuming in practice and, ultimately, the lack of data would make it impossible. What is needed is a method of estimating risk that will give convincing results that are known to be sufficiently reliable and accurate to serve as a basis for managerial decisions. A consistent judgment by the risk analyst based on the seriousness of incidents that could happen, the degree of exposure to the hazard, and the likelihood that the hazard event However, attempting to consider realistically the uncertainty in construction schedules poses three challenges.

- The first challenge is that systems are not endorsed professionally or available commercially, which can be used to structure project uncertainty and measure the effects on the project schedule.
- The second challenge is the lack of easily accessible information documenting the experience of the construction industry or the knowledge scattered within a corporation. The third challenge is the difficulty motivating the involvement of the senior project management team to address adequately schedule risks.

Where the team members who study the project risks should have the experience and good visibility to identify the risks.

3.12 External Risks

External risks are those that are prevalent in the external environment of projects, such as those due to inflation, currency exchange rate fluctuations, technology change, major client induced changes, politics, and major accidents or disasters. They are relatively non-controllable and so there is the need to continually scan and forecast these risks and in the context of a company's strategy (Tah et al., 1993).

3.13 Internal Risks

According to Tah et al. (1993), internal risks are relatively more controllable and vary between projects. They include the level of resources available, experience in the type of work, the location, and the conditions of contract. Some of these risks are local to individual work packages or categories within a project, whilst others are global to an individual project and cannot be associated with any particular work package. The local risks cover uncertainties due to labor (availability, quality, and productivity), plant (availability, suitability, and productivity), material (availability, suitability, supply, wastage) and subcontractor (availability, quality, productivity, and failure) resources and the site (ground conditions, accessibility, type of work, complexity of work). They are considered for each work package in the case of bill of quantities. Global risks are often allocated to the project as a whole because of their very nature. They cover risks relating to the performance (management experience, availability of partners, relationship with client, workload commitment), contract (contract type, contractual liabilities, amendments to standard form), location (head office, project) and financial (cash flow, funding, economic conditions) aspects of the project.

3.14 Qualitative risk analysis

Qualitative Risk Analysis covers the methods for prioritizing identified risks for subsequent further analysis or action by assessing and combining their probability of occurrence and impact. The tools and techniques for qualitative risk analysis include:

- risk probability and impact assessment
- probability and impact matrix
- risk data quality assessment
- risk categorization;
- Risk urgency assessment. The inputs required for a qualitative risk analysis are :
    - organizational process assets
    - project scope statement
    - risk management plan
    - Risk register.

3.15 Quantitative risk analysis

PMBOK5th (2013) had identify quantitative risks as the process of numerically analyzing the effect of identified risks on overall projects objectives

- The process is used mostly to evaluate the aggregate effect of all risks affecting the project
- When the risks drive the quantitative analysis, the process may be used to assign a numerical priority rating to those risks individually

3.16 Risk Analysis

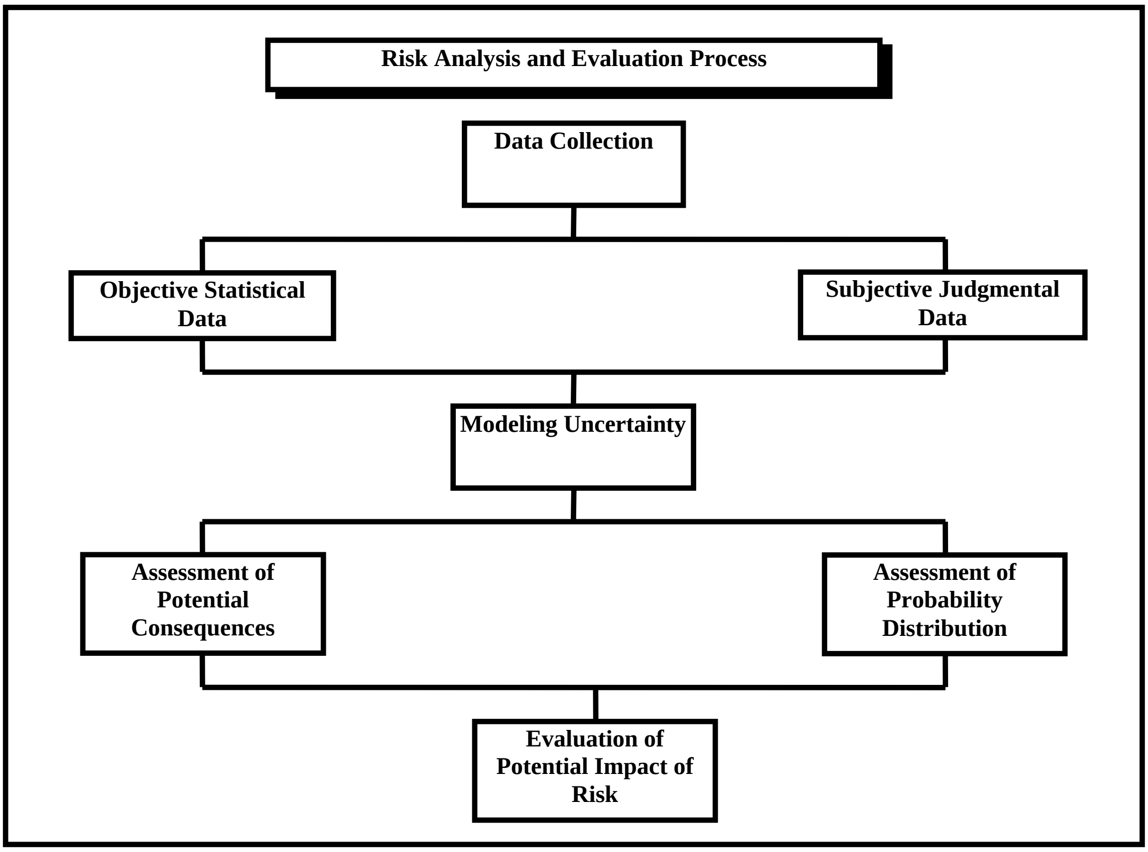
The risk analysis and evaluation process is the vital link between systematic identification of risks and rational management of the significant ones. It forms the foundations for decision-making between different management strategies. Since the significance, and therefore impact, of any risk is constantly changing, it must be analyzed and evaluated regularly as information changes (Al-Bahar, 1988).

Risk analysis and evaluation defined by Al-Bahar (1988) is “A process which incorporates uncertainty in a quantitative manner, using probability theory, to evaluate the potential impact of risk”. The evaluation should generally concentrate on risks with high probabilities, high financial consequences or combination thereof which yield a substantial financial impact.

From Flanagan and Norman (1993) research, they proposed that “the main purpose of a risk management system is to assist business to take the right risk”. In accordance, the essence of risk analysis is that it attempts to capture all feasible options and analyze the various outcomes of any decision.

Fig. 3.5 developed by Al-Bahar (1988) is a schematic presentation of the various components of the process. There are three steps involved in the process which are:

- Data collection
- Modeling uncertainty
- Evaluation of potential impact of risk



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Components of the Risk Analysis process

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3.17 Stakeholder

An individual or organization that has an effect on, or could be affected by, the outcome of the project.

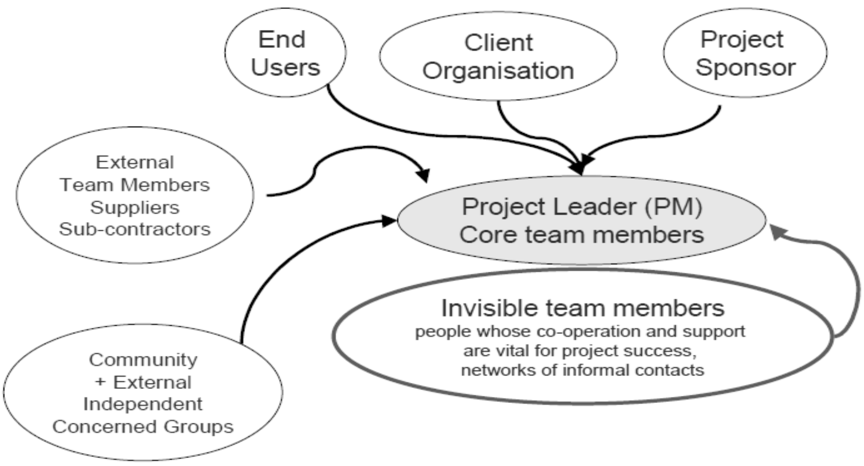

Fig. 3.6 Project Stakeholder PMBOK® Guide 2013 5th Edition, PMI.

Classify to prioritize key stakeholders and utilize efforts. Example of classification models items:

1. Power = authority
2. Interest = concern
3. Influence = involvement
4. Impact = ability to affect planning or execution

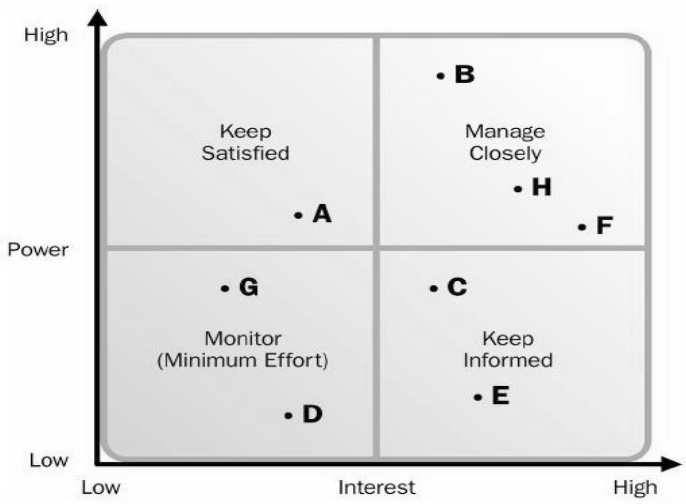

Fig. 3.7 Stakeholders Classification PMBOK® Guide 2013 5th Edition, PMI.

3.18 Risk and price relationship

The following four cases in the construction management literature show that risk apportionment could influence prices by up to 17% of a bid price. First, a bid simulation experiment by Neufville and King (1991) in which 30 US contractors were involved showed that contractors add significant premiums, around 3% of the total value of a project, to their bid markups to compensate for risk and their lack of enthusiasm to do a job. However, there was no account of how contractors behave when they do indeed need the work.

The second case is an interview study of 30 specialist contractors in the US by Shash (1993) showed that they would generally increase their prices by 5-10% if they were uncertain about a main contractor with whom they had no previous experience. The third case is represented by another interview study of 12 US contractors by Smith and Bohn (1999) showed that risk analysis generally has no impact (0%) on bids during times when contractors have a high need for work and competition is high.

In the fourth, Atkinson (2007) reported the case[1] involving problems caused by risk on a specific design and build project won by Balfour Beatty – the final link of the M60 outer ring road around Manchester from Medlock to Irk. The works involved cut-and-fill of 2 million m^3 of excavation and 1.8 million m^3 of deposition. Blackwell, who won the fixed-price job to carry out the earthworks under a subcontract to Balfour Beatty, performed a formal risk analysis and included 17% of the subcontract price for unseen ground conditions and weather. Therefore, risk analysis and apportionment may have a significant impact on tenders.

Another area of literature is about factors that influence contingencies. Several surveys have been carried out on this topic. In an interview of 30 US contractors, Neufville and King (1991: 664) found that the following factors affect bidding contingencies: project complexity, identity of client, quality of design, identity of consultants, site conditions, logistics, project duration, and safety hazards. On the same topic, Smith and Bohn (1999: 106) interviewed 12 US contractors and identified the following factors: workload, contract size, project complexity, number of bidders, owner's reputation, bidder's mentality, clarity of contract documents and bidding period. A study of 38 contractors in Hong Kong by Wong and Hui (2006: 431) showed that project characteristics, client's identity, consultant's identity, contractor-related issues, contract documents, contract administration, bidding situation and economic environment affect contingencies. The findings are significantly similar, especially given the time elapsed between the different studies.

3.19 Risk Response

Flanagan and Norman (1993) allocate The response to the risk to four basic forms, as shown in Fig. 3.8 Proper allocation of risk must consider the ability to absorb the risk

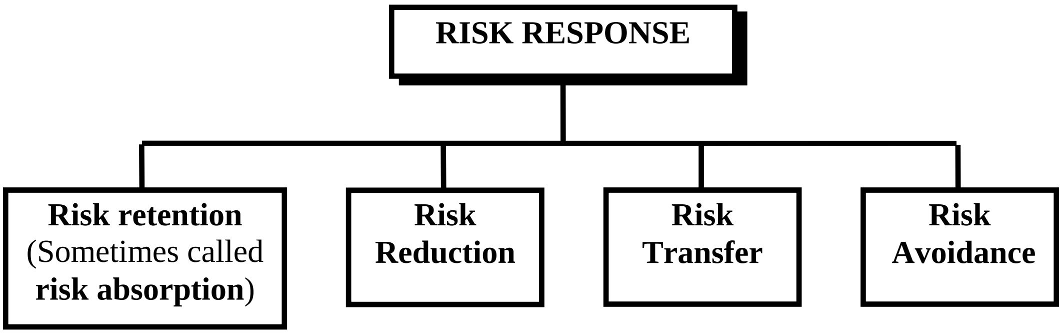

Fig. 3.8 Risk response by Flanagan and Norman (1993)

And the incentives being offered to carry it. Figure 3.4 listed some of the fundamental principles which govern the allocation of risk (Flanagan and Norman, 1993).

Some fundamental consideration which govern the allocation of risk:

- Which party can best control the events that may lead to the risk occurring;
- Which party can best manage the risk if it occurs;
- Whether or not it is preferable for the client to retain an involvement in the management of the risk;
- Which party should carry the risk if it cannot be controlled;
- Whether the premium to be charged by the transferee is likely to be reasonable and acceptable;
- Whether the transferee is likely to be able to sustain the consequences if the risk occurs;
- Whether , if the risk is transferred, it leads to the possibility of risks of a different nature
- Being transferred back to the client.

Fig. 3.9 some fundamental considerations which govern the allocation of risk

(Flanagan and Norman, 1993)

According to Raftery (1994) research, the purpose of the identification and the analysis is to enable the decision maker to make a considered response in advance of the problem occurring. The general guiding principle of risk response is that the parties to the project should seek a collaborative and, insofar as is possible, a mutually beneficial distribution of risk. Responses to identified risk are usually listed as follows: Elimination, Transfer, Retention, and Reduction.

3.19.1 Risk Retention

This is the method of handling risks by the company who controls them. The risks, foreseen or unforeseen, are controlled and financed by the company or contractor that is fulfilling the terms of the contract. There are two retention methods (Carter and Doherty, 1974), active and passive. Active retention (sometimes referred to as self-insurance) is a deliberate management strategy after a conscious evaluation of the possible losses and costs of alternative ways of handling risks. Passive retention (sometimes called non-insurance), however, occurs through neglect, ignorance or absence of decision, e.g. a risk has not been identified and handling the consequences of that risk must be borne by the contractor performing the work.

3.19.2 Risk Reduction

It may be argued that reducing risks is a part of risk retention, because the risk has to be retained before pursuing actions to reduce the effects of a foreseen risk. Alternatively, risk reduction may be an action within the overall risk management, and it is because of the possible wider use of risk reduction that it has been categorized separately. The actual reduction of risks within these categories is confined to the improvements of a company's physical, procedural, educational, and training devices (Flanagan and Norman, 1993).

The physical devices can be improved by continually maintaining and updating the devices which help prevent loss. The effect of improving procedural devices can be significant. Simple, low cost measures like housekeeping, maintenance, first aid procedures and security can lead to better morale, improved labor relations and increased productivity, as well as their more obvious benefits. Education and training within every department of a business are important, especially in reducing the harmful effects of risks within the working environment. Loss prevention consumes capital resources, and with better education and training devices the effect may be minimized, freeing capital for more productive investments.

3.19.3 Risk Transfer

Risk transfer can take two basic forms (Thompson and Perry 1992):

- The property or activity responsible for the risk may be transferred, i.e. hire a subcontractor to work on a hazardous process; or
- The property or activity may be retained, but the financial risk transferred, i.e. methods such as insurance. There are other ways of using insurance as a means of transferring the risk, for example, through risk sharing or establishing a captive insurance company. The four forms of risk sharing (Hertz, 1964) are co-insurance, re-insurance, excess or deductible, and first loss cover.

3.19.4 Risk Avoidance

- Involves changing the project plan to prevent a potentially detrimental risk condition or event from happening. might involve
- Reduce/Change Scope or Change way of meeting the requirements

3.19.5 Reactive Risk Response

An action or set of actions to be taken after a risk event has occurred in order to reduce or address the effect of the threat, or maximize the effect of the opportunity. The cost of reactive risk responses is met from contingency (unallocated provision). More usually applied to threats, and detailed within a contingency plan.

3.19.6 Proactive Risk Response

An action or set of actions to reduce the probability or impact of a threat (or delay its occurrence), or increase the probability or impact of an opportunity (or bring forward its occurrence). Proactive risk responses, if approved, are carried out in advance of the occurrence of the risk. They are funded from the project budget.

3.20 Risk rating

A measure of risk importance, usually using a combination of probability and impact. May be expressed semi-quantitatively or quantitatively.

3.21 Risk Elimination

Risk elimination is sometimes referred to as risk avoidance. A contractor not placing a bid or the owner not proceeding with project funding are two examples of eliminating the risks totally. There are a number of ways through which risks can be avoided, e.g. tendering a very high bid; placing conditions on the bid; pre contract negotiations as to which party takes certain risks; and not binding on the high risk portion of the contract (Carter and Doherty, 1974).

3.22 Mitigation

- A proactive risk response to a threat. Reduce probability or if not possible, reduce the impact of a potential risk event to an acceptable level.
- May involve implementing a new courses of action in an effort to reduce the problem or changing the current conditions so that the probability of the risk occurring is reduced.

3.23 Contingency

Unallocated provision (UAP), a sum of money to be included as an additional provision in the project cost estimate, used to cover goods and services that are currently undefined, but which the probabilistic estimate shows will be needed to achieve the project objectives. This sum covers the implementation of risk contingency plans.

3.24 Contingency Plan

A planned and documented set of actions to be taken in response to a risk event when it has occurred. Usually related to threats rather than opportunities and implemented if proactive response plans have not been identified or have failed to prevent occurrence of the event and/or its impact. The cost of these reactive responses is met from contingency.

3.25 Monitoring & Control Risks

Is the process of responding to identified and unforeseen risk. It involves tracking identified risk, identifying new risks, implementing risk response plans, and monitoring their effectiveness.

CHAPTER (4)

RESEARCH IMPLEMENTATION

4.1 Introductions

This Research is a field survey study through a structured questionnaire which directed to construction projects of **Off-shore petroleum & gas projects in Egypt**. The survey identifies the probabilities of occurrence and degree of impact of risks which might face these companies during the construction of this kind of projects, and ranking these risks based on their importance

This chapter presents a detailed description of the research methodology used in this thesis. Figure 4.1 includes the different tasks and also shows the flow of the main topics.

4.2 Research Approach

The study approach includes the steps as shown in fig 4.1 which can summarize in the following points:-

A. Perform a comprehensive review of literature relative relating to the topic of thesis study, in addition to interviews and discussion with some experienced project managers, consultants and engineers for collecting data concerned with identifying the risk factors facing the construction contractors during the construction of petroleum and gas projects in Egypt
B. Formulate data collected to develop and design a comprehensive questionnaire that covers the required data , the sources of risks and their probability of occurrence and their impact
C. Conduct a field survey for construction companies working in this field in Egypt and define the sample according to the numbers of the executive project managers at the level of general manager assistant
D. Perform Quantitative risk analysis tool “risky project” for data by using applicable analysis techniques.
E. Ranking the risk factors according to the importance based on the response of all companies / Expected Companies working in this field in Egypt and also ranking these risk factor according to every company point of view
F. Demonstrate the impact caused by various risk elements on the performance of petroleum and gas projects through case study.

Chapter (4)

Report the discussed results and major findings to introduce conclusion and recommendations

Fig. 4.1

Study Approach Diagram

4.3 Risk Identification Tools and Techniques

The tools used to identify risks and the used techniques are:

- **Documentation reviews** - Documentation reviews involve comprehensively reviewing the project documents and assumptions from the project overview and detailed scope perspective in order to identify areas of inconsistency or lack of clarity. Missing information and inconsistencies are indicators of a hidden risk.
- **Information gathering techniques** - Information gathering techniques are used to develop lists of risks and risk characteristics. Each technique is helpful for collecting a particular kind of information. The five techniques are:

  a. **Brainstorming –** Brainstorm is employed as a general data-gathering and creativity technique which identifies risks, ideas, or solutions to issues. Brainstorming uses a group of team members or subject-matter experts spring boarding off each other's' ideas, to generate new ideas.
  b. **Delphi technique –** The Delphi technique gains information from experts, anonymously, about the likelihood of future events (risks) occurring. The technique eliminates bias and prevents any one expert from having undue influence on the others.
  c. **Interviewing –** Interviewing in a face-to-face meeting comprised of project participants, stakeholders, subject-matter experts, and individuals who may have participated in similar, past projects is a technique for gaining first-hand information about and benefit of others' experience and knowledge
  d. **Root cause identification –** Root cause identification is a technique for identifying essential causes of risk. Using data from an actual risk event, the technique enables you to find out what happened and how it happened, and understand why it happened, so that you can devise responses to prevent recurrences.
  e. **Strengths, weaknesses, opportunities, and threats (SWOT) analysis** - A SWOT analysis examines the project from the perspective of each project's strengths, weaknesses, opportunities, and threats to increase the breadth of the risks considered by risk management

- **Checklist analysis** - Checklists list all identified or potential risks in one place. Checklists are commonly developed from historical information or lessons learned. The Risk Breakdown Structure (RBS) can also be used as a checklist. Just keep in mind that checklists are never comprehensive, so using another technique is still necessary.

- **Assumptions analysis -** All projects are initially planned on a set of assumptions and what if scenarios. These assumptions are documented in the Project Scope Document. During Risk Identification, assumptions are analyzed to determine the amount of inaccuracy, inconsistency, or incompleteness associated with them.
- **Diagramming techniques** - Diagramming techniques, such as system flow charts, cause-and-effect diagrams, and influence diagrams are used to uncover risks that aren't readily apparent in verbal descriptions.
    - **Cause and effect diagrams –** Cause and effect diagrams or fishbone diagrams are used for identifying causes of risk
    - **System or process flow charts –** Flow charts illustrate how elements and processes interrelate.
    - **Influence diagrams –** Influence diagrams depict causal influences, time ordering of events and other relationships between input variables and output variables.

The tools and techniques used for the Risk Identification process are designed to help the project manager gather information, analyze it, and identify risks to and opportunities for the project's objectives, scope, cost, and budget. The information gathered is entered on the Risk Register, which is the primary output of Risk Identification.

- **Risk Register -** The Risk Register containing the results of the Qualitative Risk Analysis, Quantitative Risk Analysis, and Risk Response Planning. The Risk Register illustrates all identified risks, including description, category, and cause, probability of occurring, impact on objectives, proposed responses, owners, and current status. While the risk register will become the comprehensive output, Risk Identification process results in four entries in the Risk Register:

    - Lists of identified risks – Identified Risks with their root causes and risk assumptions are listed.
    - List of potential responses – Potential responses identified here will serve as inputs to the Risk Response Planning process.
    - Root causes of risk - Root causes of risk are fundamental conditions which cause the identified risk.

Updated risk categories - The process of identifying risks can lead to new risk categories being added.

4.4 Questionnaire Development and Design

This investigate is undertaken in two stages. The first stage is the collection of data. This stage includes literature search, field visit and interview. This led to formation of the questionnaire which was distributed to construction managers at every company according to the sample which depend on the numbers of the project manager at every company with 20 year experience or more at the level of general manager assistant

Questionnaires are extremely critical components of the research process because they identify which information is important and the participants about the discussed problem. the design of the questionnaire required very careful consideration. One should aim at formulating the question such that no misinterpretation is possible. To do this, the following points should be taken into consideration in designing the questionnaire:-

1- Proper introduction of the questionnaire explaining the purpose of the study and emphasizing the confidentiality of responses.
2- Question must give the information required.
3- Question must be concise and clear.
4- Question must be presented in the best sequence possible, preferably from simplest to most complex.

The questionnaire consists of two pats (part A) includes general in relating to expert experience and used for purpose of collecting data and information from the project managers

Part (B) includes a list of sources of risks affecting the construction contractor working in construction of Off-shore petroleum and gas projects during construction of these projects.

The second stage focuses on data analysis and identification of the most relevant risk factors influences the contractors working in construction of petroleum & gas projects in Egypt. (Questionnaire templet: As shown in page 104)

4.5 Statistical Sample

The study is covered five companies. Working in this field in Egypt, Table 4.1 illustrate the numbers of experts representing every company according to Population of each company

Table 4.1 Population of each company

No	Company	Population
1	COMPANY 1	55
2	COMPANY 2	72
3	COMPANY 3	14
4	COMPANY 5	18
5	COMPANY 4	37
	TOTAL	196

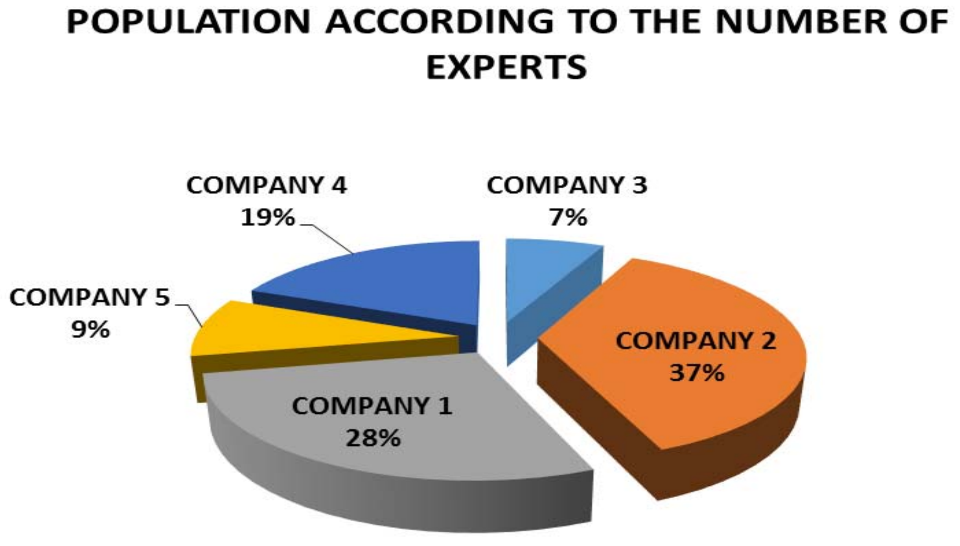

Fig 4.2 Percentage of the Experts Representing Every Company

CHAPTER (5)

DATA ANALYSIS AND RESULTS

5.1 Introductions

This chapter presents and discusses the results of the collected data .also analysis has been achieved. In order to ranking the risk factors affecting the companies working in construction of offshore petroleum & gas projects in Egypt by using importance index and average risk score. The comparisons of risk factors between the different companies are tabulated. The rank correlation, hypothesis of agreement on ranking between the companies have been tested and also compared with results with the previous research " Risk Assessment in Construction On-Shore in Egypt " concerning risk in construction in Egypt

5.2 The construction companies working in construction of oil & gas in Egypt

The following table 5.1 illustrates the profile of the companies working in construction of off-shore petroleum & gas projects in Egypt

Description of the respondents and their companies

5.2.1 Total Working experience

Working experience is measured in a number of years a contractor has been working in the construction industry. About 40% of the companies have been practicing the construction of offshore for petroleum and gas projects for 15 years and the other 40% of the companies have been practicing the construction of offshore for petroleum and gas projects for 10 years and the remain 20% have practicing for 5 years the following table 4.1 illustrate the working experience for every company

Table 5.1 the working experience for each company

No	Company	working experience /year
1	Company 1	15
2	Company 2	10
3	Company 5	5
4	Company 3	15
5	Company 4	10

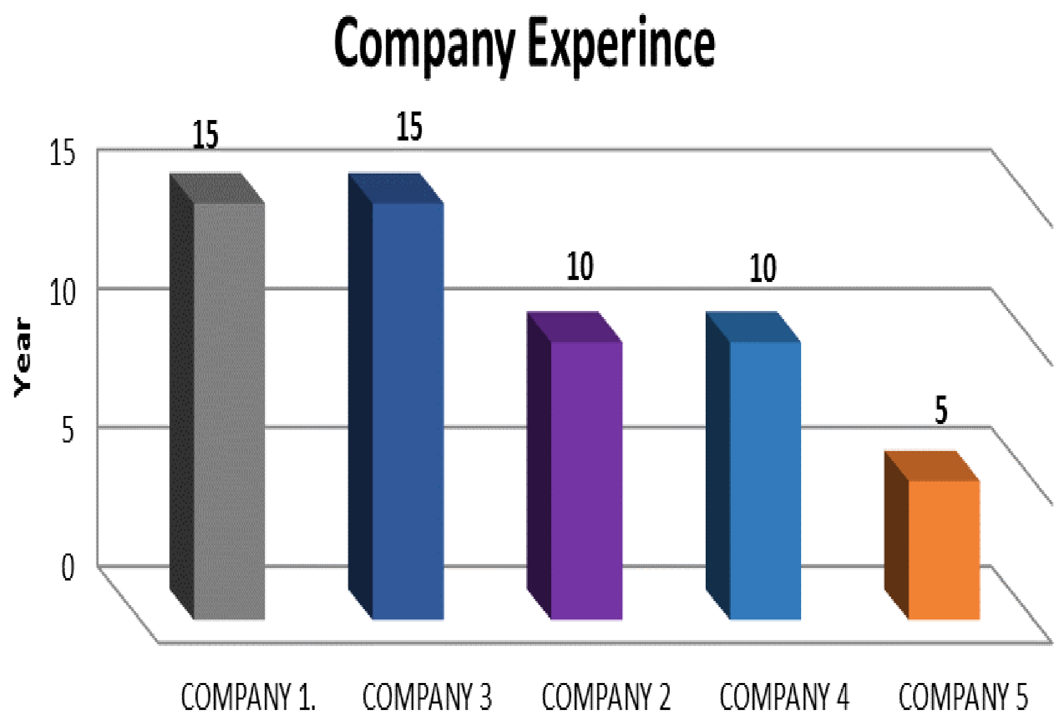

Fig 5.1 the working experience for each company

5.2.2 Companies Analysis Due to working experience

As per the evaluation criteria, which identify the company experience in this Research, to be 10 years or above: So the company (5) selected in this research have been neglected due to insufficient years of Experience (it had only five years of Oil & Gas Experience)

The Collected data from company (5) in the civil survey were as following:

- Frequency of Increasing of Duration in construction of petroleum & gas project in Egypt is (100% Sometimes) and that's mean the increase of duration in project is Certain happened
- Frequency of Increasing of Cost over run in construction of petroleum & gas project in Egypt is (50% Sometimes & 50 % Often) and that's mean the increase in cost in them project is always happened

Observance: the above two study cases leads to one result:

"The Company need more control in the phase of projects study & preparation"

This kind of result will case unspecified criteria which cannot be used as a major case in the research

5.2.3 Delay and cost overrun in projects

In this section the results concerning frequency of increasing the Duration & Cost overrun in construction of Off-shore oil & gas projects in Egypt are presented, according to the response of the experts in the section (A) of the questionnaire.

5.3 Frequency of Time Increasing in construction of petroleum & gas projects in Egypt

The results of the questionnaire for frequency of Increasing of Duration in construction of petroleum projects are presented in table 5.2 due to the response of every company experts

TABLE 5.2 Frequency of Time Increasing Companies Working In Construction of Off-Shore Oil & Gas Projects in Egypt

FREQUENCY OF INCREASING OF DURATION	Companies Working In Off-Shore Oil & Gas Construction Projects In Egypt			
	Company 1	Company 2	Company 3	Company 4
Always	7.69 %	0.00 %	0.00 %	0.00 %
Often	38.46 %	0.00 %	50.0 %	25.0 %
Sometimes	53.85 %	90.91 %	50.0 %	50.0 %
Never	0.00 %	9.09 %	0.00 %	25.0 %

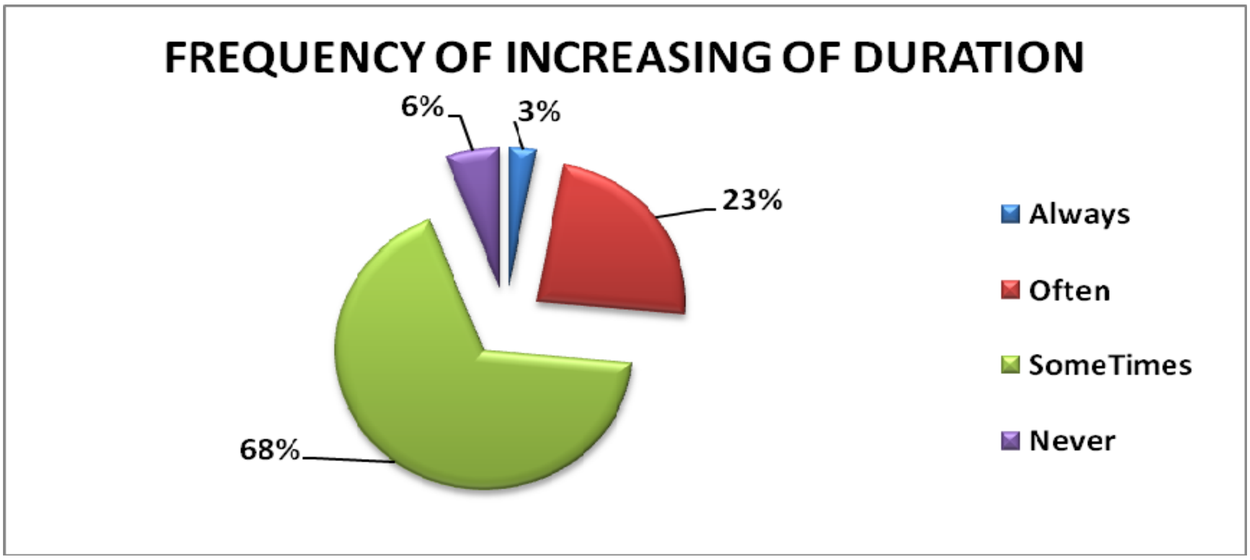

Fig 5.2 Frequency of Delay for all Companies Due to Sample Response

5.4 Frequency of cost overrun in construction of petroleum &gas projects in Egypt

The results of the questionnaire for increasing frequency of cost overrun in construction of petroleum& gas projects in Egypt are presented in table 5.3 due to the response of every company experts

Table 5.3 Frequency of Cost over Run for Companies Working In Construction of Off-Shore Oil & Gas Projects in Egypt

FREQUENCY OF INCREASING OF COST	Companies Working in Off-Shore Oil & Gas Construction Projects In Egypt			
	Company 1	Company 2	Company 3	Company 4
Always	23.08 %	0.0 %	0.0 %	0.0 %
Often	38.46 %	0.0 %	25.0 %	50.0 %
Sometimes	38.46 %	81.82 %	75.0 %	25.0 %
Never	0.0 %	18.18 %	0.0 %	25.0 %

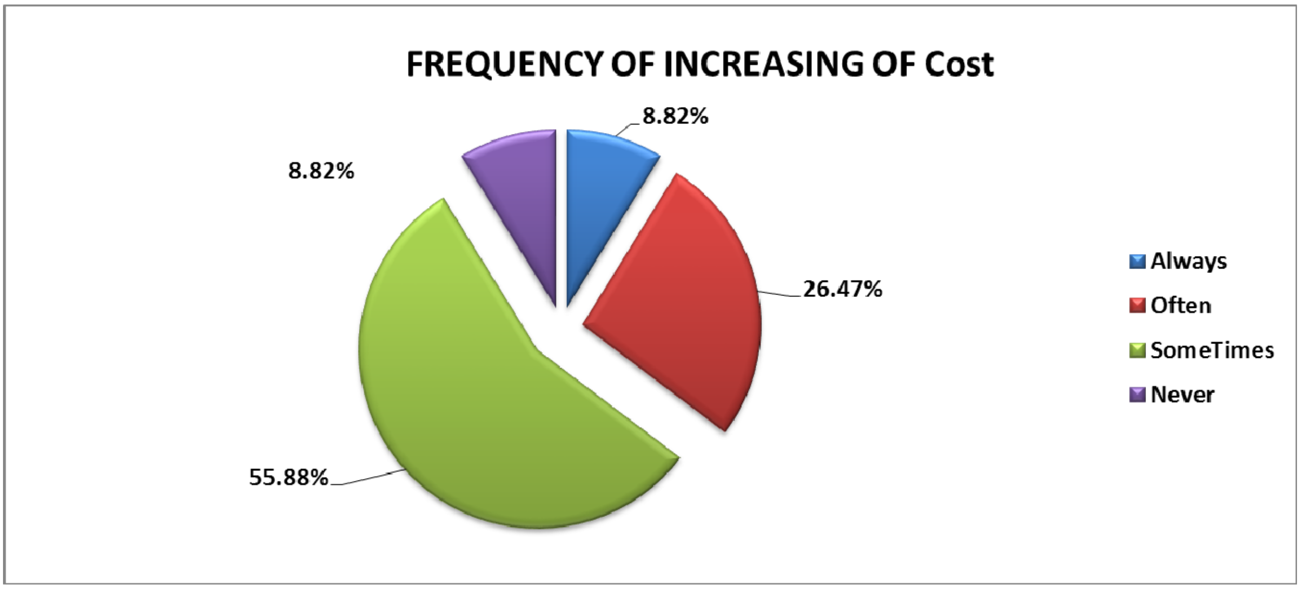

Fig 5.3 Frequency of Increasing of Cost for all Companies Due to Sample Response

5.5 DATA ANALYSISN

Mean , standard deviation , standard error of mean , and confidence interval are used to aid the researcher in interpretation of the information at appendix (b) & appendix (c) show the techniques used to analyze the collected data . These appendixes contains the computation of the following statistical equations

1- Mean

$\bar{X} = 1/n * \sum (f X) n$ Eq. (5.1)

Where;

$\bar{x}$ = Average mean for n the observation.

fX = Values of observant

n = Number of observant

2- Standard Deviation

$S_n = [\sum f * (X-\bar{X})^2 / N) - (\sum f * (X- X) /N)^2]^{½}$ Eq. (5.2)

Where;

S_n = Standard deviation of each factor.

3- The standard Error of Mean

$S_E = S_n / n^{1/2}$ Eq. (5.3)

Where;

S_E = Standard Error of mean

The standard error of mean is used to describe the deviation of sample means around their population mean.

5.6 Qualitative Risk Analysis

Qualitative risk analysis is the process of assessing the impact and likelihood of identified risk. This process prioritizes risks according to their potential effect on project objectives.

Ward (1997) suggests risks are categorized based on identification and in relation to the level of importance of risk; interaction between different events should also be studied. In cases of correlation existence minor risks shall not be neglected.

Generally, the higher the risk rate the higher the amount of effort and resources to be dedicated to it. He suggested the use of a probability/impact grid where the higher the risk rating the more important the risk is, and should receive more dedication of effort in order to reduce its effort

Probability / impact grid:

i. **Risk Probability** :- The likelihood that a risk will occur

ii. **Risk Impact** :- The effect on project objectives if the risk event occurs

The two dimension of risk are applied to specific risk event .analysis of risks using probability and impact helps identify those risks that should be managed aggressively

A risk's probability scale naturally falls between 0.0 (no probability) and 1.0 (certainty). Assessing risk probabilities may be difficult because expert judgments are used, often without benefit of historical data. An ordinal scale, representing relative probability values from very unlikely to almost certain could be used. Alternatively specific probability could assign by using a general scale shown in table 5.4 the risk's impact scale reflects on the project objectives , cardinal scale s assign could be used such as shown in table 5.5 (PMBOK 2000)

These scales for probability of occurrence and degree of impact were used in part (b) of the questionnaire.

Table 5.4 probability scale

S	option	Weight (P_s)
1	Very high	0.9
2	High	0.7
3	Moderate	0.5
4	Low	0.3
5	Very low	0.1

Table 5.5 impact scale

S	option	Weight (I_s)
1	Very high	5
2	High	4
3	Moderate	3
4	Low	2
5	Very low	1

5.7 The Methods used to Rank the Risk Factors:

One method was used to rank the risk factors in this research. These methods gave the same results for the ranking of risk factors. These methods are**:-**

- Important Index

5.7.1 Importance Index

Importance index is used to assess the relative significance among risk factors**.**

And then ranking these risks. It is depended on probability index and impact index the probability index (**P.I**) and impact index (**I.I**) of each factor will be calculated by the following formula (AL-Ghafly 1995)

$$\mathbf{P.I} = \left[\sum_{S=1}^{S} (PS * X\,P_S) / (P_{max})\right] * 100 \qquad \textbf{Eq. (5.4)}$$

$$\mathbf{I.I} = \left[\sum_{S=1}^{S} (I_S * X\,I_S) / (I_{max})\right] * 100 \qquad \textbf{Eq. (5.5)}$$

Where:-

P_S	Constant expressing the weight assigned to option (s) on the Probability of occurrence scales.
$I._S$	Constant expressing the weight assigned to option (s) on the probability of occurrence scales.
$X\,P_S$	Variable expressing number of respondent who selected option (s) for probability of occurrence
$X\,L_S$	Variable expressing number of responded who selected option (s) for degree of impact
n	Total number of respondents
P_{MAX}	The maximum probability of occurrence scales
I_{max}	The maximum Impact of occurrence scales

Then the importance index (IMP .IND.) will be calculated by the following formula:

$$\textbf{IMP .IND. \% = (P.I * I.I.) * 100} \qquad \textbf{Eq. (5.6)}$$

An example is given for illustration of this importance index:

Consider risk factor no. 1 (Stringent Regulatory, Code, and Safety)

Probability Of Occurrence		Degree Of Impact	
Option (s)	**Respondents (XPs)**	**Option (s)**	**Respondents (XIs)**
Very high	***2***	***Very high***	***3***
high	***4***	***high***	***9***
moderate	***10***	***moderate***	***10***
low	***11***	***low***	***8***
Very low	***7***	***Very low***	***4***

Total respondents (n) =34

P.I= [(2*0.9+4*0.7+10*0.5+11*0.3+7*0.1) / (34*0.9)]*100 = 45.40%

I.I= [(3*5+9*4+10*3+8*2+4*1) / (34*5)]*100 = 59.41%

Then IMP .IND.%= (P.I * I.I.) * 100 = (45.40% * 59.41 %) = 26.97%

5.8 Survey Results

The questionnaire provided respondents with a set of risk factors, for which they were to assign probability of occurrence and degree of impact. The following sections present and discuss the results concerning the probability of occurrence and degree of impact, then describes the importance of risk factors and sources of these Risk factors based on their probability and degree of impact index. Ranking of risk factors and the sources for construction contractors working in the field of construction of offshore petroleum and gas projects in Egypt as well as the rank correlation and testing of the hypothesis of agreement on the ranking

5.8.1 Probability of Occurrence and Impact of Risk Factors

The probability of occurrence and degree of impact of the risk factors were measured by the scores given to each factor by the respondents as described in section (5.5) statistical techniques were used to analyze and interpret the collected data concerning the probability and impact scores of the risk factors. Both of these scales are 5 levels scales ranging between 0.1 to 0.9 and 1 to 5 these techniques include the calculation of mean, standard deviation standard error and confidence intervals.

5.9 calculations and charts for importance index and risk score

Table5.6 Comparison of Risk Score and Importance index

Item No	Risk Factors	Comparison between all companies rank , Score and importance index									
		ALL COMPANIES		Company 1		Company 2		Company 3		Company 4	
		Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %
1	**Weather effect on the project**	2.8	61.25	1.9	42.2	3.2	71.6	3.3	72.8	3.8	83.8
2	**Increase in material price**	2.2	48.15	2.4	53.5	2.3	50.1	2.1	45.6	1.5	33.6
4	**The conflict between the contractor and the consultant**	2.1	46.34	1.7	37.0	2.8	61.7	1.7	38.4	2.2	49.0
5	**Client delay in making decision or delay in approval of contractor's submittals**	2.0	45.12	2.7	60.9	2.1	46.6	0.9	19.6	1.6	34.8
6	**Delay in performing inspection &testing by the consultant**	1.9	42.28	2.3	51.1	1.5	34.3	1.4	30.7	2.3	51.6
8	**Commitment to the schedule (delay due to contactor)**	1.7	38.26	1.8	39.2	1.7	38.7	1.5	33.6	1.7	38.6
9	**Delay of tender offer evaluation and purchase order cycle**	1.7	38.31	1.8	40.4	1.3	30.0	1.9	41.3	2.2	49.6
10	**Project duration (schedule is too short for the required activities**	1.7	37.65	2.2	49.3	1.2	27.6	1.7	36.8	1.5	33.6
11	**Currency fluctuation (foreign exchange rate)**	1.6	35.79	1.5	32.9	1.6	35.6	1.7	38.4	1.9	41.2
12	**Design changes during construction**	1.5	33.83	1.4	31.3	1.6	36.4	1.8	40.8	1.3	28.6
13	**Design errors**	1.5	32.39	1.8	39.2	1.6	36.0	0.8	17.3	1.1	23.6
14	**Delay of engineering designs during work**	1.4	32.16	1.4	31.5	1.7	37.7	1.4	30.7	1.1	24.3
15	**Reputation risk (company defamation)**	1.4	31.12	1.3	27.9	1.7	37.0	1.2	27.0	1.4	30.2
16	**Suppliers bid greater than estimate**	1.3	29.75	1.1	23.5	1.3	29.2	2.1	46.8	1.4	30.2
17	**Pay liquidate damage**	1.3	29.75	2.0	44.8	0.8	18.0	1.3	28.0	1.1	25.3

Continued

Item No	Risk Factors	Comparison between all companies rank , Score and importance index									
		ALL COMPANIES		Company 1		Company 2		Company 3		Company 4	
		Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %
18	**Increase in labor price**	1.3	29.31	1.9	42.2	0.7	15.6	1.4	30.7	1.4	31.7
19	**Delay of mobilization**	1.3	29.02	1.8	40.1	1.1	23.3	1.0	22.7	1.0	22.0
20	**Delay in materials delivery**	1.3	28.74	1.1	23.7	1.4	31.9	1.7	37.8	1.2	26.6
21	**Uncompleted design at start of site work**	1.3	28.25	0.9	20.8	2.2	49.4	1.0	22.4	0.7	16.6
22	**Bad selection of sub-contractors**	1.3	28.24	1.2	27.7	1.5	32.4	1.3	28.0	1.0	21.2
23	**Project financing availability (debts & delayed payment on contract)**	1.3	28.07	1.4	30.5	1.3	29.7	1.1	25.3	1.0	21.2
24	**Bad management of project budget**	1.2	27.74	1.5	32.9	1.7	38.0	0.6	13.6	0.4	8.7
25	**Subcontractor default**	1.2	27.60	1.0	22.3	1.4	31.1	1.8	40.0	1.0	22.5
26	**Cost over-run (bad initial cost estimation)**	1.2	27.32	1.5	32.9	1.2	27.6	1.0	22.7	0.8	17.3
27	**Lack of communication between different parties(client , consultant , contractor)**	1.2	27.30	1.1	25.3	1.2	27.6	1.4	31.7	1.1	25.3
28	**Bad coordination between sub-contractors**	1.2	26.91	1.1	25.3	1.3	27.9	1.4	30.4	1.1	24.2
29	**Low productivity of labors**	1.2	26.41	1.1	24.4	1.0	21.5	1.4	31.7	1.7	38.8
30	**Shortages of qualified labors**	1.2	26.39	0.9	20.4	1.2	26.4	1.6	34.8	1.6	35.5
31	**Construction mistakes**	1.2	26.14	1.2	27.0	1.0	22.2	1.6	35.5	1.1	23.6
32	**Bad site stores management**	1.1	25.34	1.1	23.5	0.8	18.2	1.5	33.6	1.8	40.9

Continued

Item No	Risk Factors	Comparison between all companies rank , Score and importance index									
		ALL COMPANIES		Company 1		Company 2		Company 3		Company 4	
		Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %
33	**Bad vendor performance**	1.1	25.10	1.1	25.3	1.1	23.3	1.6	34.8	0.9	19.6
34	**Bad start-up plan**	1.1	24.63	1.2	27.2	1.1	24.4	1.2	25.7	0.8	17.3
35	**Delay of government permits**	1.1	24.14	1.3	28.9	0.8	17.7	1.3	28.6	1.0	22.7
36	**Shortages of equipment's**	1.1	23.36	1.2	26.2	0.9	21.1	1.2	25.7	0.8	17.3
37	**Bad of construction tasks definition**	1.0	22.51	1.3	29.5	0.6	14.2	0.8	18.5	1.3	28.7
38	**Low engineering productivity**	1.0	21.69	1.3	29.7	0.5	10.1	1.5	32.7	1.0	21.3
39	**Bad staff for site management**	0.9	21.04	1.0	21.3	0.7	15.9	1.2	25.7	1.2	27.2
40	**Environmental impact of the project**	0.9	20.59	1.1	24.4	1.0	22.1	0.7	16.6	0.6	12.7
41	**Difficult site access**	0.9	19.40	0.9	20.6	0.9	19.0	1.0	22.0	0.6	13.7
42	**Defective materials**	0.9	19.10	0.8	17.3	0.6	12.9	1.3	28.7	1.4	31.7
43	**Inaccurate (inadequate) specifications**	0.8	18.09	0.7	15.6	0.9	21.1	0.5	10.8	1.2	27.0
44	**Lack of engineering resource qualifications and pool depth**	0.8	18.09	1.1	25.3	0.7	16.1	0.5	10.4	0.6	12.7
45	**Low productivity of equipment's**	0.8	18.09	0.7	14.9	0.6	13.7	1.5	32.7	1.1	25.3
46	**Bad management for project records**	0.8	17.49	0.8	17.3	0.6	12.9	1.0	22.7	1.1	24.0
47	**Bad or insufficient organization for material management**	0.7	16.62	0.8	17.3	0.6	13.3	0.8	17.3	0.9	19.6
48	**Vendor-labor problems**	0.7	16.59	0.8	17.0	0.7	16.4	1.0	22.7	0.5	10.8

Continued

Item No	Risk Factors	Comparison between all companies rank , Score and importance index									
		ALL COMPANIES		Company 1		Company 2		Company 3		Company 4	
		Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %	Score (0.1-4.5)	Importance Index %
49	Bad application of safety	0.7	16.34	0.9	20.4	0.5	11.7	0.8	17.3	0.7	14.7
50	Earnings volatility (revenue)	0.7	16.15	0.9	21.0	0.5	11.7	0.8	17.3	0.5	12.0
51	Bad identification of equipment and material	0.7	15.92	0.6	13.3	0.7	15.4	1.4	32.1	0.5	10.4
52	Bad site management process	0.7	15.54	0.6	14.1	0.7	15.8	0.7	14.7	0.8	18.5
53	Slow manufacturing process	0.7	15.49	0.5	10.2	0.5	11.4	1.9	43.2	0.9	19.6
54	Owner suspending or delaying the project	0.7	15.39	0.7	15.6	0.5	10.9	0.7	15.0	1.2	26.7
55	Increase of material waste	0.7	15.26	0.7	15.4	0.6	13.8	1.0	22.7	0.5	11.6
56	Insufficient site information (include site access, definitions of site boundaries)	0.7	14.51	0.7	15.6	0.6	12.2	1.1	25.3	0.4	8.0
57	Bad planning for labor resources	0.7	14.64	0.5	10.8	0.7	16.5	1.1	24.2	0.6	12.7
58	Bad quality control	0.6	14.19	0.8	18.3	0.5	10.4	0.6	12.7	0.6	13.7
59	Owner cancellation of project	0.4	9.77	0.7	16.4	0.2	4.1	0.4	8.7	0.3	7.1

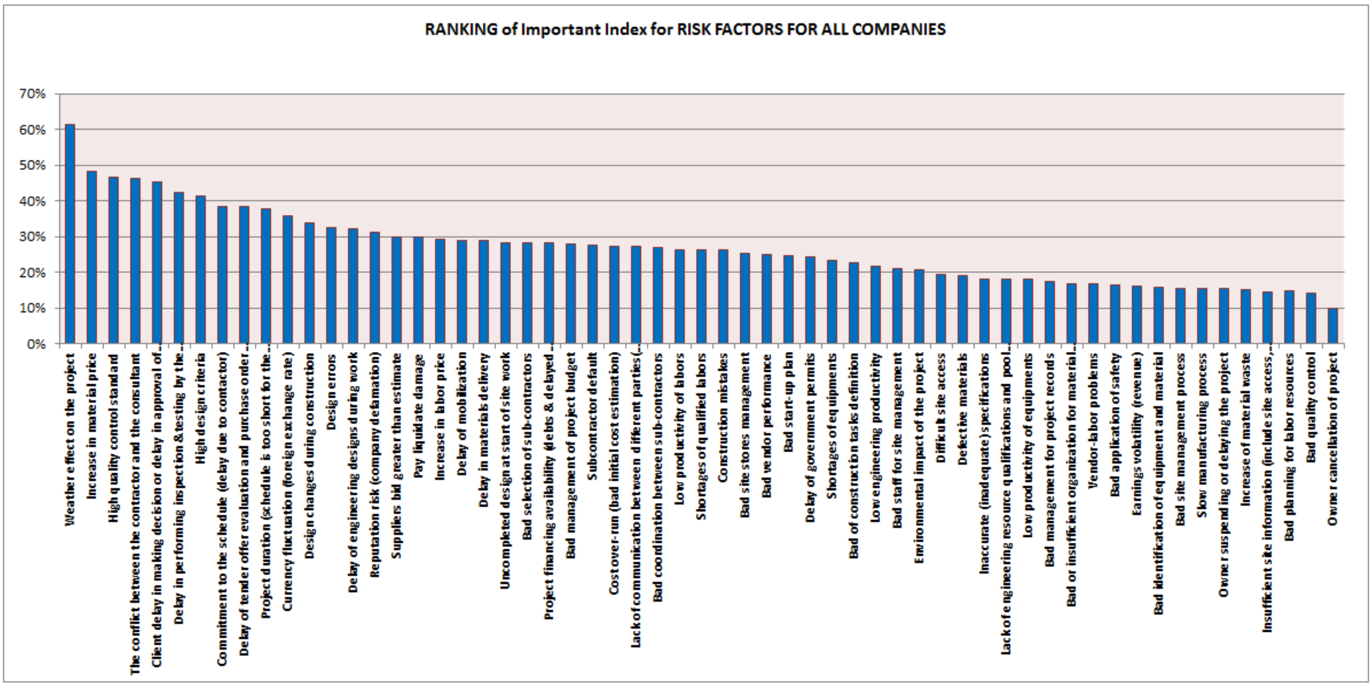

Figure. 5.4 Ranking of Important Index for all companies

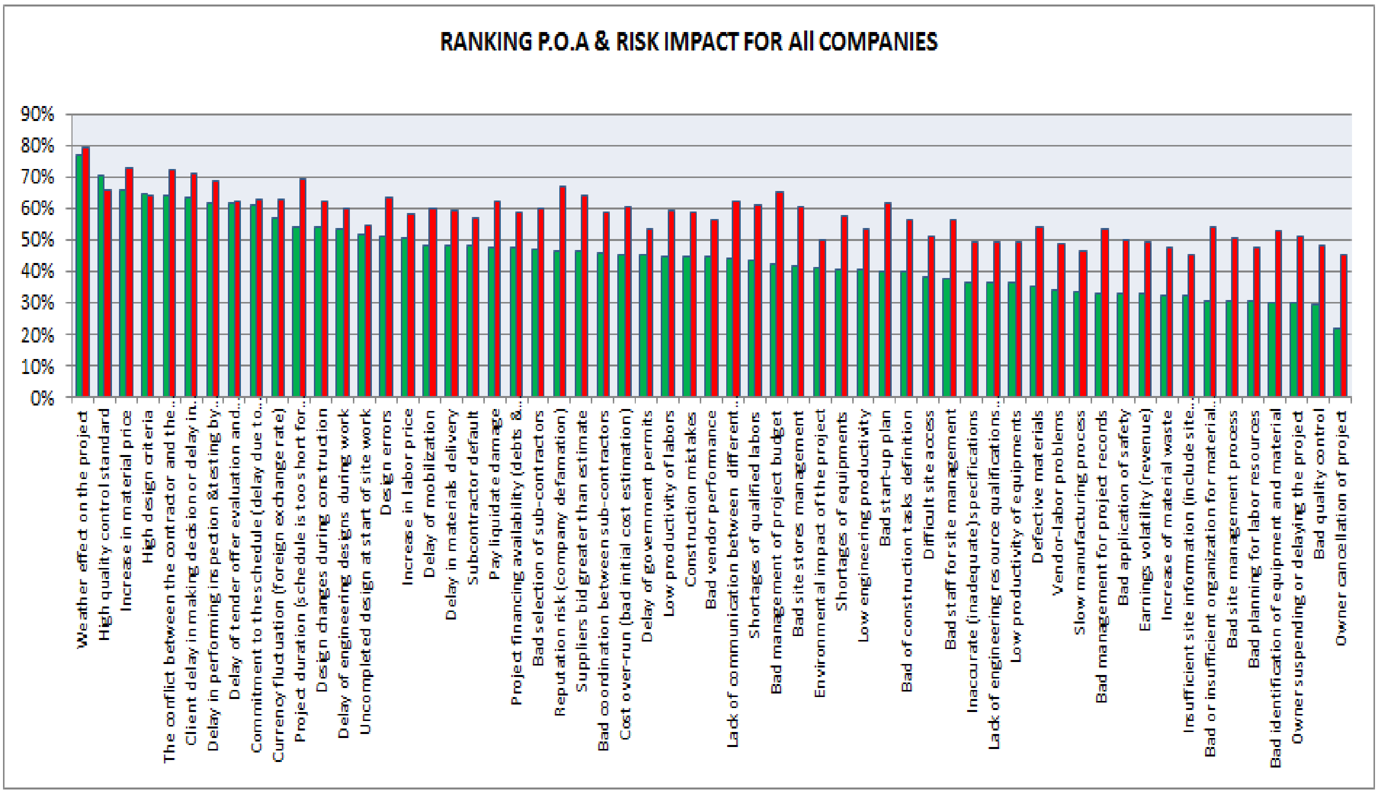

Figure. 5.5 Ranking of Probability and Impact for each factor

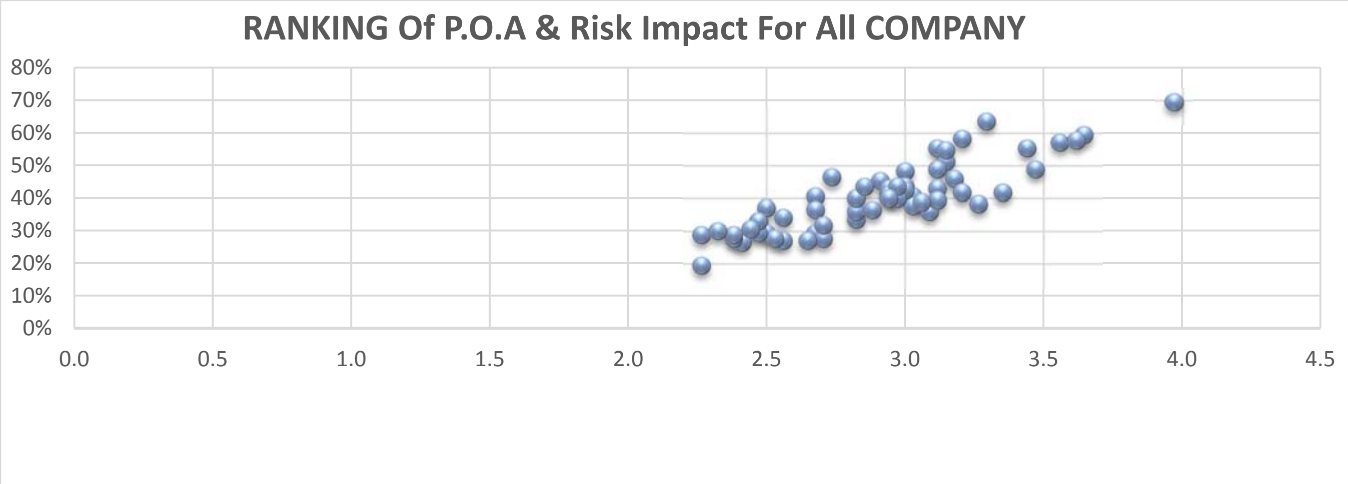

Figure. 5.6 Ranking of P.O.A & Risk Impact for All COMPANY

5.10 Decision

The Risk Score Shows Us the Important Risk Factor in this research, The Risk Score in our study is limiting from 0.1 to 4.5 this limitation is divided into Four Levels as following

- 0.1 to 0.6 is Negligible
- 0.6 to 1.5 is Low
- 1.5 to 2.8 is High
- 2.8 to 4.5 is Extreme

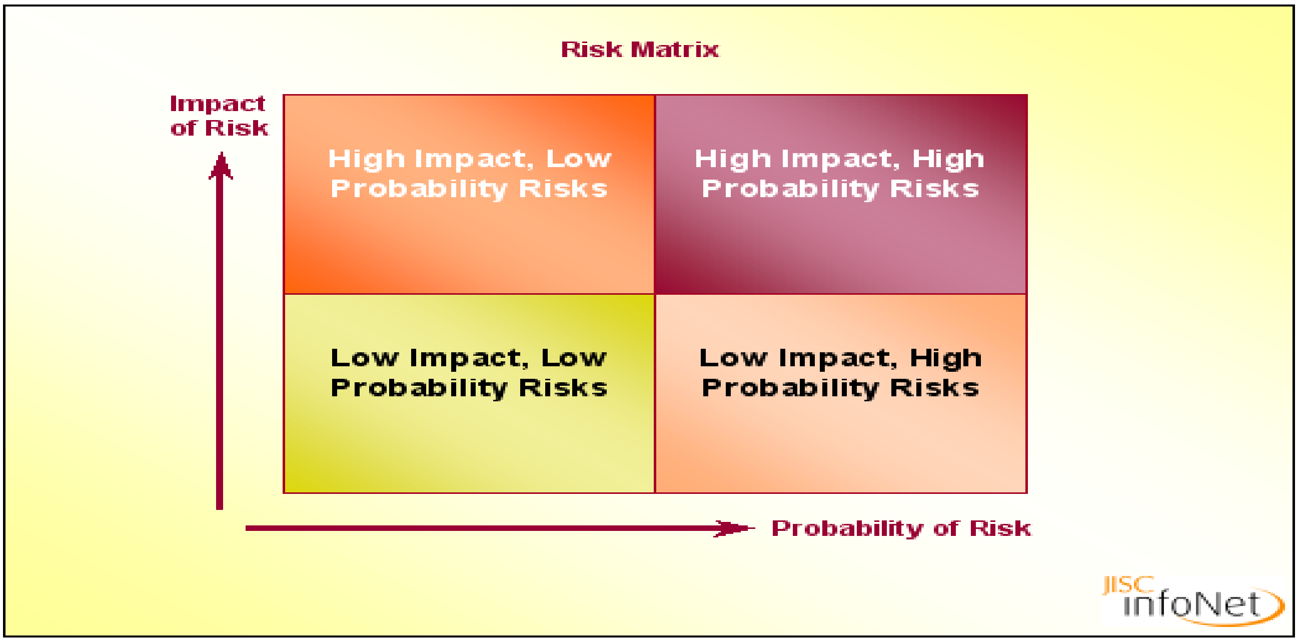

Fig. 5.7 Risk matrix

In this case the calculated value is greater than the critical value therefore, the null hypothesis is rejected and it is concluded that all companies agree on the ranking of the importance of the risk factors the table below is show us the Important Risk factor affecting on the Construction.

Table 5.7 Comparison between all companies risk score

	Item	***All Comp.***		***Company 1***		***Company 2***		***Company 3***		***Company 4***	
	Risk Factor	***Des.***	***score***	***Des.***	***score***	***Des.***	***score***	***Des.***	***score***	***Des.***	***score***
1	Weather effect on the project	Extreme	2.8	High	1.9	High	3.2	Extreme	3.3	Extreme	3.8
2	Increase in material price	High	2.2	High	2.4	High	2.3	High	2.1	Low	1.5
3	The conflict between the contractor and the consultant	High	2.1	High	1.7	Extreme	2.8	High	1.7	High	2.2
4	Client delay in making decision or delay in approval of contractor's submittals	High	2.0	High	2.7	High	2.1	Low	0.9	High	1.6
5	Delay in performing inspection &testing by the consultant	High	1.9	High	2.3	Low	1.5	Low	1.4	High	2.3
6	Commitment to the schedule delay due to contactor)	High	1.7	High	1.8	High	1.7	Low	1.5	High	1.7
7	Delay of tender offer evaluation and purchase order cycle	High	1.7	High	1.8	Low	1.3	High	1.9	High	2.2
8	Project duration (schedule is too short for the required activities	High	1.7	High	2.2	Low	1.2	High	1.7	Low	1.5
9	Currency fluctuation (foreign exchange rate**)**	High	1.6	Low	1.5	High	1.6	High	1.7	High	1.9

- **<u>Where Analysis indicated that most of the top-9 risk factors according to Company (1) point of view are:-</u>**

a) Weather effect
b) Increase in material price
c) Increase in labor price
d) Delay of tender offer evaluation and purchase order cycle
e) Design errors
f) Project duration (schedule is too short for the required activities)
g) Client delay in making decision or delay in approval of contractor's submittals
h) Delay in performing inspection &testing by the consultant
i) Commitment to the schedule (delay due to contactor)

- **<u>And the top-9 risk factors according to Company (2) point of view are:-</u>**

a) Weather effect
b) Increase in material price
c) Currency fluctuation (foreign exchange rate)
d) Bad management of project budget
e) Uncompleted design at start of site work
f) Delay of engineering designs during work
g) The conflict between the contractor and the consultant
h) Commitment to the schedule (delay due to contactor)
i) Reputation risk (company defamation)

- **<u>And the top-9 risk factors according to Company (3) point of view are:-</u>**

a) Weather effect
b) Increase of material price
c) Currency fluctuation (foreign exchange rate)
d) Delay of tender offer evaluation and purchase order cycle
e) Design changes during construction
f) Project duration (schedule is too short for the required activities
g) The conflict between the contractor and the consultant

h) Suppliers bid greater than estimate
i) Slow manufacturing process

- **<u>And the top-9 risk factors according to Company (4) point of view are:-</u>**

a) Weather effect
b) Currency fluctuation (foreign exchange rate)
c) Delay of tender offer evaluation and purchase order cycle
d) Client delay in making decision or delay in approval of contractor's submittals
e) Delay in performing inspection &testing by the consultant
f) The conflict between the contractor and the consultant
g) Commitment to the schedule (delay due to contactor)
h) Bad site stores management
i) Low productivity of labors

- **<u>And the top-9 risk factors according to all Company point of view are:-</u>**

a) Weather effect on the project
b) Increase in material price
c) Currency fluctuation (foreign exchange rate)
d) Delay of tender offer evaluation and purchase order cycle
e) Project duration (schedule is too short for the required activities
f) Client delay in making decision or delay in approval of contractor's submittals
g) Delay in performing inspection &testing by the consultant
h) The conflict between the contractor and the consultant
i) Commitment to the schedule delay due to contactor

5.10.1 Important Factors

By Analysis the above Activity and there important Value we had found that there is some activities with very high P.O.A and its Impact is so high as well Such as:

- Weather effect on the project: by Study this case we had found that the probability of this item is over 60 % and its effects on Project Duration and Cost by Delaying on handling the material to Project location or by Stoppage of the Project activities and this Item maybe

Increase the Schedule plan over 25% of the Total execution Duration and it has other effect on the project Cost due the Operation Time without any productivity.

- Increase in material price: According to the change in Currency fluctuation and Market Inflation the Material price has a direct effect on project Cost and need controlling from project team during studying the project Activities
- All Activities in the above Table is consider high Probability and high Impact and agreed with all Companies shared in the civil survey, this activities is used in the next Modeling below and was matched and had a direct effect on project duration and cost

5.11 Case Study

To demonstrate the impact caused by various risk factors on the performance of oil and gas projects constructed in Egypt, two Modeling are presented for more concise Presentation of the case studies, a filtering of the original list of risk elements, previously identified was made primarily to exclude the elements with low and very low significance. This resulted in a shortened list of 9 risk factors. Details of the two Modeling are given hereafter.

5.11.1 Model (I)

Fig. 5.8 Platform for Model I

The selected project is a major project for Petroleum Company located at Ras Ghareb, red sea, Egypt.

- **Project name**

Development Projects for Petroleum Company

- **The purpose of the project**

The purpose of this project is to construct a major Platform for Oil, fields located in Ras Ghareb, Red Sea, Egypt and Transfer the oil from offshore field to onshore plant of Oil Grid. An image of this project is shown in figure 5.8

- **SCOPE OF WORK**

Pre\post Lay survey, Laying Of 6" pipeline with length of 1.2 km between P/F-1 and P/F-2, Laying Of 8" pipeline with length of 3.7 km between P/F-1 and P/F-2, Offshore Transportation And Installation of Amer-8 Platform, Submarine Cables Installation, Installation of new Riser and J-Tube at P/F-1, Closed Spool & Tie-In and Hook up Activities at P/F-1 and P/F-2, Hydro-Test, Pre commissioning

- **WORK VOLUME**

• Jacket & Riser Weight	454 Ton
• Piles Weight	444 Ton
• Boat Landing & B.B Weight	105 Ton
• Deck Structure Weight	550 ton
• Equipment Weight	66 ton
• Piping Weight	33 Ton
• **Total**	**1652 tons**

- ## Project duration

Examination of Platform project documents and feedback from project participants indicated that the actual levels of risk for the identified 9 important Risk elements were as illustrated.

According to plan, the project duration was estimated to be 320 Days starting from 1 March 2011 till 27 December 2011. The actual amount of delay for this project was reported as 21 % from its original duration. The reason behind these extensive delays is:

- delay in materials delivery " Fabrication & Delivered Of Amer-8 Platform supplied by anther contractor he delayed in delivery more than 40 Days
- Stoppage because the Weather Down Time in Project

The Above Points expose the project extend for Two month over the original duration also the delay of the project expose the contractor for extra cost due his stand by for the supplied man power and equipment which lead him to modify the project schedule to re organize his recourses in anther activities, also the contractor expose to extra cost due to the long period of project and it's extension where he suffered due to many increase of material prices through the project period and also increase the prices of subcontractors over than the budgetary estimated prices the contractor also expose to low productivity of man power and equipment's due to delay of some supplied material " equipment's for project " which also expose the contractor for extra expenditure

5.11.2 Model (II)

Fig. 5.9 Model II

The selected project is a major project for SA Petroleum Company located at Persian Gulf Area

- **Project Name:**

Maintain Future Phase II

- **The purpose of the project**

The purpose of this project is to construct a major network of Subsea Pipelines and Cables to maintain the expected Oil production from Oil fields located in the Persian Gulf. An image of this project is shown in figure 5.9

SCOPE OF WORK

Pre\post Lay survey, Laying Of 17 Pipelines of various sizes (12", 24" & 30") with total pipeline with length of 76 km between 23 offshore platforms and 1 pipeline connection with onshore facilities, Fabrication and transportation of protecting structures for subsea facilities, diving activities to connect subsea pipelines with the offshore platforms, Laying of 10 subsea cables with total length of 58 km between 18 offshore platforms and cable termination on the platforms, testing of subsea cables and hydro-test for subsea pipelines, installation of off-shore cathodic protection system for subsea pipelines and offshore platforms, smart survey for all subsea pipelines using smart pigs

- **Project duration**

According to plan, the project duration was estimated to be 890 Days starting from 26 July 2006 till 31 December 2008. The actual amount of delay for this project was reported as 225 % from its original duration. The reason behind these extensive delays is:

Examples of those Concurrent risks are

1. False cost, duration and resources estimates due to absence of Persian Gulf market conditions
2. The Weather Down Time effect on the project
3. Client stringent inspection and requirement for offshore vessels
4. Competing companies in gulf area collecting planned offshore resources from supplier to delay project start
5. Increase in material price
6. Increase of offshore vessels prices
7. Currency fluctuation (foreign exchange rate)
8. Project duration (schedule is too short for the required activities

5.11.3 Comparison the results of the correlation

rank	risk factors	CASE STUDY (I)	CASE STUDY (II)
1	The Weather Down Time effect on the project	√	√
2	Increase in material price	√	√
3	Currency fluctuation (foreign exchange rate	-	√
4	High Design criteria	-	√
5	High quality control standard	√	√
6	Delay of tender offer evaluation and purchase order cycle	√	√
7	Project duration (schedule is too short for the required activities	√	√
8	Client delay in making decision or delay in approval of contractor's submittals	√	-
9	Delay in performing inspection &testing by the consultant	√	√
10	The conflict between the contractor and the consultant	-	√
11	Commitment to the schedule delay due to contactor	-	√

5.12 RECOMMENDATIONS

5.12.1 General recommendations

Based on the conclusion identified previously, and the results obtained from this research, the following points can be recommended:

- Risk identification and management for this kind of projects requires experience of construction team and cannot be done by one person alone, forming the right team to identify the risks demands a serious investment of effort, time and selection of the right tools and techniques
- The team work should study the risks which might face the project along the project duration to define how to deal with these risks.

- The contractor should study the inflation rate and define the contingences which enable him to finish the project and overcome the risk of inflation
- It is recommended that the contractors try to transfer as much of their financial obligations , items having high inflations and liabilities as possible to their subcontractors and /or suppliers within conditions of the subcontract
- It is recommended that the contractors chose their subcontractors with high financial and technical capabilities to be sure that they can afford the transfer risks.
- The contractor should be familiar with the changes of the material prices in the market and follow the effect of the changes in the international market in the local market also he should update his data base with faster rates.
- The contractor should prepare the purchase orders for the required material in an early stage and increase his efforts to decrease the purchase order circulation to secure the required material according to the project schedules.
- The contractor should have a local and international specialized vendor list and be aware of durations required for materials suppliers and prepare his schedule according to martial arrival dates.
- The contractor should control on the man powers and equipment's and check the numbers and the productivities of each element and take any required action to decrees his losses.
- The contractor should study the owner financial capabilities and his ability to finance the project along the duration of the project
- The contractor should take all required means to be aware of the project complexity and to be aware of the required resource for the project and the not to estimate the project according to a planning estimates.
- It recommended that the contractors have to try to include increased advanced payment in contracts as much as they can to reduce the required fund for the project.
- The contractor should study the acceptance of The surrounded population to the project and the expected work circumstances through which the project my proceed
- The contractor should study well the contract terms and conditions and to try to minimize his risk or to share it with the client.
- The contractor should be aware of the contract type and to be able to deal with the risks which might face him during the construction of each type of these contracts.

- For joint venture projects the contractor should have the capabilities to face the requirements of this kind of contract and well study his roll and well chose of his partners
- It is recommended that the contractor should study the site and subsurface conditions before introducing the bids to the owners to consider any problems in estimating.
- for the big projects the contractor should prepare the required resources for the project along the execution period and well control of these recourses
- The contractor should study the owner's financial capabilities and be sure that the owner can finance the projects before bid for a project.

The contractor should be aware of his employee's requirements and has the financial capabilities to cover their requirements

CHAPTER (6)

SUMMARY, CONCLUSION AND FUTURE RECOMMENDATION

6.1 SUMMARY OF THE RESEARCH

This thesis discusses the risk factors affecting the construction contractors during construction of Off-shore oil and gas projects in Egypt. It studies the importance of the risk factors based on their probability of occurrence and degree of impact. This research is a field survey research through a structured questionnaire directed to the constructed contractor working in this field in Egypt. The introduction gave the statement of problem, study objectives, study scope and limitations, and significance of the study. It was shown that there are many risk factors affecting the contractors. These factors are considered to be an important field of study for the future improvement and stabilization of the construction industry in this field and they need to be studied in detail. 59 risk factors were identified described and combined into four major groups related to their sources. These risk factors which were considered in the questionnaire were related to the following groups: Engineering Major Factors, Owner Factors, Contractor Factors, Sub-Contractors and Suppliers Factors, Organizational Risks and Exposures (Project Delivery Methods) and Insurable Risks & Exposures the last part of the chapter two summarized the previous studies related to the risk factors facing the construction contractors all over the world and particularly in Egypt.

The field survey includes five companies who are working in field of Off-shore construction of petroleum and gas projects in Egypt. A sample is selected to represent the companies according to the numbers of the executive project managers at the level of general manager assistant

The questionnaire developed had two parts: one part for general information about the respondents, and the second related to the respondent's opinion on probability of occurrence and degree of impact of the risk factors. All collected data were analyzed "the important index and average risk score were calculated for the risk factors as a function of their probability of occurrence and degree of impact. Risk factors were ranked for whole companies and for each company as well based on their importance index and average risk score. The hypothesis of agreement in the ranking of the risk factors was tested between companies.

6.2 CONCLUSION

In this section, the major findings and conclusions are discussed. The following finding and conclusions may be drawn:

- About 40% of the companies have been practicing the construction of gas projects for 15 years and the other 40% of the companies have been practicing the construction of off-shore for petroleum and gas projects for 10 years and the remain 20% have practicing for 5 years
- The most of companies in this study agree on degree of frequency of delay in their projects resulting from failure to face the risk factors.
- The most of companies in this study agree on degree of frequency of cost over run in their projects resulting from failure to face the risk factors.
- The result of Company 5 were neglected in this research because of the years of the company experience is less than 5 years and the number of the survey questionnaire were not sufficient to illustrate.
- All the companies participating in this study agree on the ranking of these risk factors in terms of their significance. Analysis indicated that most of the top-9 risk factors affecting the companies working in the construction of oil & gas projects in Egypt are:-

a) Weather effect on the project
b) Increase in material price
c) Currency fluctuation (foreign exchange rate)
d) Delay of tender offer evaluation and purchase order cycle
e) Project duration (schedule is too short for the required activities
f) Client delay in making decision or delay in approval of contractor’s submittals
g) Delay in performing inspection &testing by the consultant
h) The conflict between the contractor and the consultant
i) Commitment to the schedule delay due to contactor

6.2.1 Recommended future work

The following point of research can be recommended for future studies in this field:-

- Risk assessment for construction of pipe lines

A research can be done for comparison of risks which might face the contractor in different contract types for the oil & gas petroleum.

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Annex

QUESTIONNAIRE

Arab Academy for Science, Technology & Maritime Transport

Faculty of Engineering, Construction Department

Master's Thesis Questionnaire

This questionnaire is designed to take no more than 10 minutes of your valuable time.

Dear Participant,

I am currently writing my master thesis at the Arab Academy for Science, Technology & Maritime Transport. at Cairo, Egypt. In the field of Construction Engineering & Management, specifically in the:

RISK ASSESSMENT AND ANALYSIS FOR:

CONSTRUCTION OF OFFSHORE OIL & GAS PROJECTS IN EGYPT

As you are one of the organization working in this field in Egypt, would you please participate in filling the attached questionnaire and provide the required data which will be an important element in this research and offering valuable results for all.

Thank you very much for taking the time to read and answer this short questionnaire!

Comments

1. Please read and answer all questions. Please follow the instructions given below.
2. All data will be analyzed as whole, and will be used for this purpose of scientific research only
3. You should be noted that the factors considered in this research are to be evaluated from private personal's point of view in order to make his decision.

Please send back the filled out questionnaire to the following email address:
elshehaby@hotmail.com

Thank you very much for your support!

Eng, Mohamed El-Shehaby
Arab Academy for Science, Technology & Maritime Transport
Faculty of Engineering, Construction Department

Section (A) Basic Information

Name:	---	الأسـم :
Company:	---	اسـم الشركه :
Position:	---	المستوى الوظيفى :
Company Address:	---	عنوان الشركه :
Phone Number (optional):	---	رقم التليفون : (اختيارى)
Email:	---	عنوان البريد الالكترونى :
Number of workers:	---	عدد العاملين بالشركه :
Number of executive general manager:	---	عدد مديرى العموم والمساعدين (التنفذيين) :
Another Information:	---	معلومات اخرى :

Kindly Read These Notes before Filling Out This Questionnaire:-

Introduction:-

The objectives of this questionnaire is to identify and analysis the risks affecting the construction companies working in the field of off shore construction for petroleum and gas projects in Egypt. As you are one of the effective persons working in this field you are kindly requested to identify the risk factors and their impacts during the construction phase of the off shore petroleum and gas projects in Egypt.

The questionnaire consists of two parts, part (A) includes general in relating to your experience, and (B) include a list of risks sources affecting the construction contractor working in of offshore oil and gas projects during the construction phase so you are kindly requested to choose a probability of occurrence of each risk and the its impact rating from 1:5 when:

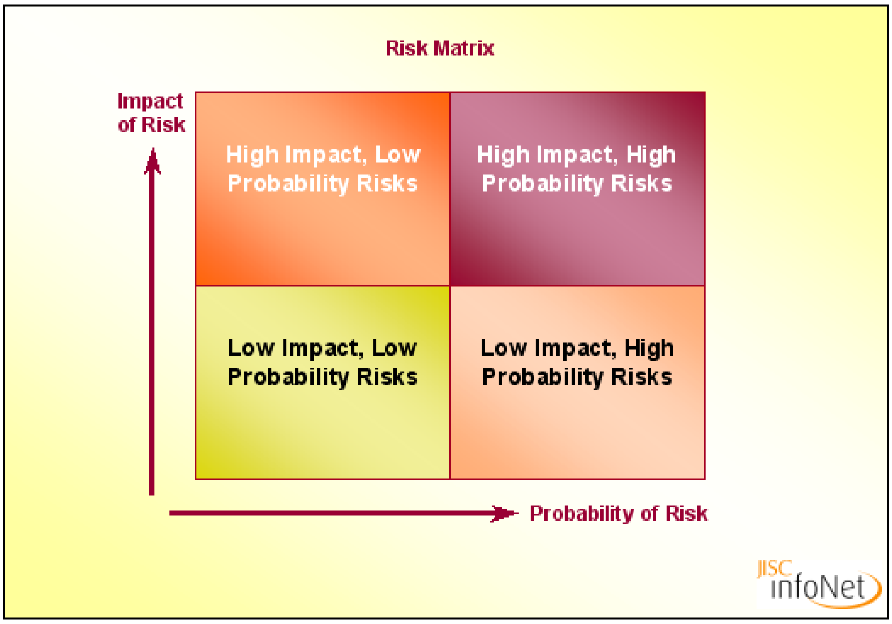
Rate	Probability of Risk Occurrence	Impact of risk
1	Rare	Insignificant
2	Low	Low
3	Moderate	Medium
4	Frequent	High
5	High	Catastrophic

Definitions:-

Risk - An Uncertain event or condition that, if it occurs, has a positive or negative effect on a projects objectives

Probability of Risk Occurrence – A risk is an event that "may" occur. The probability of it occurring can range anywhere from just above 0% to just below 100%. (Note: It can't be exactly 100%, because then it would be a certainty, not a risk. And it can't be exactly 0%, or it wouldn't be a risk.)

Risk Impact – A risk, by its very nature, always has a negative impact. However, the size of the impact varies in terms of cost and impact on health, human life, or some other critical factor.



Part (A)

GENERAL INFORMATION

You are kindly requested to choose the appropriate answer from following question

1. How many of Total years of experience have your firm working in the field of *construction of oil and gas projects?*

   - Less than Five Years ☐
   - From Five to ten Years ☐
   - From ten to Fifteen Years ☐
   - More Than Fifteen Years ☐

2. How many years have your firm working in the *offshore oil and gas construction projects*?

   - Less than Five Years ☐
   - From Five to ten Years ☐
   - From ten to Fifteen Years ☐
   - More Than Fifteen Years ☐

3. What is frequency of occurrence for increasing the duration of project than it planned?

   - Always ☐
   - Often ☐
   - Sometimes ☐
   - Never ☐

4. What is frequency of occurrence for increasing the cost of project than it planned ?

   - Always ☐
   - Often ☐
   - Sometimes ☐
   - Never ☐

5. What the type of owners is for projects that performed by your company and your answer in the questionnaire will depend on?

   - investment firm ☐
   - Governmental ☐
   - Foreign ☐
   - All ☐

If you have any suggestions or comments, please feel free to contact me:
Mobile phone: +2 (010) 7109248 E-mail: elshehaby@hotmail.com

Questionnaire
Part (B)

Item number	Risk Type	انواع المخاطرالتى يمكن ان يتعرض لها المقاول	PROBABILTY OF OCCURRENCE تكرار الحدوث					IMPACT OF RISK درجة التأثير على المقاول					Notes
			Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Meduim	High	Catastrophic	
Major Factors		**اولا: المشروع**											
1	Environmental impact of the project	المشروع له تاثير ضار على البيئة المحيطة بعد التشغيل ومدى تاثر المقاول من ذلك											
2	Weather effect on the project	الطقس على المشروع											
3	Difficult site access	صعوبة الوصول الى موقع المشروع للعمالة والمهمات											
4	Insufficient site information (include site access, definitions of site boundaries)	عدم وجود معلومات كافية عن الموقع محل الدراسة تشمل الطرق المؤدية اليه وتحديد حدود الموقع والبيئة المحيطه بالموقع											
5	Increase in material price	زيادة اسعار المهمات											
6	Increase in labor price	زيادة اجور العمالة											
7	Currency fluctuation (foreign exchange rate)	تذبذب سعر تغير العملة الاجنبية طبقا لسعر السوق											
Owner Factors		**ثانيا: المالك و اعمال التصميم**											
1	High design criteria	وجود متطلبات تصميم عالية											
2	High quality control standard	سياسة تاكيد الجودة الخاصة بالمالك											
3	Delay of tender offer evaluation and purchase order cycle	تاخر المشروع نتيجه طول المدة المستنفذة فى المناقصات وتقيم العطاءات الخاصة بمقاولى الباطن وطول مدة الدورة المستندية الخاصة بطلبات المهمات											
4	Delay of government permits	عدم وجود تصاريح او موافقات حكومية لبدء تنفيذ المشروع وتاثير ذلك على المشروع											
5	Owner cancellation of project	المالك يلغى المشروع بعد العمل به											
6	Owner suspending or delaying the project	المالك يقوم بتعطيل المشروع او تاجيلة فترة كبيرة عن العمل											
7	Cost over-run (bad initial cost estimation)	زيادة التكلفة نتيجة الاعتماد على تقدير تخطيطى											
8	Project financing availability (debts & delayed payment on contract)	تمويل المشروع ووجود تاخر دائم من قبل المالك فى صرف مستحقات المقاول											
9	Bad management of project budget	ادارة سيئة لموازنة المشروع ومدى تاثر المشروع بذلك											
10	Inaccurate (inadequate) specifications	استخدام موصفات خاطئة او غير متمشية مع الغرض المطلوب له التصميم											
11	Uncompleted design at start of site work	وجود نسبة قليلة منتهية من اعمال التصميم عند البدء فى تنفيذ المشروع ومدى تاثر المشروع بذلك											

Item number	Risk Type	انواع المخاطرالتى يمكن ان يتعرض لها المقاول	PROBABILTY OF OCCURRENCE تكرار الحدوث					IMPACT OF RISK درجة التأثير على المقاول					Notes
			Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Meduim	High	Catastrophic	
12	Delay of engineering designs during work	تاخير تسليم اعمال التصميم											
13	Design changes during construction	وجود تغيرات كثيرة فى التصميم بعد البدء فى تنفيذ الاعمال ومدى تاثر المشروع بذلك											
14	Design errors	وجود اخطاء كثيرة بالتصميم واكتشاف ذلك فى مرحلة التنفيذ ومدى تاثر المشروع بذلك											
15	Lack of engineering resource qualifications and pool depth	قلة المصادر الهندسية و الخبرات الخاصة بالمشروع محل الدراسة											
16	Bad quality control	عدم وجود سياسة للجودة بالمشروع او عدم وجود ادارة للجودة											
17	Bad application of safety	تطبيق سيئ للامن والسلامة المهنية وتاثير ذلك على المشروع											
18	Bad site management process	ادارة غير كفئة للمشروع وتاثير ذلك على المشروع											
19	Bad management for project records	عدم الادارة الجيدة لسجلات المشروع											
20	Project duration (schedule is too short for the required activities	سوء تقدير مدة تنفيذ للمشروع ومدى تاثر المقاول بذلك											
21	Client delay in making decision or delay in approval of contractor's submittals	تاخر المالك فى اتخاذ قرار فى الطلبات المقدمة من المقاول											
22	Delay in performing inspection &testing by the consultant	تاخر الاستشارى فى مراجعة الاعمال المنتهية من قبل المقاول											
23	The conflict between the contractor and the consultant	وجود نزاع بين المقاول و الاستشارى											
Contractor Factors		ثالثاً : المقاول	Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Meduim	High	Catastrophic	
1	Bad start-up plan	عدم وجود خطة جيدة للبدء فى تنفيذ المشروع وتاثر المشروع بذلك											
2	Delay of mobilization	تاخر المقاول فى التحرك الى موقع الاعمال											
3	Commitment to the schedule (delay due to contactor)	مدى التزام المقاول بالجدول الزمنى للمشروع او تاخرة											
4	Pay liquidate damage	دفع الغرمات الناتجة عن التاخير											
5	Low engineering productivity	انخفاض الانتاجية الهندسية											
6	Bad staff for site management	وجود هيكل تنظيمى سيئ لادارة المشروع											
7	Bad or insufficient organization for material management	عدم وجود سيطرة على المهمات الواردة للمشروع او وجود ادارة غير فاعلة فى عملية السيطرة على المهمات بالمشروع											

Item number	Risk Type	انواع المخاطرالتى يمكن ان يتعرض لها المقاول	PROBABILTY OF OCCURRENCE تكرار الحدوث					IMPACT OF RISK درجة التأثير على المقاول					Notes
			Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Meduim	High	Catastrophic	
8	Bad site stores management	وجود ادارة سيئة للمخازن بالمشروع											
9	Supliers bid greater than estimate	اسعار الموردين اكبر من المتوقع											
10	Bad selection of sub-contractors	اختيار سئ لمقاولى الباطن العامليين بالمشروع											
11	Lack of communication between different parties(client , consultant , contractor)	عدم التواصل الجيد بين اطراف المشروع (المالك - المقاول - الموردين- مقاول الباطن - الاستشارى)											
12	Bad coordination between sub-contractors	عدم التنسيق الجيد بين مقاولى الباطن والعاملين بالمشروع											
13	Bad of construction tasks definition	وجود اعمال انشاء لا يتم التنسيق بينها مما يؤدى الى تنفيذ الاعمال اكثر من مرة وتاثير ذلك على المشروع											
14	Earnings volatility (revenue)	وجود ربحية صغيرة متطايرة بالمشروع ومدى تاثر المالك بذلك											
15	Reputation risk (company defamation)	مخاطر تشوه سمعة المقاول ومدى تاثير ذلك عليه											
Sub-Contractors and Suppliers Factors		رابعاً: الموردين ومقاولى الباطن											
1	Bad planning for labor resources	تخطيط سئ لمصادر العمالة ومدى تاثر المشروع بذلك											
2	Bad identification of equipment and material	تحديد سيئ للمعدات المطلوب استخدامها بالمشروع وكذلك المهمات المطلوب استخدمها											
3	Shortages of qualified labors	عدم توفر عمالة ماهرة كافية للمشروع											
4	Shortages of equipments	نقص فى المعدات الازمة لتنفيذ المشروع											
5	Low productivity of labors	انخفاض الانتاجية الخاصة بالعمالة											
6	Low productivity of equipments	انخفاض الانتاجية الخاصة بالمعدات											
7	Delay in materials delivery	تاخر الموردين فى تسليم المهمات الى المشروع											
8	Increase of material waste	زيادة الفاقد فى المهمات الموردة الى المشروع											
9	Defective materials	وجود مهمات معيبة											
10	Slow manufacturing process	عمليات تصنيع بطيئة											
11	Bad vendor performance	اداء سيئ من الموردين (من حيث الاسعار او التزامهم بتقديم العطاءات الخاصة بهم فى مواعيدها ومدى التزامهم بمواصفات المشروع)											

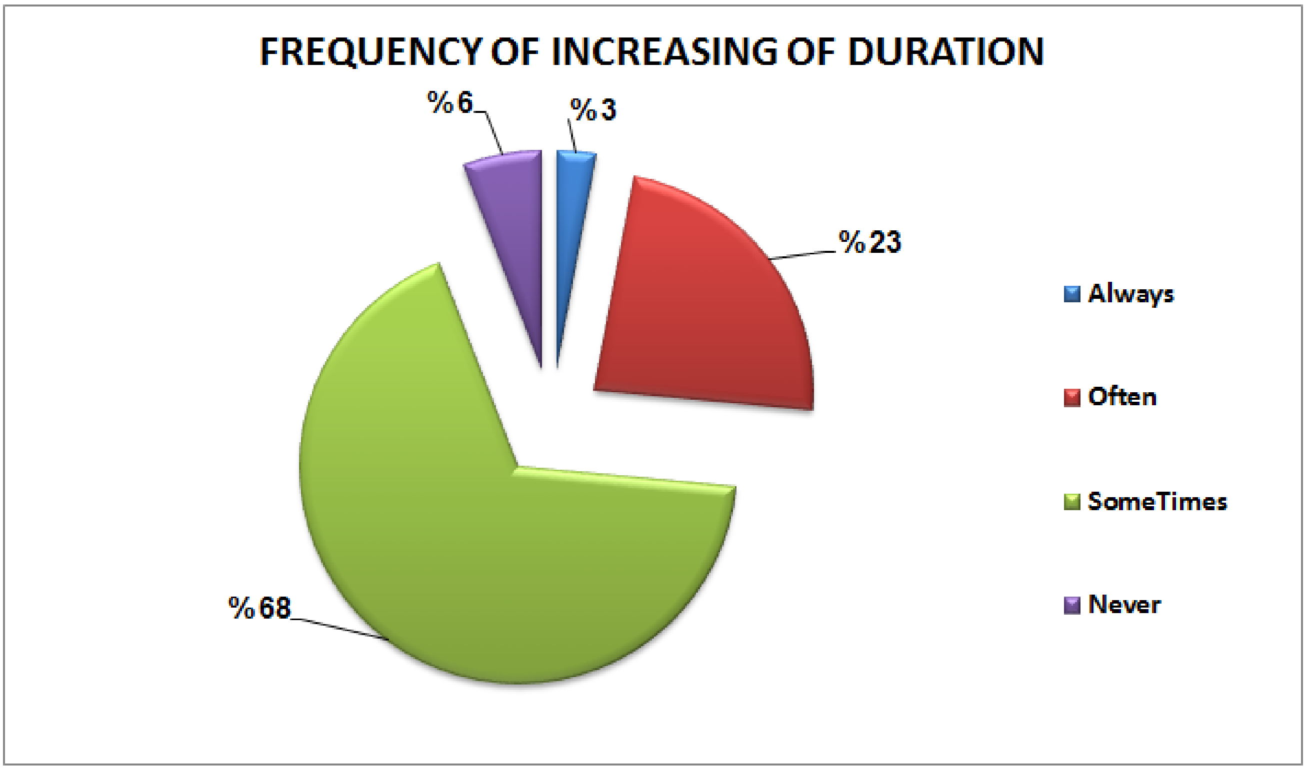
Item number	Risk Type	انواع المخاطرالتى يمكن ان يتعرض لها المقاول	PROBABILTY OF OCCURRENCE تكرار الحدوث					IMPACT OF RISK درجة التأثير على المقاول					Notes
			Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Meduim	High	Catastrophic	
12	Vendor-labor problems	وجود مشاكل كثيرة بين الموردين والعمالة الخاصة بهم تؤثر على اداء الموردين											
13	Subcontractor default	اخطاء مقاول الباطن											
14	Construction mistakes	الاخطاء التنفذية											
	PLEASE , WRITE ANY IMPORTANT RISK FACTOR DOES NOT MENTIONED IN THE LIST	يمكن اضافة اى نوع من انواع المخاطر تم اغفالها بالاعلى											

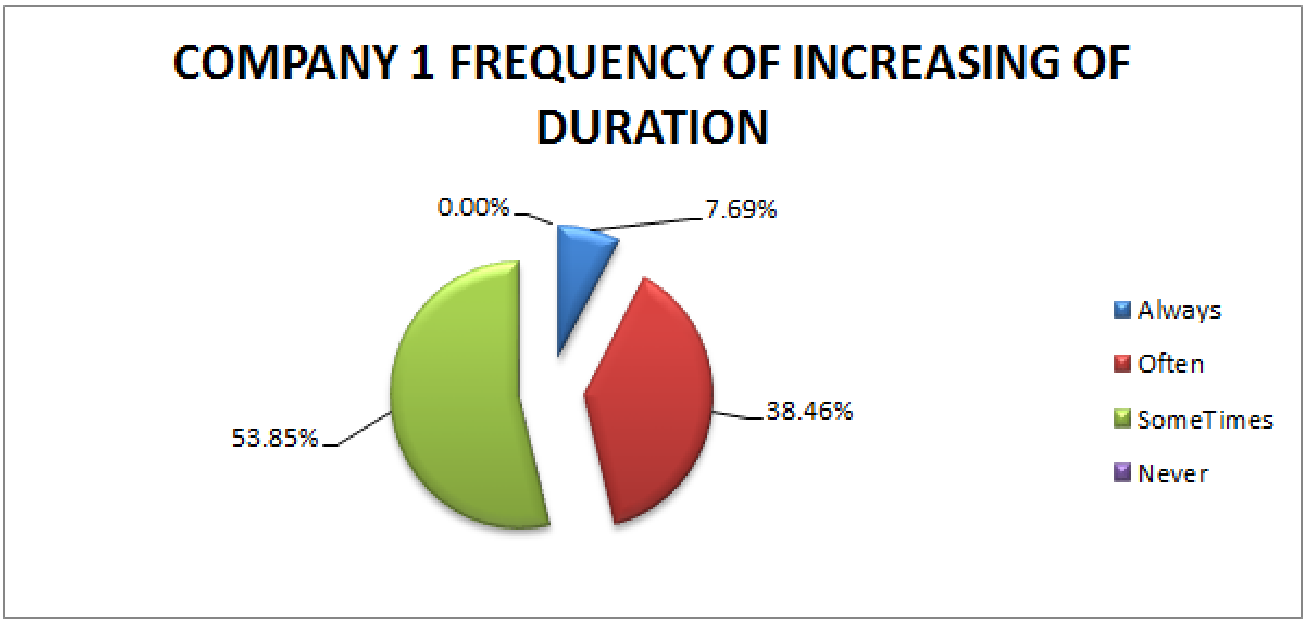
FREQUENCY OF DELAY FOR EACH COMPANY DUE TO SAMPLE RESPONSE

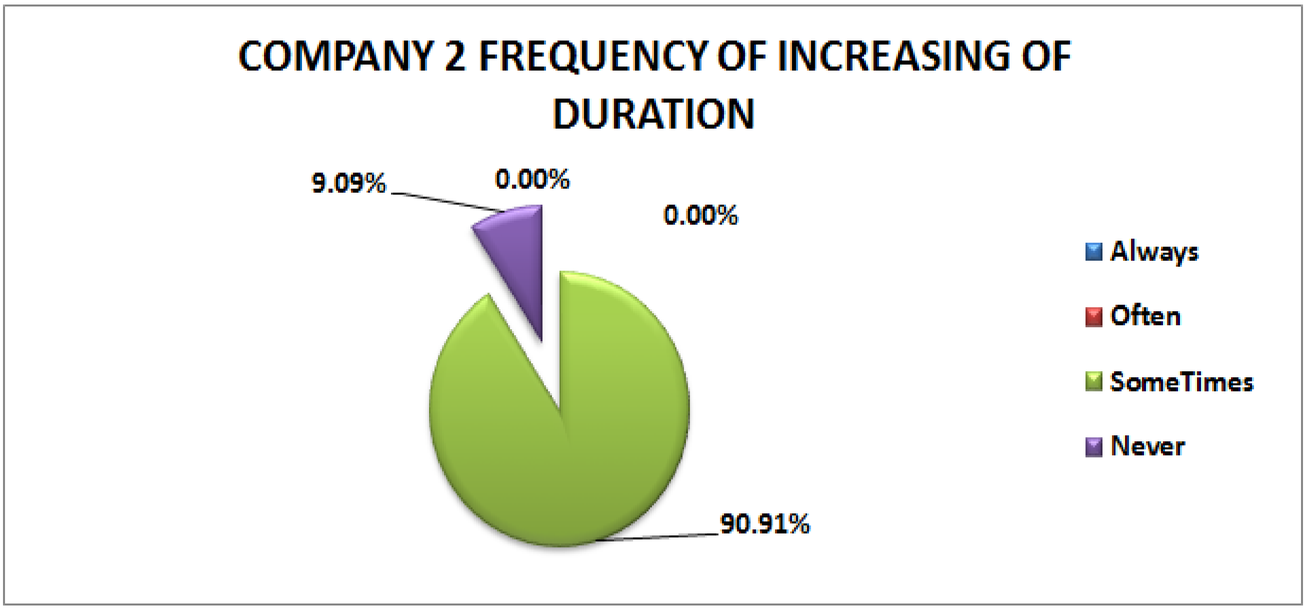
FREQUENCY OF INCREASING OF DURATION	Companies Working In Off-Shore Oil & Gas Construction Projects In Egypt			
	Company 1	Company 2	Company 3	Company 4
Always	7.69 %	0.00 %	0.00 %	0.00 %
Often	38.46 %	0.00 %	50.0 %	25.0 %
Sometimes	53.85 %	90.91 %	50.0 %	50.0 %
Never	0.00 %	9..09 %	0.00 %	25.0 %

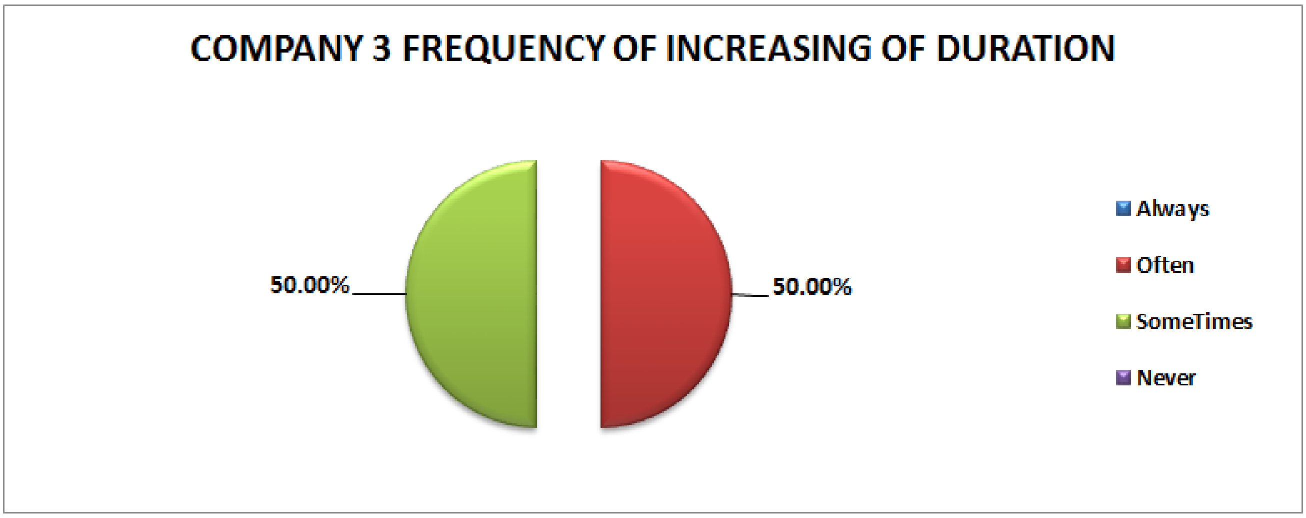
	Always	Often	Sometimes	Never
Company 1 Que. Num. (13)	-	1	-	-
	-	1	-	-
	-	-	1	-
	-	1	-	-
	-	-	1	-
	1	-	-	-
	-	-	1	-
	-	1	-	-
	-	-	1	-
	-	1	-	-
	-	-	1	-
	-	-	1	-
	-	-	1	-
Total	**1**	**5**	**7**	**0**
	7.69%	**38.46%**	**53.85%**	**0.00%**
Company 2 Que. Num. (11)	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	-	1
	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	1	-

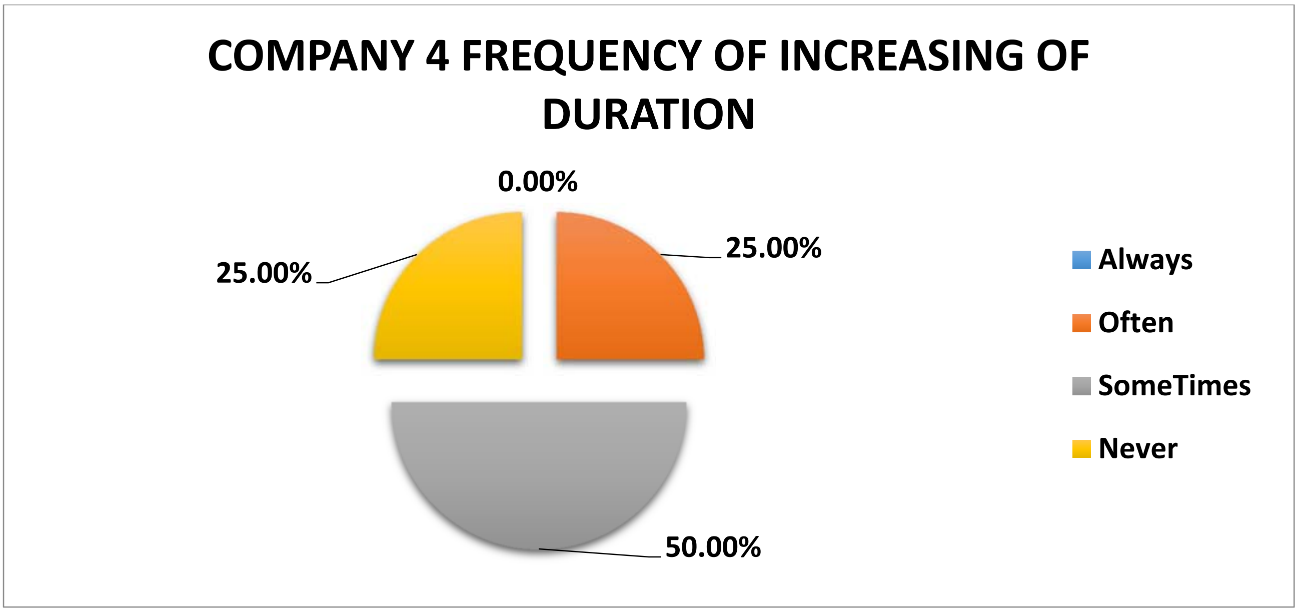
Total	**0**	**0**	**10**	**1**
	0	**0**	**90.91%**	**9.09%**
Company 3 Que. Num (4)	-	1	-	-
	-	-	1	-
	-	1	-	-
	-	-	1	-
Total	**0**	**2**	**2**	**0**
	0.00%	**50.00%**	**50.00%**	**0.00%**
Company 5 Que. Num (2)	-	-	1	-
	-	-	1	-
Total	**0**	**0**	**2**	**0**
	0.00%	**0.00%**	**100.00%**	**0.00%**
Company 4 Que. Num (4)	-	-	1	-
	-	1	-	-
	-	-	1	-
	-	-	-	1
Total	**0**	**1**	**2**	**1**
	0.00%	**25.00%**	**50.00%**	**25.00%**
FREQUENCY OF INCREASING OF DURATION	**Always**	**Often**	**sometime**	**Never**
	1	**8**	**23**	**2**
	2.94%	**23.53%**	**67.65%**	**5.88%**

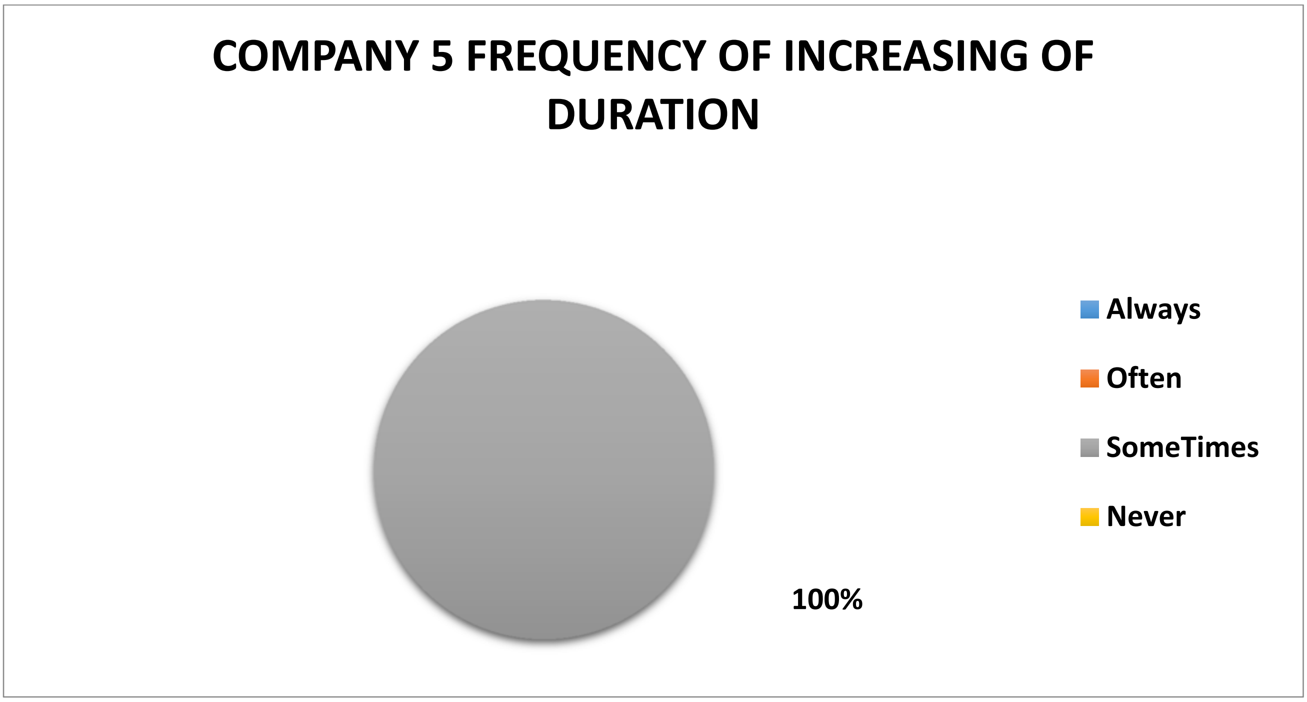



COMPANY 1 FREQUENCY OF INCREASING OF DURATION
0.00%
7.69%
38.46%
53.85%
Always
Often
SomeTimes
Never


COMPANY 2 FREQUENCY OF INCREASING OF DURATION
9.09%
0.00%
0.00%
90.91%
Always
Often
SomeTimes
Never


COMPANY 3 FREQUENCY OF INCREASING OF DURATION
50.00%
50.00%
Always
Often
SomeTimes
Never


COMPANY 4 FREQUENCY OF INCREASING OF DURATION
0.00%
25.00%
25.00%
50.00%
Always
Often
SomeTimes
Never

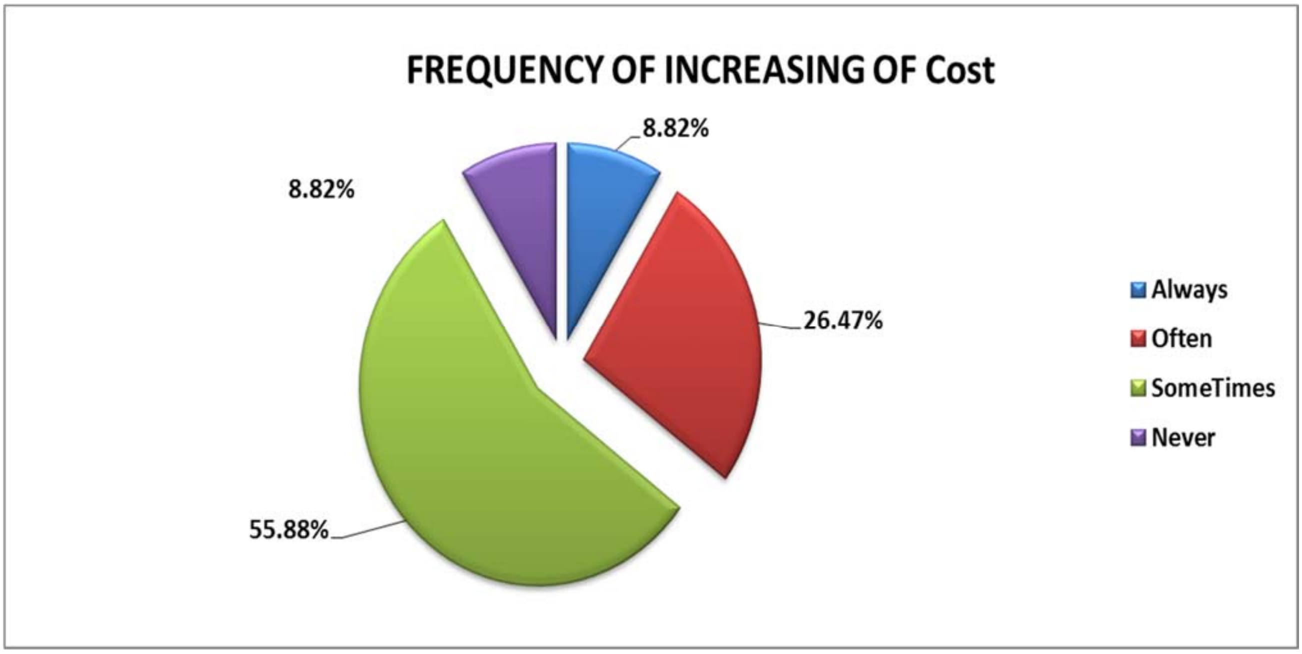

COMPANY 5 FREQUENCY OF INCREASING OF DURATION
100%
Always
Often
SomeTimes
Never

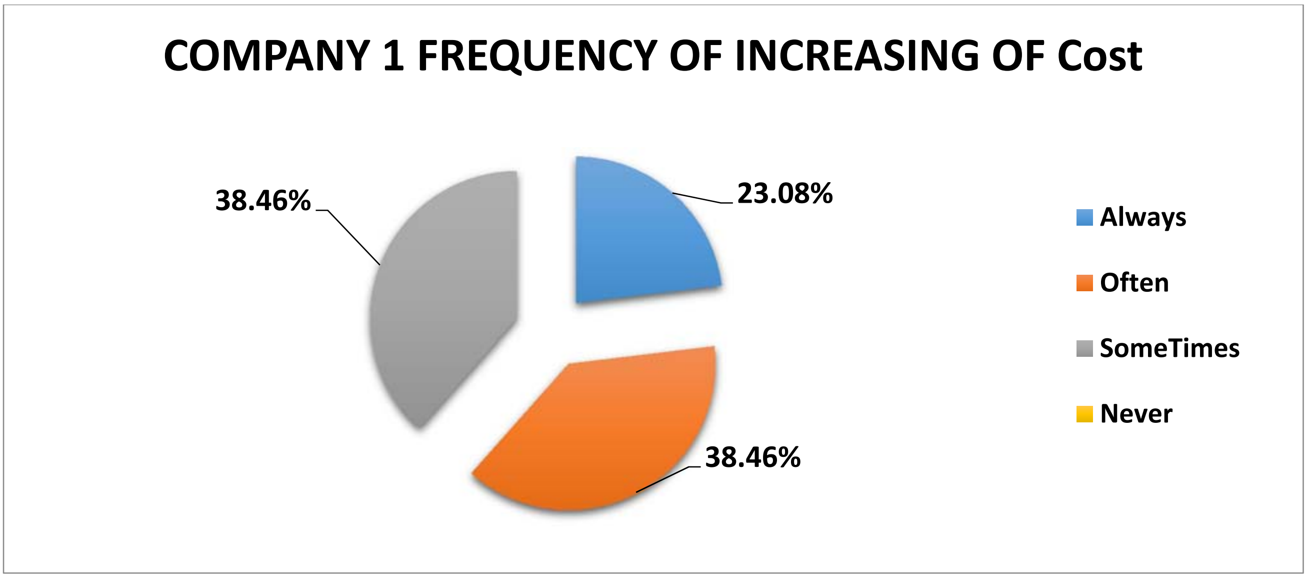
FREQUENCY OF INCREASING OF COST FOR EACH COMPANY DUE TO SAMPLE REEPONSE

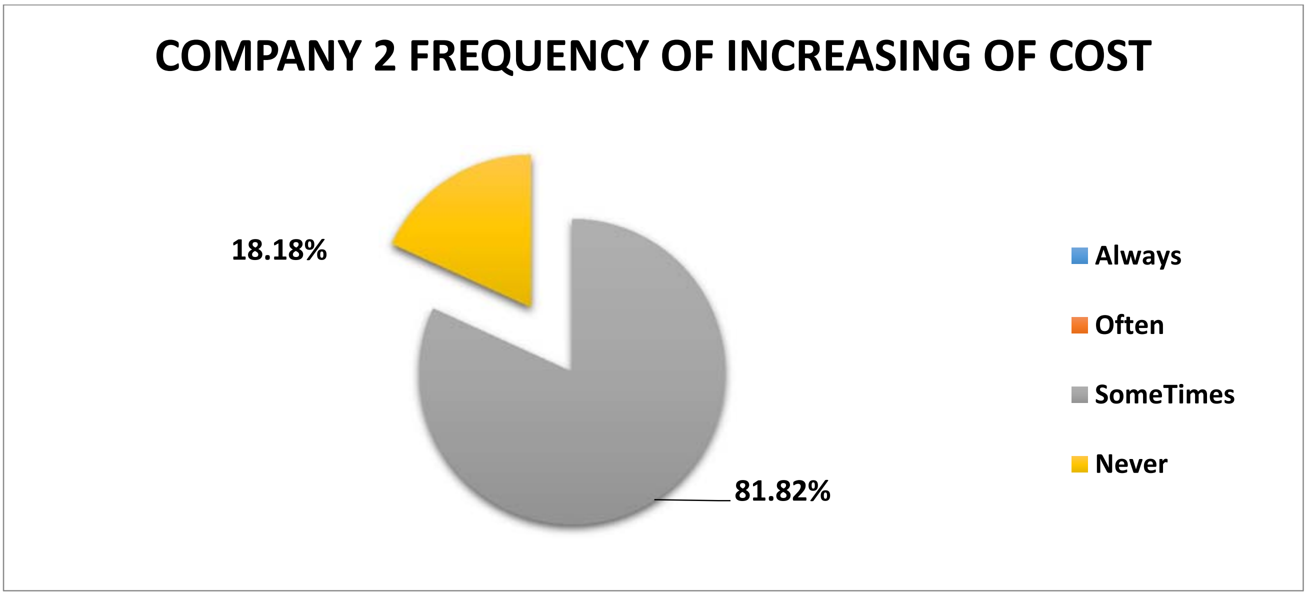
FREQUENCY OF INCREASING OF COST	Companies Working in Off-Shore Oil & Gas Construction Projects In Egypt			
	Company 1	Company 2	Company 3	Company 4
Always	23.08 %	0.0 %	0.0 %	0.0 %
Often	38.46 %	0.0 %	25.0 %	50.0 %
Sometimes	38.46 %	81.82 %	75.0 %	25.0 %
Never	0.0 %	18.18 %	0.0 %	25.0 %

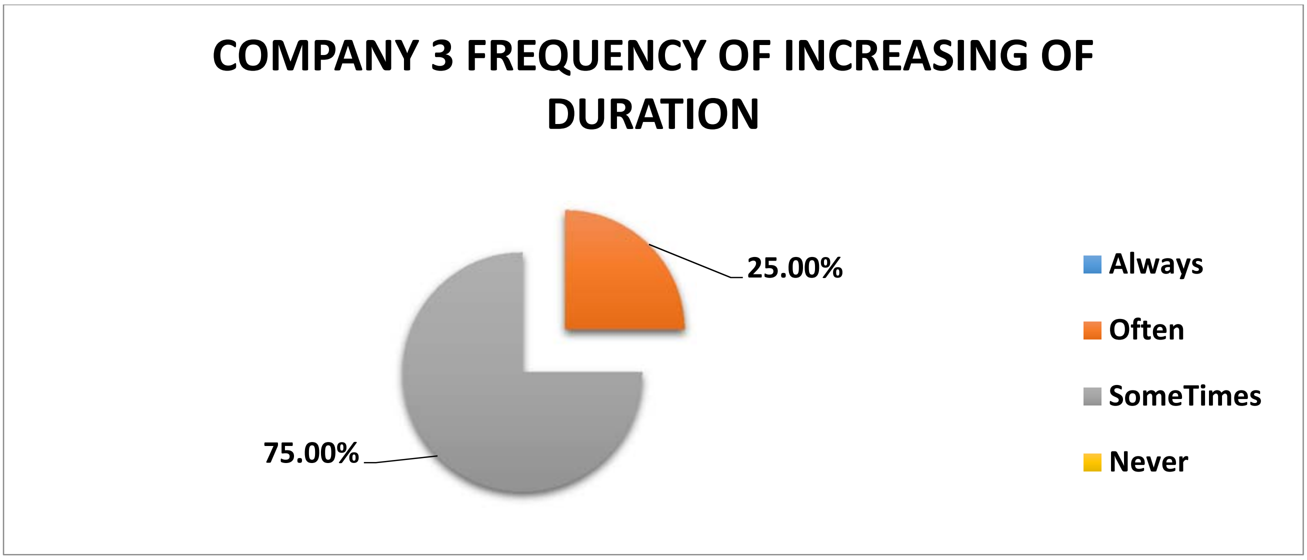
	Always	Often	sometime	Never
Company 1 Que. Num. (13)	1	-	-	-
	-	-	1	-
	-	1	-	-
	-	1	-	-
	-	-	1	-
	1	-	-	-
	-	-	1	-
	-	1	-	-
	1	-	-	-
	-	-	1	-
	-	-	1	-
	-	1	-	-
	-	1	-	-
Total	**3**	**5**	**5**	**0**
	23.08%	**38.46%**	**38.46%**	**0.00%**
Company 2 Que. Num. (11)	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-		1
	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	1	-
	-	-	-	1

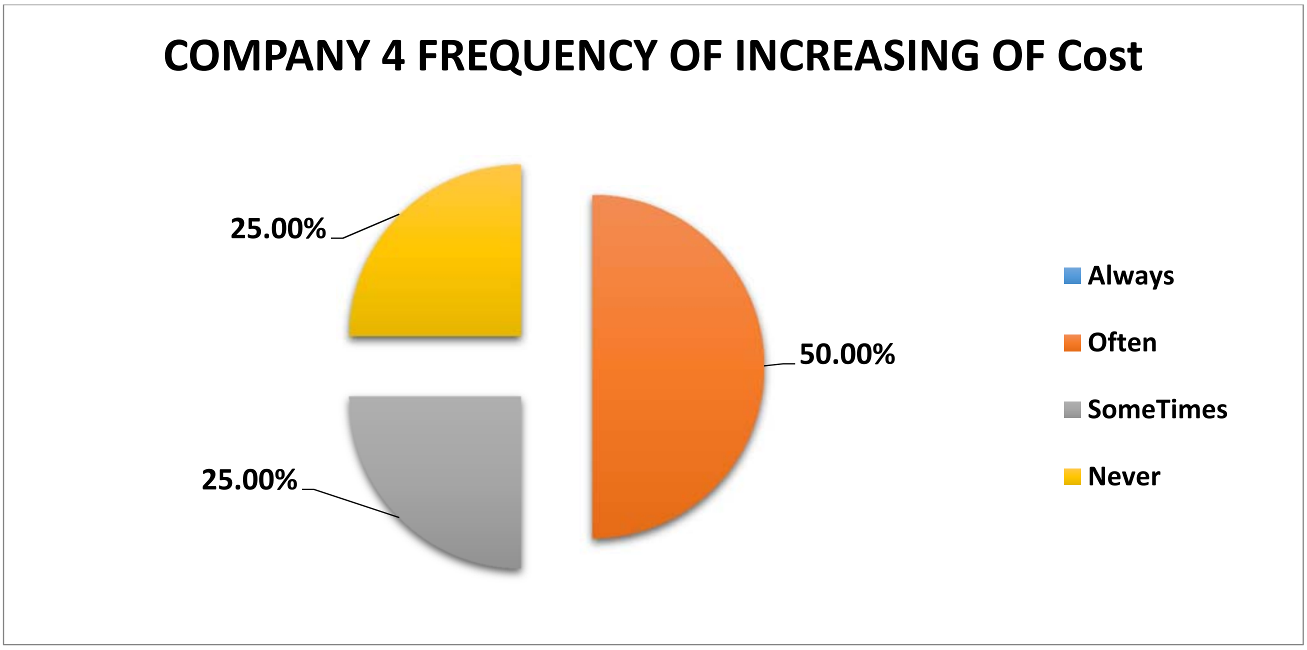
	-	-	1	-
Total	**0**	**0**	**9**	**2**
	0	**0**	**81.82%**	**18.18%**
Company 3 Que. Num (4)	-	1	-	-
	-	-	1	-
	-	-	1	-
	-	-	1	-
Total	**0**	**1**	**3**	**0**
	0.00%	**25.00%**	**75.00%**	**0.00%**
Company 5 Que. Num (2)	-	1	-	-
	-	-	1	-
Total	**0**	**1**	**1**	**0**
	0.00%	**50.00%**	**50.00%**	**0.00%**
Company 4 Que. Num (4)	-	1	-	-
	-	1	-	-
	-	-	1	-
	-	-		1
Total	**0**	**2**	**1**	**1**
	0.00%	**50.00%**	**25.00%**	**25.00%**
FREQUENCY OF INCREASING OF Cost	**Always**	**Often**	**sometime**	**Never**
	3	**9**	**19**	**3**
	8.82%	**26.47%**	**55.88%**	**8.82%**

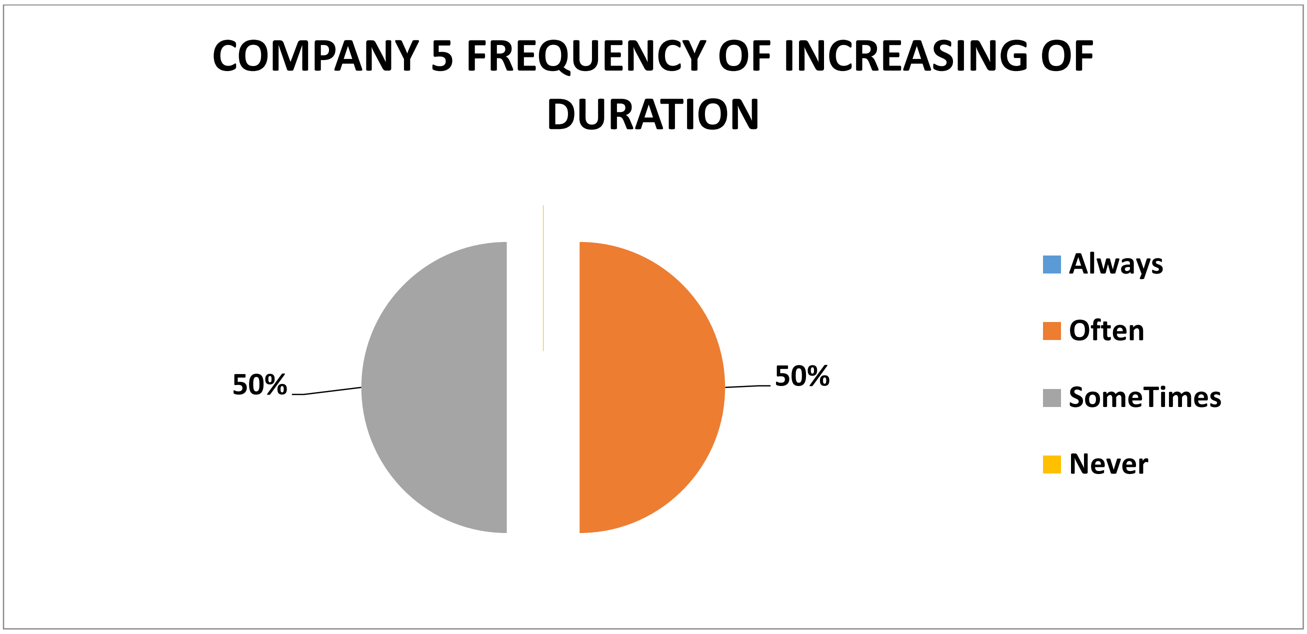



COMPANY 1 FREQUENCY OF INCREASING OF Cost
38.46%
23.08%
38.46%
Always
Often
SomeTimes
Never


COMPANY 2 FREQUENCY OF INCREASING OF COST
18.18%
81.82%
Always
Often
SomeTimes
Never


COMPANY 3 FREQUENCY OF INCREASING OF DURATION
25.00%
75.00%
Always
Often
SomeTimes
Never


COMPANY 4 FREQUENCY OF INCREASING OF Cost
25.00%
50.00%
25.00%
Always
Often
SomeTimes
Never


COMPANY 5 FREQUENCY OF INCREASING OF DURATION
50%
50%
Always
Often
SomeTimes
Never

Total IMP. IND. for all Companies

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					Total P.O.A %	Total I.O.R %	IMP IND.
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	8	11	12	1	2	6	12	11	3	2	41.2%	50.0%	20.59%
2	Weather effect on the project	0	5	3	14	12	0	5	1	18	10	77.1%	79.4%	61.25%
3	Difficult site access	10	11	10	2	1	5	12	12	3	2	37.9%	51.2%	19.40%
4	Insufficient site information (include site access, definitions of site boundaries)	17	6	7	4	0	9	13	6	6	0	32.0%	45.3%	14.51%
5	Increase in material price	0	4	15	10	5	0	4	9	16	5	66.0%	72.9%	48.15%
6	Increase in labor price	2	14	11	4	3	1	14	9	7	3	50.3%	58.2%	29.31%
7	Currency fluctuation (foreign exchange rate)	2	6	17	6	3	3	6	11	11	3	56.9%	62.9%	35.79%
8	High design criteria	0	7	13	7	7	0	8	13	11	2	64.7%	64.1%	41.49%
9	High quality control standard	2	6	5	9	12	2	6	10	12	4	70.6%	65.9%	46.51%
10	Delay of tender offer evaluation and purchase order cycle	2	8	8	11	5	3	7	9	13	2	61.4%	62.4%	38.31%
11	Delay of government permits	4	16	9	2	3	4	11	13	4	2	45.1%	53.5%	24.14%
12	Owner cancellation of project	26	3	3	1	1	16	5	5	4	4	21.6%	45.3%	9.77%
13	Owner suspending or delaying the project	15	12	5	1	1	9	8	9	5	3	30.1%	51.2%	15.39%
14	Cost over-run (bad initial cost estimation)	6	12	11	2	3	5	1	18	8	2	45.1%	60.6%	27.32%
15	Project financing availability (debts & delayed payment on contract)	4	9	18	1	2	2	7	19	3	3	47.7%	58.8%	28.07%
16	Bad management of project budget	11	8	8	4	3	4	5	10	8	7	42.5%	65.3%	27.74%
17	Inaccurate (inadequate) specifications	10	17	2	2	3	9	13	3	5	4	36.6%	49.4%	18.09%

18	**Uncompleted design at start of site work**	**3**	**9**	**15**	**5**	**2**	**2**	**16**	**7**	**7**	**2**	51.6%	54.7%	28.25%
19	**Delay of engineering designs during work**	**3**	**12**	**7**	**9**	**3**	**2**	**11**	**8**	**11**	**2**	53.6%	60.0%	32.16%
20	**Design changes during construction**	**3**	**9**	**11**	**9**	**2**	**2**	**9**	**7**	**15**	**1**	54.2%	62.4%	33.83%
21	**Design errors**	**7**	**4**	**16**	**3**	**4**	**5**	**5**	**8**	**11**	**5**	51.0%	63.5%	32.39%
22	**Lack of engineering resource qualifications and pool depth**	**10**	**15**	**4**	**4**	**1**	**8**	**10**	**9**	**6**	**1**	36.6%	49.4%	18.09%
23	**Bad quality control**	**16**	**11**	**5**	**1**	**1**	**12**	**6**	**7**	**8**	**1**	29.4%	48.2%	14.19%
24	**Bad application of safety**	**17**	**6**	**8**	**1**	**2**	**9**	**6**	**14**	**3**	**2**	32.7%	50.0%	16.34%
25	**Bad site management process**	**17**	**8**	**6**	**2**	**1**	**11**	**5**	**8**	**9**	**1**	30.7%	50.6%	15.54%
26	**Bad management for project records**	**13**	**12**	**7**	**1**	**1**	**7**	**9**	**7**	**10**	**1**	32.7%	53.5%	17.49%
27	**Project duration (schedule is too short for the required activities**	**3**	**11**	**9**	**7**	**4**	**3**	**4**	**5**	**18**	**4**	54.2%	69.4%	37.65%
28	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**8**	**13**	**6**	**7**	**0**	**5**	**12**	**10**	**7**	63.4%	71.2%	45.12%
29	**Delay in performing inspection &testing by the consultant**	**1**	**3**	**21**	**4**	**5**	**1**	**3**	**15**	**10**	**5**	61.4%	68.8%	42.28%
30	**The conflict between the contractor and the consultant**	**1**	**6**	**12**	**9**	**6**	**2**	**3**	**9**	**12**	**8**	64.1%	72.4%	46.34%
31	**Bad start-up plan**	**4**	**22**	**4**	**2**	**2**	**3**	**7**	**12**	**8**	**4**	39.9%	61.8%	24.63%
32	**Delay of mobilization**	**4**	**12**	**11**	**5**	**2**	**3**	**11**	**7**	**9**	**4**	48.4%	60.0%	29.02%
33	**Commitment to the schedule (delay due to contactor)**	**0**	**6**	**15**	**12**	**1**	**0**	**5**	**20**	**8**	**1**	60.8%	62.9%	38.26%
34	**Pay liquidate damage**	**7**	**7**	**14**	**3**	**3**	**7**	**5**	**8**	**5**	**9**	47.7%	62.4%	29.75%
35	**Low engineering productivity**	**7**	**14**	**10**	**1**	**2**	**7**	**7**	**11**	**8**	**1**	40.5%	53.5%	21.69%
36	**Bad staff for site management**	**8**	**13**	**12**	**1**	**0**	**5**	**5**	**15**	**9**	**0**	37.3%	56.5%	21.04%
37	**Bad or insufficient organization for material management**	**15**	**11**	**6**	**1**	**1**	**8**	**8**	**6**	**10**	**2**	30.7%	54.1%	16.62%
38	**Bad site stores management**	**6**	**13**	**11**	**4**	**0**	**4**	**7**	**7**	**16**	**0**	41.8%	60.6%	25.34%

39	**Suppliers bid greater than estimate**	3	14	12	4	1	2	7	13	6	6	46.4%	64.1%	29.75%
40	**Bad selection of sub-contractors**	5	10	12	7	0	3	10	8	10	3	47.1%	60.0%	28.24%
41	**Lack of communication between different parties(client , consultant , contractor)**	5	17	5	5	2	1	12	8	8	5	43.8%	62.4%	27.30%
42	**Bad coordination between sub-contractors**	5	12	11	5	1	4	7	11	11	1	45.8%	58.8%	26.91%
43	**Bad of construction tasks definition**	8	13	8	5	0	6	8	7	12	1	39.9%	56.5%	22.51%
44	**Earnings volatility (revenue)**	14	11	6	2	1	9	11	4	9	1	32.7%	49.4%	16.15%
45	**Reputation risk (company defamation)**	5	10	14	4	1	4	4	9	10	7	46.4%	67.1%	31.12%
46	**Bad planning for labor resources**	9	21	3	1	0	5	16	9	3	1	30.7%	47.6%	14.64%
47	**Bad identification of equipment and material**	12	16	5	1	0	4	14	6	10	0	30.1%	52.9%	15.92%
48	**Shortages of qualified labors**	5	13	12	4	0	3	11	4	13	3	43.1%	61.2%	26.39%
49	**Shortages of equipment**	7	11	14	2	0	4	8	10	12	0	40.5%	57.6%	23.36%
50	**Low productivity of labors**	5	10	16	3	0	3	9	10	10	2	44.4%	59.4%	26.41%
51	**Low productivity of equipment**	5	19	10	0	0	4	17	6	7	0	36.6%	49.4%	18.09%
52	**Delay in materials delivery**	2	11	17	4	0	1	10	14	7	2	48.4%	59.4%	28.74%
53	**Increase of material waste**	8	20	6	0	0	5	15	11	2	1	32.0%	47.6%	15.26%
54	**Defective materials**	7	18	8	1	0	4	11	11	7	1	35.3%	54.1%	19.10%
55	**Slow manufacturing process**	13	9	11	1	0	12	9	4	8	1	33.3%	46.5%	15.49%
56	**Bad vendor performance**	4	9	21	0	0	3	8	16	6	1	44.4%	56.5%	25.10%
57	**Vendor-labor problems**	10	13	11	0	0	4	12	17	1	0	34.0%	48.8%	16.59%
58	**Subcontractor default**	4	9	15	6	0	3	9	14	6	2	48.4%	57.1%	27.60%
59	**Construction mistakes**	3	11	20	0	0	2	5	21	5	1	44.4%	58.8%	26.14%
		7	11	10	4	2	4	8	10	9	3	45.40%	59.41%	26.97%

Total IMP. IND. For Company (1)

Item number	Risk Factors	Total Of P.O.ACC				Total of I.O.R						Total P.O.A %	Total I.O.R %	IMP IND.
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	4	2	5	0	2	2	4	5	0	2	45.3%	53.8%	24.4%
2	Weather effect on the project	0	5	2	3	3	0	5	1	4	3	62.4%	67.7%	42.2%
3	Difficult site access	4	4	2	2	1	2	6	3	1	1	41.9%	49.2%	20.6%
4	Insufficient site information (include site access, definitions of site boundaries)	6	2	3	2	0	4	4	3	2	0	35.0%	44.6%	15.6%
5	Increase in material price	0	1	5	4	3	0	1	4	5	3	70.9%	75.4%	53.5%
6	Increase in labor price	1	1	7	1	3	1	1	6	2	3	62.4%	67.7%	42.2%
7	Currency fluctuation (foreign exchange rate)	1	4	5	2	1	1	3	3	5	1	52.1%	63.1%	32.9%
8	High design criteria	0	4	5	2	2	0	5	6	1	1	59.0%	56.9%	33.6%
9	High quality control standard	2	4	2	3	2	2	4	4	2	1	53.8%	53.8%	29.0%
10	Delay of tender offer evaluation and purchase order cycle	1	3	2	4	3	1	3	3	5	1	64.1%	63.1%	40.4%
11	Delay of government permits	1	6	3	0	3	1	6	3	1	2	52.1%	55.4%	28.9%
12	Owner cancellation of project	8	0	3	1	1	5	2	2	3	1	33.3%	49.2%	16.4%
13	Owner suspending or delaying the project	6	4	2	0	1	4	3	3	2	1	31.6%	49.2%	15.6%
14	Cost over-run (bad initial cost estimation)	2	4	3	2	2	2	0	6	4	1	52.1%	63.1%	32.9%
15	Project financing availability (debts & delayed payment on contract)	1	2	9	0	1	1	1	10	0	1	52.1%	58.5%	30.5%
16	Bad management of project budget	1	3	7	1	1	0	2	8	2	1	52.1%	63.1%	32.9%
17	Inaccurate (inadequate) specifications	4	6	2	0	1	3	7	1	1	1	35.0%	44.6%	15.6%

18	**Uncompleted design at start of site work**	**2**	**5**	**5**	**0**	**1**	**1**	**8**	**3**	**0**	**1**	**43.6%**	**47.7%**	**20.8%**
19	**Delay of engineering designs during work**	**0**	**6**	**4**	**1**	**2**	**0**	**5**	**5**	**2**	**1**	**53.8%**	**58.5%**	**31.5%**
20	**Design changes during construction**	**2**	**3**	**5**	**1**	**2**	**1**	**4**	**3**	**4**	**1**	**52.1%**	**60.0%**	**31.3%**
21	**Design errors**	**1**	**2**	**6**	**1**	**3**	**1**	**3**	**4**	**2**	**3**	**60.7%**	**64.6%**	**39.2%**
22	**Lack of engineering resource qualifications and pool depth**	**1**	**7**	**2**	**2**	**1**	**1**	**6**	**3**	**2**	**1**	**47.0%**	**53.8%**	**25.3%**
23	**Bad quality control**	**4**	**5**	**3**	**1**	**0**	**3**	**3**	**3**	**4**	**0**	**35.0%**	**52.3%**	**18.3%**
24	**Bad application of safety**	**4**	**2**	**6**	**1**	**0**	**2**	**3**	**7**	**1**	**0**	**40.2%**	**50.8%**	**20.4%**
25	**Bad site management process**	**6**	**3**	**3**	**1**	**0**	**5**	**2**	**4**	**2**	**0**	**31.6%**	**44.6%**	**14.1%**
26	**Bad management for project records**	**4**	**6**	**2**	**0**	**1**	**2**	**7**	**1**	**2**	**1**	**35.0%**	**49.2%**	**17.3%**
27	**Project duration (schedule is too short for the required activities**	**0**	**4**	**3**	**3**	**3**	**0**	**1**	**3**	**6**	**3**	**64.1%**	**76.9%**	**49.3%**
28	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**1**	**4**	**3**	**5**	**0**	**1**	**3**	**4**	**5**	**76.1%**	**80.0%**	**60.9%**
29	**Delay in performing inspection &testing by the consultant**	**0**	**2**	**5**	**2**	**4**	**0**	**2**	**4**	**3**	**4**	**69.2%**	**73.8%**	**51.1%**
30	**The conflict between the contractor and the consultant**	**1**	**3**	**5**	**2**	**2**	**1**	**2**	**5**	**3**	**2**	**57.3%**	**64.6%**	**37.0%**
31	**Bad start-up plan**	**1**	**8**	**2**	**0**	**2**	**1**	**3**	**6**	**1**	**2**	**45.3%**	**60.0%**	**27.2%**
32	**Delay of mobilization**	**0**	**4**	**4**	**3**	**2**	**0**	**4**	**3**	**4**	**2**	**60.7%**	**66.2%**	**40.1%**
33	**Commitment to the schedule (delay due to contactor)**	**0**	**4**	**2**	**7**	**0**	**0**	**2**	**6**	**5**	**0**	**60.7%**	**64.6%**	**39.2%**
34	**Pay liquidate damage**	**1**	**3**	**4**	**2**	**3**	**1**	**1**	**3**	**4**	**4**	**60.7%**	**73.8%**	**44.8%**
35	**Low engineering productivity**	**2**	**3**	**5**	**1**	**2**	**2**	**3**	**4**	**3**	**1**	**52.1%**	**56.9%**	**29.7%**
36	**Bad staff for site management**	**2**	**4**	**7**	**0**	**0**	**2**	**3**	**7**	**1**	**0**	**41.9%**	**50.8%**	**21.3%**
37	**Bad or insufficient organization for material management**	**5**	**4**	**3**	**0**	**1**	**5**	**1**	**4**	**2**	**1**	**35.0%**	**49.2%**	**17.3%**
38	**Bad site stores management**	**2**	**5**	**4**	**2**	**0**	**2**	**4**	**3**	**4**	**0**	**43.6%**	**53.8%**	**23.5%**

39	Suppliers bid greater than estimate	1	6	5	1	0	1	4	7	0	1	43.6%	53.8%	23.5%
40	Bad selection of sub-contractors	2	3	5	3	0	1	4	4	4	0	48.7%	56.9%	27.7%
41	Lack of communication between different parties(client , consultant , contractor)	1	8	1	1	2	0	8	2	2	1	47.0%	53.8%	25.3%
42	Bad coordination between sub-contractors	2	4	5	1	1	2	4	4	2	1	47.0%	53.8%	25.3%
43	Bad of construction tasks definition	1	4	5	3	0	1	3	5	4	0	50.4%	58.5%	29.5%
44	Earnings volatility (revenue)	4	5	1	2	1	3	4	2	3	1	40.2%	52.3%	21.0%
45	Reputation risk (company defamation)	3	4	3	2	1	3	1	3	4	2	45.3%	61.5%	27.9%
46	Bad planning for labor resources	4	8	1	0	0	2	10	1	0	0	28.2%	38.5%	10.8%
47	Bad identification of equipment and material	4	7	2	0	0	1	9	2	1	0	29.9%	44.6%	13.3%
48	Shortages of qualified labors	1	8	3	1	0	1	7	3	1	1	40.2%	50.8%	20.4%
49	Shortages of equipment	1	4	6	2	0	1	4	6	2	0	48.7%	53.8%	26.2%
50	Low productivity of labors	1	5	6	1	0	1	5	5	1	1	45.3%	53.8%	24.4%
51	Low productivity of equipment	1	11	1	0	0	1	9	2	1	0	33.3%	44.6%	14.9%
52	Delay in materials delivery	1	5	6	1	0	1	5	5	2	0	45.3%	52.3%	23.7%
53	Increase of material waste	2	9	2	0	0	2	6	4	1	0	33.3%	46.2%	15.4%
54	Defective materials	2	8	3	0	0	2	5	4	2	0	35.0%	49.2%	17.3%
55	Slow manufacturing process	6	5	2	0	0	6	4	1	2	0	26.5%	38.5%	10.2%
56	Bad vendor performance	2	1	10	0	0	2	1	9	1	0	47.0%	53.8%	25.3%
57	Vendor-labor problems	4	3	6	0	0	3	3	7	0	0	36.8%	46.2%	17.0%
58	Subcontractor default	2	3	7	1	0	2	3	8	0	0	45.3%	49.2%	22.3%
59	Construction mistakes	1	2	10	0	0	1	1	11	0	0	48.7%	55.4%	27.0%
		2	4	4	1	1	2	4	4	2	1	47.2%	55.9%	26.4%

Total IMP. IND. For Company (2)

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					Total P.O.A %	Total I.O.R %	IMP IND
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	1	5	4	1	0	1	5	3	2	0	43.4%	50.9%	22.1%
2	Weather effect on the project	0	0	1	6	4	0	0	0	8	3	83.8%	85.5%	71.6%
3	Difficult site access	2	5	4	0	0	2	3	4	2	0	37.4%	50.9%	19.0%
4	Insufficient site information (include site access, definitions of site boundaries)	6	2	2	1	0	3	5	2	1	0	29.3%	41.8%	12.2%
5	Increase in material price	0	2	4	3	2	0	1	2	6	2	65.7%	76.4%	50.1%
6	Increase in labor price	0	9	2	0	0	0	10	1	0	0	37.4%	41.8%	15.6%
7	Currency fluctuation (foreign exchange rate)	1	0	8	1	1	1	1	6	2	1	57.6%	61.8%	35.6%
8	High design criteria	0	2	4	3	2	0	2	4	4	1	65.7%	67.3%	44.2%
9	High quality control standard	0	1	1	4	5	0	0	3	5	3	81.8%	80.0%	65.5%
10	Delay of tender offer evaluation and purchase order cycle	1	4	2	4	0	1	3	3	4	0	51.5%	58.2%	30.0%
11	Delay of government permits	3	4	3	1	0	3	3	3	2	0	37.4%	47.3%	17.7%
12	Owner cancellation of project	9	2	0	0	0	8	2	1	0	0	15.2%	27.3%	4.1%
13	Owner suspending or delaying the project	5	5	0	1	0	4	4	2	1	0	27.3%	40.0%	10.9%
14	Cost over-run (bad initial cost estimation)	1	4	5	0	1	1	1	8	0	1	47.5%	58.2%	27.6%
15	Project financing availability (debts & delayed payment on contract)	1	4	4	1	1	0	4	4	2	1	49.5%	60.0%	29.7%
16	Bad management of project budget	3	2	1	3	2	2	2	0	2	5	53.5%	70.9%	38.0%
17	Inaccurate (inadequate) specifications	3	5	0	2	1	3	4	1	1	2	41.4%	50.9%	21.1%

18	**Uncompleted design at start of site work**	**0**	**0**	**5**	**5**	**1**	**0**	**1**	**4**	**5**	**1**	**69.7%**	**70.9%**	**49.4%**
19	**Delay of engineering designs during work**	**2**	**1**	**3**	**4**	**1**	**1**	**2**	**2**	**5**	**1**	**57.6%**	**65.5%**	**37.7%**
20	**Design changes during construction**	**0**	**4**	**3**	**4**	**0**	**0**	**3**	**2**	**6**	**0**	**55.6%**	**65.5%**	**36.4%**
21	**Design errors**	**2**	**1**	**5**	**2**	**1**	**2**	**1**	**1**	**5**	**2**	**53.5%**	**67.3%**	**36.0%**
22	**Lack of engineering resource qualifications and pool depth**	**5**	**2**	**2**	**2**	**0**	**5**	**1**	**2**	**3**	**0**	**35.4%**	**45.5%**	**16.1%**
23	**Bad quality control**	**7**	**2**	**1**	**0**	**1**	**7**	**1**	**1**	**1**	**1**	**27.3%**	**38.2%**	**10.4%**
24	**Bad application of safety**	**8**	**1**	**0**	**0**	**2**	**7**	**1**	**1**	**0**	**2**	**29.3%**	**40.0%**	**11.7%**
25	**Bad site management process**	**7**	**0**	**2**	**1**	**1**	**6**	**0**	**1**	**3**	**1**	**33.3%**	**47.3%**	**15.8%**
26	**Bad management for project records**	**7**	**1**	**2**	**1**	**0**	**5**	**0**	**3**	**3**	**0**	**27.3%**	**47.3%**	**12.9%**
27	**Project duration (schedule is too short for the required activities**	**3**	**3**	**1**	**3**	**1**	**3**	**2**	**0**	**5**	**1**	**47.5%**	**58.2%**	**27.6%**
28	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**2**	**4**	**3**	**2**	**0**	**2**	**3**	**4**	**2**	**65.7%**	**70.9%**	**46.6%**
29	**Delay in performing inspection &testing by the consultant**	**1**	**0**	**9**	**0**	**1**	**1**	**0**	**7**	**3**	**0**	**55.6%**	**61.8%**	**34.3%**
30	**The conflict between the contractor and the consultant**	**0**	**1**	**3**	**4**	**3**	**1**	**0**	**1**	**3**	**6**	**73.7%**	**83.6%**	**61.7%**
31	**Bad start-up plan**	**1**	**7**	**2**	**1**	**0**	**1**	**3**	**3**	**2**	**2**	**39.4%**	**61.8%**	**24.4%**
32	**Delay of mobilization**	**2**	**5**	**2**	**2**	**0**	**2**	**4**	**1**	**2**	**2**	**41.4%**	**56.4%**	**23.3%**
33	**Commitment to the schedule (delay due to contactor)**	**0**	**2**	**7**	**1**	**1**	**0**	**1**	**6**	**3**	**1**	**57.6%**	**67.3%**	**38.7%**
34	**Pay liquidate damage**	**4**	**2**	**5**	**0**	**0**	**4**	**1**	**4**	**0**	**2**	**35.4%**	**50.9%**	**18.0%**
35	**Low engineering productivity**	**5**	**5**	**1**	**0**	**0**	**5**	**3**	**1**	**2**	**0**	**25.3%**	**40.0%**	**10.1%**
36	**Bad staff for site management**	**5**	**3**	**2**	**1**	**0**	**3**	**2**	**3**	**3**	**0**	**31.3%**	**50.9%**	**15.9%**
37	**Bad or insufficient organization for material management**	**6**	**2**	**2**	**1**	**0**	**3**	**5**	**1**	**1**	**1**	**29.3%**	**45.5%**	**13.3%**
38	**Bad site stores management**	**4**	**3**	**4**	**0**	**0**	**2**	**3**	**2**	**4**	**0**	**33.3%**	**54.5%**	**18.2%**

39	**Suppliers bid greater than estimate**	2	3	5	1	0	1	2	3	2	3	43.4%	67.3%	29.2%
40	**Bad selection of sub-contractors**	1	4	3	3	0	1	3	2	2	3	49.5%	65.5%	32.4%
41	**Lack of communication between different parties(client , consultant , contractor)**	2	5	1	3	0	1	4	1	2	3	43.4%	63.6%	27.6%
42	**Bad coordination between sub-contractors**	1	5	1	4	0	1	3	4	3	0	49.5%	56.4%	27.9%
43	**Bad of construction tasks definition**	3	6	2	0	0	3	5	1	1	1	31.3%	45.5%	14.2%
44	**Earnings volatility (revenue)**	5	3	3	0	0	4	5	0	2	0	29.3%	40.0%	11.7%
45	**Reputation risk (company defamation)**	0	3	6	2	0	0	3	3	2	3	53.5%	69.1%	37.0%
46	**Bad planning for labor resources**	3	6	2	0	0	2	3	4	1	1	31.3%	52.7%	16.5%
47	**Bad identification of equipment and material**	4	5	2	0	0	2	3	3	3	0	29.3%	52.7%	15.4%
48	**Shortages of qualified labors**	3	2	5	1	0	2	2	0	6	1	41.4%	63.6%	26.4%
49	**Shortages of equipment**	3	3	5	0	0	2	3	1	5	0	37.4%	56.4%	21.1%
50	**Low productivity of labors**	2	5	3	1	0	2	4	0	5	0	39.4%	54.5%	21.5%
51	**Low productivity of equipment**	4	4	3	0	0	3	5	1	2	0	31.3%	43.6%	13.7%
52	**Delay in materials delivery**	1	4	4	2	0	0	3	3	3	2	47.5%	67.3%	31.9%
53	**Increase of material waste**	3	7	1	0	0	1	7	2	0	1	29.3%	47.3%	13.8%
54	**Defective materials**	4	6	1	0	0	2	6	1	1	1	27.3%	47.3%	12.9%
55	**Slow manufacturing process**	5	4	2	0	0	4	5	0	1	1	27.3%	41.8%	11.4%
56	**Bad vendor performance**	1	5	5	0	0	0	5	4	1	1	41.4%	56.4%	23.3%
57	**Vendor-labor problems**	2	7	2	0	0	0	7	3	1	0	33.3%	49.1%	16.4%
58	**Subcontractor default**	1	5	2	3	0	0	4	2	3	2	47.5%	65.5%	31.1%
59	**Construction mistakes**	2	4	5	0	0	1	3	5	1	1	39.4%	56.4%	22.2%
		3	3	3	1	1	2	3	2	3	1	43.3%	56.3%	24.3%

Total IMP. IND. For Company (3)

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					Total P.O.A%	Total I.O.R %	IMP IND
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	1	2	2	0	0	1	2	2	0	0	37.8%	44.0%	16.6%
2	Weather effect on the project	0	0	0	3	2	0	0	0	4	1	86.7%	84.0%	72.8%
3	Difficult site access	1	1	3	0	0	0	2	3	0	0	42.2%	52.0%	22.0%
4	Insufficient site information (include site access, definitions of site boundaries)	1	2	1	1	0	0	2	1	2	0	42.2%	60.0%	25.3%
5	Increase in material price	0	1	2	2	0	0	0	1	4	0	60.0%	76.0%	45.6%
6	Increase in labor price	1	1	1	2	0	0	2	1	2	0	51.1%	60.0%	30.7%
7	Currency fluctuation (foreign exchange rate)	0	1	2	2	0	0	1	2	2	0	60.0%	64.0%	38.4%
8	High design criteria	0	0	2	2	1	0	0	1	4	0	73.3%	76.0%	55.7%
9	High quality control standard	0	0	1	1	3	0	1	1	3	0	86.7%	68.0%	58.9%
10	Delay of tender offer evaluation and purchase order cycle	0	1	2	0	2	1	1	1	1	1	68.9%	60.0%	41.3%
11	Delay of government permits	0	2	2	1	0	0	1	4	0	0	51.1%	56.0%	28.6%
12	Owner cancellation of project	4	1	0	0	0	1	1	2	0	1	15.6%	56.0%	8.7%
13	Owner suspending or delaying the project	2	2	1	0	0	1	1	2	1	0	28.9%	52.0%	15.0%
14	Cost over-run (bad initial cost estimation)	2	1	2	0	0	1	0	0	4	0	33.3%	68.0%	22.7%
15	Project financing availability (debts & delayed payment on contract)	1	1	3	0	0	0	2	2	0	1	42.2%	60.0%	25.3%
16	Bad management of project budget	3	2	0	0	0	1	0	1	2	1	20.0%	68.0%	13.6%
17	Inaccurate (inadequate) specifications	2	3	0	0	0	2	1	1	1	0	24.4%	44.0%	10.8%

18	**Uncompleted design at start of site work**	**0**	**2**	**3**	**0**	**0**	**0**	**4**	**0**	**1**	**0**	**46.7%**	**48.0%**	**22.4%**
19	**Delay of engineering designs during work**	**0**	**3**	**0**	**2**	**0**	**0**	**2**	**1**	**2**	**0**	**51.1%**	**60.0%**	**30.7%**
20	**Design changes during construction**	**0**	**1**	**2**	**2**	**0**	**0**	**1**	**1**	**3**	**0**	**60.0%**	**68.0%**	**40.8%**
21	**Design errors**	**3**	**0**	**2**	**0**	**0**	**1**	**0**	**2**	**2**	**0**	**28.9%**	**60.0%**	**17.3%**
22	**Lack of engineering resource qualifications and pool depth**	**3**	**2**	**0**	**0**	**0**	**1**	**1**	**2**	**1**	**0**	**20.0%**	**52.0%**	**10.4%**
23	**Bad quality control**	**3**	**1**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**0**	**24.4%**	**52.0%**	**12.7%**
24	**Bad application of safety**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**28.9%**	**60.0%**	**17.3%**
25	**Bad site management process**	**2**	**3**	**0**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**24.4%**	**60.0%**	**14.7%**
26	**Bad management for project records**	**0**	**4**	**1**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**37.8%**	**60.0%**	**22.7%**
27	**Project duration (schedule is too short for the required activities**	**0**	**2**	**2**	**1**	**0**	**0**	**1**	**0**	**4**	**0**	**51.1%**	**72.0%**	**36.8%**
28	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**4**	**1**	**0**	**0**	**0**	**2**	**3**	**0**	**0**	**37.8%**	**52.0%**	**19.6%**
29	**Delay in performing inspection &testing by the consultant**	**0**	**1**	**4**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**51.1%**	**60.0%**	**30.7%**
30	**The conflict between the contractor and the consultant**	**0**	**2**	**1**	**1**	**1**	**0**	**1**	**2**	**2**	**0**	**60.0%**	**64.0%**	**38.4%**
31	**Bad start-up plan**	**1**	**3**	**0**	**1**	**0**	**0**	**1**	**1**	**3**	**0**	**37.8%**	**68.0%**	**25.7%**
32	**Delay of mobilization**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**37.8%**	**60.0%**	**22.7%**
33	**Commitment to the schedule (delay due to contactor)**	**0**	**0**	**4**	**1**	**0**	**0**	**1**	**4**	**0**	**0**	**60.0%**	**56.0%**	**33.6%**
34	**Pay liquidate damage**	**1**	**1**	**2**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**46.7%**	**60.0%**	**28.0%**
35	**Low engineering productivity**	**0**	**1**	**4**	**0**	**0**	**0**	**0**	**4**	**1**	**0**	**51.1%**	**64.0%**	**32.7%**
36	**Bad staff for site management**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**3**	**2**	**0**	**37.8%**	**68.0%**	**25.7%**
37	**Bad or insufficient organization for material management**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**28.9%**	**60.0%**	**17.3%**
38	**Bad site stores management**	**0**	**3**	**1**	**1**	**0**	**0**	**0**	**2**	**3**	**0**	**46.7%**	**72.0%**	**33.6%**

39	**Suppliers bid greater than estimate**	**0**	**1**	**1**	**2**	**1**	**0**	**1**	**1**	**3**	**0**	**68.9%**	**68.0%**	**46.8%**
40	**Bad selection of sub-contractors**	**1**	**1**	**2**	**1**	**0**	**0**	**2**	**1**	**2**	**0**	**46.7%**	**60.0%**	**28.0%**
41	**Lack of communication between different parties(client , consultant , contractor)**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**3**	**2**	**0**	**46.7%**	**68.0%**	**31.7%**
42	**Bad coordination between sub-contractors**	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**42.2%**	**72.0%**	**30.4%**
43	**Bad of construction tasks definition**	**3**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**3**	**0**	**28.9%**	**64.0%**	**18.5%**
44	**Earnings volatility (revenue)**	**1**	**3**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**0**	**33.3%**	**52.0%**	**17.3%**
45	**Reputation risk (company defamation)**	**1**	**1**	**3**	**0**	**0**	**1**	**0**	**1**	**3**	**0**	**42.2%**	**64.0%**	**27.0%**
46	**Bad planning for labor resources**	**1**	**3**	**0**	**1**	**0**	**0**	**1**	**2**	**2**	**0**	**37.8%**	**64.0%**	**24.2%**
47	**Bad identification of equipment and material**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**1**	**4**	**0**	**42.2%**	**76.0%**	**32.1%**
48	**Shortages of qualified labors**	**1**	**0**	**3**	**1**	**0**	**0**	**1**	**1**	**3**	**0**	**51.1%**	**68.0%**	**34.8%**
49	**Shortages of equipment**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**1**	**3**	**0**	**37.8%**	**68.0%**	**25.7%**
50	**Low productivity of labors**	**1**	**0**	**4**	**0**	**0**	**0**	**0**	**3**	**2**	**0**	**46.7%**	**68.0%**	**31.7%**
51	**Low productivity of equipment**	**0**	**1**	**4**	**0**	**0**	**0**	**1**	**2**	**2**	**0**	**51.1%**	**64.0%**	**32.7%**
52	**Delay in materials delivery**	**0**	**1**	**3**	**1**	**0**	**0**	**0**	**3**	**2**	**0**	**55.6%**	**68.0%**	**37.8%**
53	**Increase of material waste**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**37.8%**	**60.0%**	**22.7%**
54	**Defective materials**	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**3**	**2**	**0**	**42.2%**	**68.0%**	**28.7%**
55	**Slow manufacturing process**	**0**	**0**	**4**	**1**	**0**	**0**	**0**	**2**	**3**	**0**	**60.0%**	**72.0%**	**43.2%**
56	**Bad vendor performance**	**0**	**1**	**4**	**0**	**0**	**0**	**0**	**3**	**2**	**0**	**51.1%**	**68.0%**	**34.8%**
57	**Vendor-labor problems**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**37.8%**	**60.0%**	**22.7%**
58	**Subcontractor default**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**55.6%**	**72.0%**	**40.0%**
59	**Construction mistakes**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**46.7%**	**76.0%**	**35.5%**
		1	**2**	**2**	**1**	**0**	**0**	**1**	**2**	**2**	**0**	**45.0%**	**63.1%**	**28.4%**

Total IMP. IND. For Company (4)

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					Total P.O.A %	Total I.O.R %	IMP IND
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	2	2	1	0	0	2	1	1	1	0	28.9%	44.0%	12.7%
2	Weather effect on the project	0	0	0	2	3	0	0	0	2	3	91.1%	92.0%	83.8%
3	Difficult site access	3	1	1	0	0	1	1	2	0	1	24.4%	56.0%	13.7%
4	Insufficient site information (include site access, definitions of site boundaries)	4	0	1	0	0	2	2	0	1	0	20.0%	40.0%	8.0%
5	Increase in material price	0	0	4	1	0	0	2	2	1	0	60.0%	56.0%	33.6%
6	Increase in labor price	0	3	1	1	0	0	1	1	3	0	46.7%	68.0%	31.7%
7	Currency fluctuation (foreign exchange rate)	0	1	2	1	1	1	1	0	2	1	64.4%	64.0%	41.2%
8	High design criteria	0	1	2	0	2	0	1	2	2	0	68.9%	64.0%	44.1%
9	High quality control standard	0	1	1	1	2	0	1	2	2	0	73.3%	64.0%	46.9%
10	Delay of tender offer evaluation and purchase order cycle	0	0	2	3	0	0	0	2	3	0	68.9%	72.0%	49.6%
11	Delay of government permits	0	4	1	0	0	0	1	3	1	0	37.8%	60.0%	22.7%
12	Owner cancellation of project	5	0	0	0	0	2	0	0	1	2	11.1%	64.0%	7.1%
13	Owner suspending or delaying the project	2	1	2	0	0	0	0	2	1	2	33.3%	80.0%	26.7%
14	Cost over-run (bad initial cost estimation)	1	3	1	0	0	1	0	4	0	0	33.3%	52.0%	17.3%
15	Project financing availability (debts & delayed payment on contract)	1	2	2	0	0	1	0	3	1	0	37.8%	56.0%	21.2%
16	Bad management of project budget	4	1	0	0	0	1	1	1	2	0	15.6%	56.0%	8.7%
17	Inaccurate (inadequate) specifications	1	3	0	0	1	1	1	0	2	1	42.2%	64.0%	27.0%

18	**Uncompleted design at start of site work**	**1**	**2**	**2**	**0**	**0**	**1**	**3**	**0**	**1**	**0**	**37.8%**	**44.0%**	**16.6%**
19	**Delay of engineering designs during work**	**1**	**2**	**0**	**2**	**0**	**1**	**2**	**0**	**2**	**0**	**46.7%**	**52.0%**	**24.3%**
20	**Design changes during construction**	**1**	**1**	**1**	**2**	**0**	**1**	**1**	**1**	**2**	**0**	**51.1%**	**56.0%**	**28.6%**
21	**Design errors**	**1**	**1**	**3**	**0**	**0**	**1**	**1**	**1**	**2**	**0**	**42.2%**	**56.0%**	**23.6%**
22	**Lack of engineering resource qualifications and pool depth**	**1**	**4**	**0**	**0**	**0**	**1**	**2**	**2**	**0**	**0**	**28.9%**	**44.0%**	**12.7%**
23	**Bad quality control**	**2**	**3**	**0**	**0**	**0**	**1**	**1**	**1**	**2**	**0**	**24.4%**	**56.0%**	**13.7%**
24	**Bad application of safety**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**24.4%**	**60.0%**	**14.7%**
25	**Bad site management process**	**2**	**2**	**1**	**0**	**0**	**0**	**1**	**2**	**2**	**0**	**28.9%**	**64.0%**	**18.5%**
26	**Bad management for project records**	**2**	**1**	**2**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**33.3%**	**72.0%**	**24.0%**
27	**Project duration (schedule is too short for the required activities**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**46.7%**	**72.0%**	**33.6%**
28	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**1**	**4**	**0**	**0**	**0**	**0**	**3**	**2**	**0**	**51.1%**	**68.0%**	**34.8%**
29	**Delay in performing inspection &testing by the consultant**	**0**	**0**	**3**	**2**	**0**	**0**	**0**	**1**	**3**	**1**	**64.4%**	**80.0%**	**51.6%**
30	**The conflict between the contractor and the consultant**	**0**	**0**	**3**	**2**	**0**	**0**	**0**	**1**	**4**	**0**	**64.4%**	**76.0%**	**49.0%**
31	**Bad start-up plan**	**1**	**4**	**0**	**0**	**0**	**1**	**0**	**2**	**2**	**0**	**28.9%**	**60.0%**	**17.3%**
32	**Delay of mobilization**	**1**	**1**	**3**	**0**	**0**	**1**	**2**	**0**	**2**	**0**	**42.2%**	**52.0%**	**22.0%**
33	**Commitment to the schedule (delay due to contactor)**	**0**	**0**	**2**	**3**	**0**	**0**	**1**	**4**	**0**	**0**	**68.9%**	**56.0%**	**38.6%**
34	**Pay liquidate damage**	**1**	**1**	**3**	**0**	**0**	**1**	**2**	**0**	**0**	**2**	**42.2%**	**60.0%**	**25.3%**
35	**Low engineering productivity**	**0**	**5**	**0**	**0**	**0**	**0**	**1**	**2**	**2**	**0**	**33.3%**	**64.0%**	**21.3%**
36	**Bad staff for site management**	**0**	**4**	**1**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**37.8%**	**72.0%**	**27.2%**
37	**Bad or insufficient organization for material management**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**24.4%**	**80.0%**	**19.6%**
38	**Bad site stores management**	**0**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**5**	**0**	**51.1%**	**80.0%**	**40.9%**

39	**Suppliers bid greater than estimate**	**0**	**4**	**1**	**0**	**0**	**0**	**0**	**2**	**1**	**2**	**37.8%**	**80.0%**	**30.2%**
40	**Bad selection of sub-contractors**	**1**	**2**	**2**	**0**	**0**	**1**	**1**	**1**	**2**	**0**	**37.8%**	**56.0%**	**21.2%**
41	**Lack of communication between different parties(client , consultant , contractor)**	**2**	**2**	**0**	**1**	**0**	**0**	**0**	**2**	**2**	**1**	**33.3%**	**76.0%**	**25.3%**
42	**Bad coordination between sub-contractors**	**1**	**2**	**2**	**0**	**0**	**1**	**0**	**1**	**3**	**0**	**37.8%**	**64.0%**	**24.2%**
43	**Bad of construction tasks definition**	**1**	**2**	**1**	**1**	**0**	**1**	**0**	**0**	**4**	**0**	**42.2%**	**68.0%**	**28.7%**
44	**Earnings volatility (revenue)**	**4**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**3**	**0**	**20.0%**	**60.0%**	**12.0%**
45	**Reputation risk (company defamation)**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**2**	**1**	**2**	**37.8%**	**80.0%**	**30.2%**
46	**Bad planning for labor resources**	**1**	**4**	**0**	**0**	**0**	**1**	**2**	**2**	**0**	**0**	**28.9%**	**44.0%**	**12.7%**
47	**Bad identification of equipment and material**	**3**	**2**	**0**	**0**	**0**	**1**	**2**	**0**	**2**	**0**	**20.0%**	**52.0%**	**10.4%**
48	**Shortages of qualified labors**	**0**	**3**	**1**	**1**	**0**	**0**	**1**	**0**	**3**	**1**	**46.7%**	**76.0%**	**35.5%**
49	**Shortages of equipment**	**2**	**2**	**1**	**0**	**0**	**1**	**0**	**2**	**2**	**0**	**28.9%**	**60.0%**	**17.3%**
50	**Low productivity of labors**	**1**	**0**	**3**	**1**	**0**	**0**	**0**	**2**	**2**	**1**	**51.1%**	**76.0%**	**38.8%**
51	**Low productivity of equipment**	**0**	**3**	**2**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**42.2%**	**60.0%**	**25.3%**
52	**Delay in materials delivery**	**0**	**1**	**4**	**0**	**0**	**0**	**2**	**3**	**0**	**0**	**51.1%**	**52.0%**	**26.6%**
53	**Increase of material waste**	**2**	**2**	**1**	**0**	**0**	**2**	**1**	**2**	**0**	**0**	**28.9%**	**40.0%**	**11.6%**
54	**Defective materials**	**0**	**3**	**1**	**1**	**0**	**0**	**0**	**3**	**2**	**0**	**46.7%**	**68.0%**	**31.7%**
55	**Slow manufacturing process**	**2**	**0**	**3**	**0**	**0**	**2**	**0**	**1**	**2**	**0**	**37.8%**	**52.0%**	**19.6%**
56	**Bad vendor performance**	**1**	**2**	**2**	**0**	**0**	**1**	**2**	**0**	**2**	**0**	**37.8%**	**52.0%**	**19.6%**
57	**Vendor-labor problems**	**3**	**1**	**1**	**0**	**0**	**1**	**2**	**2**	**0**	**0**	**24.4%**	**44.0%**	**10.8%**
58	**Subcontractor default**	**1**	**1**	**1**	**2**	**0**	**1**	**2**	**2**	**0**	**0**	**51.1%**	**44.0%**	**22.5%**
59	**Construction mistakes**	**0**	**3**	**2**	**0**	**0**	**0**	**1**	**4**	**0**	**0**	**42.2%**	**56.0%**	**23.6%**
		1	**2**	**1**	**0**	**0**	**1**	**1**	**1**	**2**	**0**	**40.9%**	**61.6%**	**25.2%**

Risk Score for All Company

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					Total P.O.A	Total I.O.R	Risk Score
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	8	11	12	1	2	6	12	11	3	2	37.1%	2.5	0.9
2	Weather effect on the project	0	5	3	14	12	0	5	1	18	10	69.4%	4.0	2.8
3	Difficult site access	10	11	10	2	1	5	12	12	3	2	34.1%	2.6	0.9
4	Insufficient site information (include site access, definitions of site boundaries)	17	6	7	4	0	9	13	6	6	0	28.8%	2.3	0.7
5	Increase in material price	0	4	15	10	5	0	4	9	16	5	59.4%	3.6	2.2
6	Increase in labor price	2	14	11	4	3	1	14	9	7	3	45.3%	2.9	1.3
7	Currency fluctuation (foreign exchange rate)	2	6	17	6	3	3	6	11	11	3	51.2%	3.1	1.6
1	High design criteria	0	7	13	7	7	0	8	13	11	2	58.2%	3.2	1.9
2	High quality control standard	2	6	5	9	12	2	6	10	12	4	63.5%	3.3	2.1
3	Delay of tender offer evaluation and purchase order cycle	2	8	8	11	5	3	7	9	13	2	55.3%	3.1	1.7
4	Delay of government permits	4	16	9	2	3	4	11	13	4	2	40.6%	2.7	1.1
5	Owner cancellation of project	26	3	3	1	1	16	5	5	4	4	19.4%	2.3	0.4
6	Owner suspending or delaying the project	15	12	5	1	1	9	8	9	5	3	27.1%	2.6	0.7
7	Cost over-run (bad initial cost estimation)	6	12	11	2	3	5	1	18	8	2	40.6%	3.0	1.2
8	Project financing availability (debts & delayed payment on contract)	4	9	18	1	2	2	7	19	3	3	42.9%	2.9	1.3
9	Bad management of project budget	11	8	8	4	3	4	5	10	8	7	38.2%	3.3	1.2
10	Inaccurate (inadequate) specifications	10	17	2	2	3	9	13	3	5	4	32.9%	2.5	0.8

11	**Uncompleted design at start of site work**	**3**	**9**	**15**	**5**	**2**	**2**	**16**	**7**	**7**	**2**	46.5%	2.7	1.3
12	**Delay of engineering designs during work**	**3**	**12**	**7**	**9**	**3**	**2**	**11**	**8**	**11**	**2**	48.2%	3.0	1.4
13	**Design changes during construction**	**3**	**9**	**11**	**9**	**2**	**2**	**9**	**7**	**15**	**1**	48.8%	3.1	1.5
14	**Design errors**	**7**	**4**	**16**	**3**	**4**	**5**	**5**	**8**	**11**	**5**	45.9%	3.2	1.5
15	**Lack of engineering resource qualifications and pool depth**	**10**	**15**	**4**	**4**	**1**	**8**	**10**	**9**	**6**	**1**	32.9%	2.5	0.8
16	**Bad quality control**	**16**	**11**	**5**	**1**	**1**	**12**	**6**	**7**	**8**	**1**	26.5%	2.4	0.6
17	**Bad application of safety**	**17**	**6**	**8**	**1**	**2**	**9**	**6**	**14**	**3**	**2**	29.4%	2.5	0.7
18	**Bad site management process**	**17**	**8**	**6**	**2**	**1**	**11**	**5**	**8**	**9**	**1**	27.6%	2.5	0.7
19	**Bad management for project records**	**13**	**12**	**7**	**1**	**1**	**7**	**9**	**7**	**10**	**1**	29.4%	2.7	0.8
20	**Project duration (schedule is too short for the required activities**	**3**	**11**	**9**	**7**	**4**	**3**	**4**	**5**	**18**	**4**	48.8%	3.5	1.7
21	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**8**	**13**	**6**	**7**	**0**	**5**	**12**	**10**	**7**	57.1%	3.6	2.0
22	**Delay in performing inspection &testing by the consultant**	**1**	**3**	**21**	**4**	**5**	**1**	**3**	**15**	**10**	**5**	55.3%	3.4	1.9
23	**The conflict between the contractor and the consultant**	**1**	**6**	**12**	**9**	**6**	**2**	**3**	**9**	**12**	**8**	57.6%	3.6	2.1
1	**Bad start-up plan**	**4**	**22**	**4**	**2**	**2**	**3**	**7**	**12**	**8**	**4**	35.9%	3.1	1.1
2	**Delay of mobilization**	**4**	**12**	**11**	**5**	**2**	**3**	**11**	**7**	**9**	**4**	43.5%	3.0	1.3
3	**Commitment to the schedule (delay due to contactor)**	**0**	**6**	**15**	**12**	**1**	**0**	**5**	**20**	**8**	**1**	54.7%	3.1	1.7
4	**Pay liquidate damage**	**7**	**7**	**14**	**3**	**3**	**7**	**5**	**8**	**5**	**9**	42.9%	3.1	1.3
5	**Low engineering productivity**	**7**	**14**	**10**	**1**	**2**	**7**	**7**	**11**	**8**	**1**	36.5%	2.7	1.0
6	**Bad staff for site management**	**8**	**13**	**12**	**1**	**0**	**5**	**5**	**15**	**9**	**0**	33.5%	2.8	0.9
7	**Bad or insufficient organization for material management**	**15**	**11**	**6**	**1**	**1**	**8**	**8**	**6**	**10**	**2**	27.6%	2.7	0.7
8	**Bad site stores management**	**6**	**13**	**11**	**4**	**0**	**4**	**7**	**7**	**16**	**0**	37.6%	3.0	1.1

9	**Suppliers bid greater than estimate**	**3**	**14**	**12**	**4**	**1**	**2**	**7**	**13**	**6**	**6**	41.8%	3.2	1.3
10	**Bad selection of sub-contractors**	**5**	**10**	**12**	**7**	**0**	**3**	**10**	**8**	**10**	**3**	42.4%	3.0	1.3
11	**Lack of communication between different parties(client , consultant , contractor)**	**5**	**17**	**5**	**5**	**2**	**1**	**12**	**8**	**8**	**5**	39.4%	3.1	1.2
12	**Bad coordination between sub-contractors**	**5**	**12**	**11**	**5**	**1**	**4**	**7**	**11**	**11**	**1**	41.2%	2.9	1.2
13	**Bad of construction tasks definition**	**8**	**13**	**8**	**5**	**0**	**6**	**8**	**7**	**12**	**1**	35.9%	2.8	1.0
14	**Earnings volatility (revenue)**	**14**	**11**	**6**	**2**	**1**	**9**	**11**	**4**	**9**	**1**	29.4%	2.5	0.7
15	**Reputation risk (company defamation)**	**5**	**10**	**14**	**4**	**1**	**4**	**4**	**9**	**10**	**7**	41.8%	3.4	1.4
1	**Bad planning for labor resources**	**9**	**21**	**3**	**1**	**0**	**5**	**16**	**9**	**3**	**1**	27.6%	2.4	0.7
2	**Bad identification of equipment and material**	**12**	**16**	**5**	**1**	**0**	**4**	**14**	**6**	**10**	**0**	27.1%	2.6	0.7
3	**Shortages of qualified labors**	**5**	**13**	**12**	**4**	**0**	**3**	**11**	**4**	**13**	**3**	38.8%	3.1	1.2
4	**Shortages of equipment**	**7**	**11**	**14**	**2**	**0**	**4**	**8**	**10**	**12**	**0**	36.5%	2.9	1.1
5	**Low productivity of labors**	**5**	**10**	**16**	**3**	**0**	**3**	**9**	**10**	**10**	**2**	40.0%	3.0	1.2
6	**Low productivity of equipment**	**5**	**19**	**10**	**0**	**0**	**4**	**17**	**6**	**7**	**0**	32.9%	2.5	0.8
7	**Delay in materials delivery**	**2**	**11**	**17**	**4**	**0**	**1**	**10**	**14**	**7**	**2**	43.5%	3.0	1.3
8	**Increase of material waste**	**8**	**20**	**6**	**0**	**0**	**5**	**15**	**11**	**2**	**1**	28.8%	2.4	0.7
9	**Defective materials**	**7**	**18**	**8**	**1**	**0**	**4**	**11**	**11**	**7**	**1**	31.8%	2.7	0.9
10	**Slow manufacturing process**	**13**	**9**	**11**	**1**	**0**	**12**	**9**	**4**	**8**	**1**	30.0%	2.3	0.7
11	**Bad vendor performance**	**4**	**9**	**21**	**0**	**0**	**3**	**8**	**16**	**6**	**1**	40.0%	2.8	1.1
12	**Vendor-labor problems**	**10**	**13**	**11**	**0**	**0**	**4**	**12**	**17**	**1**	**0**	30.6%	2.4	0.7
13	**Subcontractor default**	**4**	**9**	**15**	**6**	**0**	**3**	**9**	**14**	**6**	**2**	43.5%	2.9	1.2
14	**Construction mistakes**	**3**	**11**	**20**	**0**	**0**	**2**	**5**	**21**	**5**	**1**	40.0%	2.9	1.2
		7	**11**	**10**	**4**	**2**	**4**	**8**	**10**	**9**	**3**	40%	2.9	1.2

Risk Score for Company (1)

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					P.I	I.I	Risk Score
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	4	2	5	0	2	2	4	5	0	2	40.8%	2.7	1.1
2	Weather effect on the project	0	5	2	3	3	0	5	1	4	3	56.2%	3.4	1.9
3	Difficult site access	4	4	2	2	1	2	6	3	1	1	37.7%	2.5	0.9
4	Insufficient site information (include site access, definitions of site boundaries)	6	2	3	2	0	4	4	3	2	0	31.5%	2.2	0.7
5	Increase in material price	0	1	5	4	3	0	1	4	5	3	63.8%	3.8	2.4
6	Increase in labor price	1	1	7	1	3	1	1	6	2	3	56.2%	3.4	1.9
7	Currency fluctuation (foreign exchange rate)	1	4	5	2	1	1	3	3	5	1	46.9%	3.2	1.5
8	High design criteria	0	4	5	2	2	0	5	6	1	1	53.1%	2.8	1.5
9	High quality control standard	2	4	2	3	2	2	4	4	2	1	48.5%	2.7	1.3
10	Delay of tender offer evaluation and purchase order cycle	1	3	2	4	3	1	3	3	5	1	57.7%	3.2	1.8
11	Delay of government permits	1	6	3	0	3	1	6	3	1	2	46.9%	2.8	1.3
12	Owner cancellation of project	8	0	3	1	1	5	2	2	3	1	30.0%	2.5	0.7
13	Owner suspending or delaying the project	6	4	2	0	1	4	3	3	2	1	28.5%	2.5	0.7
14	Cost over-run (bad initial cost estimation)	2	4	3	2	2	2	0	6	4	1	46.9%	3.2	1.5
15	Project financing availability (debts & delayed payment on contract)	1	2	9	0	1	1	1	10	0	1	46.9%	2.9	1.4
16	Bad management of project budget	1	3	7	1	1	0	2	8	2	1	46.9%	3.2	1.5
17	Inaccurate (inadequate) specifications	4	6	2	0	1	3	7	1	1	1	31.5%	2.2	0.7

18	Uncompleted design at start of site work	2	5	5	0	1	1	8	3	0	1	39.2%	2.4	0.9
19	Delay of engineering designs during work	0	6	4	1	2	0	5	5	2	1	48.5%	2.9	1.4
20	Design changes during construction	2	3	5	1	2	1	4	3	4	1	46.9%	3.0	1.4
21	Design errors	1	2	6	1	3	1	3	4	2	3	54.6%	3.2	1.8
22	Lack of engineering resource qualifications and pool depth	1	7	2	2	1	1	6	3	2	1	42.3%	2.7	1.1
23	Bad quality control	4	5	3	1	0	3	3	3	4	0	31.5%	2.6	0.8
24	Bad application of safety	4	2	6	1	0	2	3	7	1	0	36.2%	2.5	0.9
25	Bad site management process	6	3	3	1	0	5	2	4	2	0	28.5%	2.2	0.6
26	Bad management for project records	4	6	2	0	1	2	7	1	2	1	31.5%	2.5	0.8
27	Project duration (schedule is too short for the required activities	0	4	3	3	3	0	1	3	6	3	57.7%	3.8	2.2
28	Client delay in making decision or delay in approval of contractor’s submittals	0	1	4	3	5	0	1	3	4	5	68.5%	4.0	2.7
29	Delay in performing inspection &testing by the consultant	0	2	5	2	4	0	2	4	3	4	62.3%	3.7	2.3
30	The conflict between the contractor and the consultant	1	3	5	2	2	1	2	5	3	2	51.5%	3.2	1.7
31	Bad start-up plan	1	8	2	0	2	1	3	6	1	2	40.8%	3.0	1.2
32	Delay of mobilization	0	4	4	3	2	0	4	3	4	2	54.6%	3.3	1.8
33	Commitment to the schedule (delay due to contactor)	0	4	2	7	0	0	2	6	5	0	54.6%	3.2	1.8
34	Pay liquidate damage	1	3	4	2	3	1	1	3	4	4	54.6%	3.7	2.0
35	Low engineering productivity	2	3	5	1	2	2	3	4	3	1	46.9%	2.8	1.3
36	Bad staff for site management	2	4	7	0	0	2	3	7	1	0	37.7%	2.5	1.0
37	Bad or insufficient organization for material management	5	4	3	0	1	5	1	4	2	1	31.5%	2.5	0.8
38	Bad site stores management	2	5	4	2	0	2	4	3	4	0	39.2%	2.7	1.1

39	Suppliers bid greater than estimate	1	6	5	1	0	1	4	7	0	1	39.2%	2.7	1.1
40	Bad selection of sub-contractors	2	3	5	3	0	1	4	4	4	0	43.8%	2.8	1.2
41	Lack of communication between different parties(client , consultant , contractor)	1	8	1	1	2	0	8	2	2	1	42.3%	2.7	1.1
42	Bad coordination between sub-contractors	2	4	5	1	1	2	4	4	2	1	42.3%	2.7	1.1
43	Bad of construction tasks definition	1	4	5	3	0	1	3	5	4	0	45.4%	2.9	1.3
44	Earnings volatility (revenue)	4	5	1	2	1	3	4	2	3	1	36.2%	2.6	0.9
45	Reputation risk (company defamation)	3	4	3	2	1	3	1	3	4	2	40.8%	3.1	1.3
46	Bad planning for labor resources	4	8	1	0	0	2	10	1	0	0	25.4%	1.9	0.5
47	Bad identification of equipment and material	4	7	2	0	0	1	9	2	1	0	26.9%	2.2	0.6
48	Shortages of qualified labors	1	8	3	1	0	1	7	3	1	1	36.2%	2.5	0.9
49	Shortages of equipment	1	4	6	2	0	1	4	6	2	0	43.8%	2.7	1.2
50	Low productivity of labors	1	5	6	1	0	1	5	5	1	1	40.8%	2.7	1.1
51	Low productivity of equipment	1	11	1	0	0	1	9	2	1	0	30.0%	2.2	0.7
52	Delay in materials delivery	1	5	6	1	0	1	5	5	2	0	40.8%	2.6	1.1
53	Increase of material waste	2	9	2	0	0	2	6	4	1	0	30.0%	2.3	0.7
54	Defective materials	2	8	3	0	0	2	5	4	2	0	31.5%	2.5	0.8
55	Slow manufacturing process	6	5	2	0	0	6	4	1	2	0	23.8%	1.9	0.5
56	Bad vendor performance	2	1	10	0	0	2	1	9	1	0	42.3%	2.7	1.1
57	Vendor-labor problems	4	3	6	0	0	3	3	7	0	0	33.1%	2.3	0.8
58	Subcontractor default	2	3	7	1	0	2	3	8	0	0	40.8%	2.5	1.0
59	Construction mistakes	1	2	10	0	0	1	1	11	0	0	43.8%	2.8	1.2
		2	4	4	1	1	2	4	4	2	1	42.5%	2.8	1.2

Risk Score for Company (2)

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					P.I	I.I	Risk Score
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	1	5	4	1	0	1	5	3	2	0	39.1%	2.5	1.0
2	Weather effect on the project	0	0	1	6	4	0	0	0	8	3	75.5%	4.3	3.2
3	Difficult site access	2	5	4	0	0	2	3	4	2	0	33.6%	2.5	0.9
4	Insufficient site information (include site access, definitions of site boundaries)	6	2	2	1	0	3	5	2	1	0	26.4%	2.1	0.6
5	Increase in material price	0	2	4	3	2	0	1	2	6	2	59.1%	3.8	2.3
6	Increase in labor price	0	9	2	0	0	0	10	1	0	0	33.6%	2.1	0.7
7	Currency fluctuation (foreign exchange rate)	1	0	8	1	1	1	1	6	2	1	51.8%	3.1	1.6
8	High design criteria	0	2	4	3	2	0	2	4	4	1	59.1%	3.4	2.0
9	High quality control standard	0	1	1	4	5	0	0	3	5	3	73.6%	4.0	2.9
10	Delay of tender offer evaluation and purchase order cycle	1	4	2	4	0	1	3	3	4	0	46.4%	2.9	1.3
11	Delay of government permits	3	4	3	1	0	3	3	3	2	0	33.6%	2.4	0.8
12	Owner cancellation of project	9	2	0	0	0	8	2	1	0	0	13.6%	1.4	0.2
13	Owner suspending or delaying the project	5	5	0	1	0	4	4	2	1	0	24.5%	2.0	0.5
14	Cost over-run (bad initial cost estimation)	1	4	5	0	1	1	1	8	0	1	42.7%	2.9	1.2
15	Project financing availability (debts & delayed payment on contract)	1	4	4	1	1	0	4	4	2	1	44.5%	3.0	1.3
16	Bad management of project budget	3	2	1	3	2	2	2	0	2	5	48.2%	3.5	1.7
17	Inaccurate (inadequate) specifications	3	5	0	2	1	3	4	1	1	2	37.3%	2.5	0.9

18	**Uncompleted design at start of site work**	**0**	**0**	**5**	**5**	**1**	**0**	**1**	**4**	**5**	**1**	**62.7%**	**3.5**	**2.2**
19	**Delay of engineering designs during work**	**2**	**1**	**3**	**4**	**1**	**1**	**2**	**2**	**5**	**1**	**51.8%**	**3.3**	**1.7**
20	**Design changes during construction**	**0**	**4**	**3**	**4**	**0**	**0**	**3**	**2**	**6**	**0**	**50.0%**	**3.3**	**1.6**
21	**Design errors**	**2**	**1**	**5**	**2**	**1**	**2**	**1**	**1**	**5**	**2**	**48.2%**	**3.4**	**1.6**
22	**Lack of engineering resource qualifications and pool depth**	**5**	**2**	**2**	**2**	**0**	**5**	**1**	**2**	**3**	**0**	**31.8%**	**2.3**	**0.7**
23	**Bad quality control**	**7**	**2**	**1**	**0**	**1**	**7**	**1**	**1**	**1**	**1**	**24.5%**	**1.9**	**0.5**
24	**Bad application of safety**	**8**	**1**	**0**	**0**	**2**	**7**	**1**	**1**	**0**	**2**	**26.4%**	**2.0**	**0.5**
25	**Bad site management process**	**7**	**0**	**2**	**1**	**1**	**6**	**0**	**1**	**3**	**1**	**30.0%**	**2.4**	**0.7**
26	**Bad management for project records**	**7**	**1**	**2**	**1**	**0**	**5**	**0**	**3**	**3**	**0**	**24.5%**	**2.4**	**0.6**
27	**Project duration (schedule is too short for the required activities**	**3**	**3**	**1**	**3**	**1**	**3**	**2**	**0**	**5**	**1**	**42.7%**	**2.9**	**1.2**
28	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**2**	**4**	**3**	**2**	**0**	**2**	**3**	**4**	**2**	**59.1%**	**3.5**	**2.1**
29	**Delay in performing inspection &testing by the consultant**	**1**	**0**	**9**	**0**	**1**	**1**	**0**	**7**	**3**	**0**	**50.0%**	**3.1**	**1.5**
30	**The conflict between the contractor and the consultant**	**0**	**1**	**3**	**4**	**3**	**1**	**0**	**1**	**3**	**6**	**66.4%**	**4.2**	**2.8**
31	**Bad start-up plan**	**1**	**7**	**2**	**1**	**0**	**1**	**3**	**3**	**2**	**2**	**35.5%**	**3.1**	**1.1**
32	**Delay of mobilization**	**2**	**5**	**2**	**2**	**0**	**2**	**4**	**1**	**2**	**2**	**37.3%**	**2.8**	**1.1**
33	**Commitment to the schedule (delay due to contactor)**	**0**	**2**	**7**	**1**	**1**	**0**	**1**	**6**	**3**	**1**	**51.8%**	**3.4**	**1.7**
34	**Pay liquidate damage**	**4**	**2**	**5**	**0**	**0**	**4**	**1**	**4**	**0**	**2**	**31.8%**	**2.5**	**0.8**
35	**Low engineering productivity**	**5**	**5**	**1**	**0**	**0**	**5**	**3**	**1**	**2**	**0**	**22.7%**	**2.0**	**0.5**
36	**Bad staff for site management**	**5**	**3**	**2**	**1**	**0**	**3**	**2**	**3**	**3**	**0**	**28.2%**	**2.5**	**0.7**
37	**Bad or insufficient organization for material management**	**6**	**2**	**2**	**1**	**0**	**3**	**5**	**1**	**1**	**1**	**26.4%**	**2.3**	**0.6**
38	**Bad site stores management**	**4**	**3**	**4**	**0**	**0**	**2**	**3**	**2**	**4**	**0**	**30.0%**	**2.7**	**0.8**

39	Suppliers bid greater than estimate	2	3	5	1	0	1	2	3	2	3	39.1%	3.4	1.3
40	Bad selection of sub-contractors	1	4	3	3	0	1	3	2	2	3	44.5%	3.3	1.5
41	Lack of communication between different parties(client , consultant , contractor)	2	5	1	3	0	1	4	1	2	3	39.1%	3.2	1.2
42	Bad coordination between sub-contractors	1	5	1	4	0	1	3	4	3	0	44.5%	2.8	1.3
43	Bad of construction tasks definition	3	6	2	0	0	3	5	1	1	1	28.2%	2.3	0.6
44	Earnings volatility (revenue)	5	3	3	0	0	4	5	0	2	0	26.4%	2.0	0.5
45	Reputation risk (company defamation)	0	3	6	2	0	0	3	3	2	3	48.2%	3.5	1.7
46	Bad planning for labor resources	3	6	2	0	0	2	3	4	1	1	28.2%	2.6	0.7
47	Bad identification of equipment and material	4	5	2	0	0	2	3	3	3	0	26.4%	2.6	0.7
48	Shortages of qualified labors	3	2	5	1	0	2	2	0	6	1	37.3%	3.2	1.2
49	Shortages of equipment	3	3	5	0	0	2	3	1	5	0	33.6%	2.8	0.9
50	Low productivity of labors	2	5	3	1	0	2	4	0	5	0	35.5%	2.7	1.0
51	Low productivity of equipment	4	4	3	0	0	3	5	1	2	0	28.2%	2.2	0.6
52	Delay in materials delivery	1	4	4	2	0	0	3	3	3	2	42.7%	3.4	1.4
53	Increase of material waste	3	7	1	0	0	1	7	2	0	1	26.4%	2.4	0.6
54	Defective materials	4	6	1	0	0	2	6	1	1	1	24.5%	2.4	0.6
55	Slow manufacturing process	5	4	2	0	0	4	5	0	1	1	24.5%	2.1	0.5
56	Bad vendor performance	1	5	5	0	0	0	5	4	1	1	37.3%	2.8	1.1
57	Vendor-labor problems	2	7	2	0	0	0	7	3	1	0	30.0%	2.5	0.7
58	Subcontractor default	1	5	2	3	0	0	4	2	3	2	42.7%	3.3	1.4
59	Construction mistakes	2	4	5	0	0	1	3	5	1	1	35.5%	2.8	1.0
		3	3	3	1	1	2	3	2	3	1	38.9%	2.8	1.1

Risk Score for Company (3)

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					P.I	I.I	Risk Score
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	1	2	2	0	0	1	2	2	0	0	34.0%	2.2	0.7
2	Weather effect on the project	0	0	0	3	2	0	0	0	4	1	78.0%	4.2	3.3
3	Difficult site access	1	1	3	0	0	0	2	3	0	0	38.0%	2.6	1.0
4	Insufficient site information (include site access, definitions of site boundaries)	1	2	1	1	0	0	2	1	2	0	38.0%	3.0	1.1
5	Increase in material price	0	1	2	2	0	0	0	1	4	0	54.0%	3.8	2.1
6	Increase in labor price	1	1	1	2	0	0	2	1	2	0	46.0%	3.0	1.4
7	Currency fluctuation (foreign exchange rate)	0	1	2	2	0	0	1	2	2	0	54.0%	3.2	1.7
8	High design criteria	0	0	2	2	1	0	0	1	4	0	66.0%	3.8	2.5
9	High quality control standard	0	0	1	1	3	0	1	1	3	0	78.0%	3.4	2.7
10	Delay of tender offer evaluation and purchase order cycle	0	1	2	0	2	1	1	1	1	1	62.0%	3.0	1.9
11	Delay of government permits	0	2	2	1	0	0	1	4	0	0	46.0%	2.8	1.3
12	Owner cancellation of project	4	1	0	0	0	1	1	2	0	1	14.0%	2.8	0.4
13	Owner suspending or delaying the project	2	2	1	0	0	1	1	2	1	0	26.0%	2.6	0.7
14	Cost over-run (bad initial cost estimation)	2	1	2	0	0	1	0	0	4	0	30.0%	3.4	1.0
15	Project financing availability (debts & delayed payment on contract)	1	1	3	0	0	0	2	2	0	1	38.0%	3.0	1.1
16	Bad management of project budget	3	2	0	0	0	1	0	1	2	1	18.0%	3.4	0.6
17	Inaccurate (inadequate) specifications	2	3	0	0	0	2	1	1	1	0	22.0%	2.2	0.5

18	**Uncompleted design at start of site work**	**0**	**2**	**3**	**0**	**0**	**0**	**4**	**0**	**1**	**0**	**42.0%**	**2.4**	**1.0**
19	**Delay of engineering designs during work**	**0**	**3**	**0**	**2**	**0**	**0**	**2**	**1**	**2**	**0**	**46.0%**	**3.0**	**1.4**
20	**Design changes during construction**	**0**	**1**	**2**	**2**	**0**	**0**	**1**	**1**	**3**	**0**	**54.0%**	**3.4**	**1.8**
21	**Design errors**	**3**	**0**	**2**	**0**	**0**	**1**	**0**	**2**	**2**	**0**	**26.0%**	**3.0**	**0.8**
22	**Lack of engineering resource qualifications and pool depth**	**3**	**2**	**0**	**0**	**0**	**1**	**1**	**2**	**1**	**0**	**18.0%**	**2.6**	**0.5**
23	**Bad quality control**	**3**	**1**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**0**	**22.0%**	**2.6**	**0.6**
24	**Bad application of safety**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**26.0%**	**3.0**	**0.8**
25	**Bad site management process**	**2**	**3**	**0**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**22.0%**	**3.0**	**0.7**
26	**Bad management for project records**	**0**	**4**	**1**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**34.0%**	**3.0**	**1.0**
27	**Project duration (schedule is too short for the required activities**	**0**	**2**	**2**	**1**	**0**	**0**	**1**	**0**	**4**	**0**	**46.0%**	**3.6**	**1.7**
28	**Client delay in making decision or delay in approval of contractor's submittals**	**0**	**4**	**1**	**0**	**0**	**0**	**2**	**3**	**0**	**0**	**34.0%**	**2.6**	**0.9**
29	**Delay in performing inspection &testing by the consultant**	**0**	**1**	**4**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**46.0%**	**3.0**	**1.4**
30	**The conflict between the contractor and the consultant**	**0**	**2**	**1**	**1**	**1**	**0**	**1**	**2**	**2**	**0**	**54.0%**	**3.2**	**1.7**
31	**Bad start-up plan**	**1**	**3**	**0**	**1**	**0**	**0**	**1**	**1**	**3**	**0**	**34.0%**	**3.4**	**1.2**
32	**Delay of mobilization**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**34.0%**	**3.0**	**1.0**
33	**Commitment to the schedule (delay due to contactor)**	**0**	**0**	**4**	**1**	**0**	**0**	**1**	**4**	**0**	**0**	**54.0%**	**2.8**	**1.5**
34	**Pay liquidate damage**	**1**	**1**	**2**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**42.0%**	**3.0**	**1.3**
35	**Low engineering productivity**	**0**	**1**	**4**	**0**	**0**	**0**	**0**	**4**	**1**	**0**	**46.0%**	**3.2**	**1.5**
36	**Bad staff for site management**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**3**	**2**	**0**	**34.0%**	**3.4**	**1.2**
37	**Bad or insufficient organization for material management**	**2**	**2**	**1**	**0**	**0**	**0**	**2**	**1**	**2**	**0**	**26.0%**	**3.0**	**0.8**
38	**Bad site stores management**	**0**	**3**	**1**	**1**	**0**	**0**	**0**	**2**	**3**	**0**	**42.0%**	**3.6**	**1.5**

39	Suppliers bid greater than estimate	0	1	1	2	1	0	1	1	3	0	62.0%	3.4	2.1
40	Bad selection of sub-contractors	1	1	2	1	0	0	2	1	2	0	42.0%	3.0	1.3
41	Lack of communication between different parties(client , consultant , contractor)	0	2	3	0	0	0	0	3	2	0	42.0%	3.4	1.4
42	Bad coordination between sub-contractors	1	1	3	0	0	0	0	2	3	0	38.0%	3.6	1.4
43	Bad of construction tasks definition	3	1	0	1	0	1	0	1	3	0	26.0%	3.2	0.8
44	Earnings volatility (revenue)	1	3	1	0	0	1	1	2	1	0	30.0%	2.6	0.8
45	Reputation risk (company defamation)	1	1	3	0	0	1	0	1	3	0	38.0%	3.2	1.2
46	Bad planning for labor resources	1	3	0	1	0	0	1	2	2	0	34.0%	3.2	1.1
47	Bad identification of equipment and material	1	2	1	1	0	0	0	1	4	0	38.0%	3.8	1.4
48	Shortages of qualified labors	1	0	3	1	0	0	1	1	3	0	46.0%	3.4	1.6
49	Shortages of equipment	1	2	2	0	0	0	1	1	3	0	34.0%	3.4	1.2
50	Low productivity of labors	1	0	4	0	0	0	0	3	2	0	42.0%	3.4	1.4
51	Low productivity of equipment	0	1	4	0	0	0	1	2	2	0	46.0%	3.2	1.5
52	Delay in materials delivery	0	1	3	1	0	0	0	3	2	0	50.0%	3.4	1.7
53	Increase of material waste	1	2	2	0	0	0	1	3	1	0	34.0%	3.0	1.0
54	Defective materials	1	1	3	0	0	0	0	3	2	0	38.0%	3.4	1.3
55	Slow manufacturing process	0	0	4	1	0	0	0	2	3	0	54.0%	3.6	1.9
56	Bad vendor performance	0	1	4	0	0	0	0	3	2	0	46.0%	3.4	1.6
57	Vendor-labor problems	1	2	2	0	0	0	0	5	0	0	34.0%	3.0	1.0
58	Subcontractor default	0	0	5	0	0	0	0	2	3	0	50.0%	3.6	1.8
59	Construction mistakes	0	2	3	0	0	0	0	1	4	0	42.0%	3.8	1.6
		1	2	2	1	0	0	1	2	2	0	40.5%	3.2	1.3

Risk Score for Company (4)

Item number	Risk Factors	Total Of P.O.ACC					Total of I.O.R					P.I	I.I	Risk Score
		Rare	Low	Moderate	Frequent	High	Unsignificant	Low	Medium	High	Catastrophic			
		10%	30%	50%	70%	90%	1	2	3	4	5			
1	Environmental impact of the project	2	2	1	0	0	2	1	1	1	0	26.0%	2.2	0.6
2	Weather effect on the project	0	0	0	2	3	0	0	0	2	3	82.0%	4.6	3.8
3	Difficult site access	3	1	1	0	0	1	1	2	0	1	22.0%	2.8	0.6
4	Insufficient site information (include site access, definitions of site boundaries)	4	0	1	0	0	2	2	0	1	0	18.0%	2.0	0.4
5	Increase in material price	0	0	4	1	0	0	2	2	1	0	54.0%	2.8	1.5
6	Increase in labor price	0	3	1	1	0	0	1	1	3	0	42.0%	3.4	1.4
7	Currency fluctuation (foreign exchange rate)	0	1	2	1	1	1	1	0	2	1	58.0%	3.2	1.9
8	High design criteria	0	1	2	0	2	0	1	2	2	0	62.0%	3.2	2.0
9	High quality control standard	0	1	1	1	2	0	1	2	2	0	66.0%	3.2	2.1
10	Delay of tender offer evaluation and purchase order cycle	0	0	2	3	0	0	0	2	3	0	62.0%	3.6	2.2
11	Delay of government permits	0	4	1	0	0	0	1	3	1	0	34.0%	3.0	1.0
12	Owner cancellation of project	5	0	0	0	0	2	0	0	1	2	10.0%	3.2	0.3
13	Owner suspending or delaying the project	2	1	2	0	0	0	0	2	1	2	30.0%	4.0	1.2
14	Cost over-run (bad initial cost estimation)	1	3	1	0	0	1	0	4	0	0	30.0%	2.6	0.8
15	Project financing availability (debts & delayed payment on contract)	1	2	2	0	0	1	0	3	1	0	34.0%	2.8	1.0
16	Bad management of project budget	4	1	0	0	0	1	1	1	2	0	14.0%	2.8	0.4

17	Inaccurate (inadequate) specifications	1	3	0	0	1	1	1	0	2	1	38.0%	3.2	1.2
18	Uncompleted design at start of site work	1	2	2	0	0	1	3	0	1	0	34.0%	2.2	0.7
19	Delay of engineering designs during work	1	2	0	2	0	1	2	0	2	0	42.0%	2.6	1.1
20	Design changes during construction	1	1	1	2	0	1	1	1	2	0	46.0%	2.8	1.3
21	Design errors	1	1	3	0	0	1	1	1	2	0	38.0%	2.8	1.1
22	Lack of engineering resource qualifications and pool depth	1	4	0	0	0	1	2	2	0	0	26.0%	2.2	0.6
23	Bad quality control	2	3	0	0	0	1	1	1	2	0	22.0%	2.8	0.6
24	Bad application of safety	3	1	1	0	0	0	0	5	0	0	22.0%	3.0	0.7
25	Bad site management process	2	2	1	0	0	0	1	2	2	0	26.0%	3.2	0.8
26	Bad management for project records	2	1	2	0	0	0	0	2	3	0	30.0%	3.6	1.1
27	Project duration (schedule is too short for the required activities	0	2	3	0	0	0	0	2	3	0	42.0%	3.6	1.5
28	Client delay in making decision or delay in approval of contractor’s submittals	0	1	4	0	0	0	0	3	2	0	46.0%	3.4	1.6
29	Delay in performing inspection &testing by the consultant	0	0	3	2	0	0	0	1	3	1	58.0%	4.0	2.3
30	The conflict between the contractor and the consultant	0	0	3	2	0	0	0	1	4	0	58.0%	3.8	2.2
31	Bad start-up plan	1	4	0	0	0	1	0	2	2	0	26.0%	3.0	0.8
32	Delay of mobilization	1	1	3	0	0	1	2	0	2	0	38.0%	2.6	1.0
33	Commitment to the schedule (delay due to contactor)	0	0	2	3	0	0	1	4	0	0	62.0%	2.8	1.7
34	Pay liquidate damage	1	1	3	0	0	1	2	0	0	2	38.0%	3.0	1.1
35	Low engineering productivity	0	5	0	0	0	0	1	2	2	0	30.0%	3.2	1.0
36	Bad staff for site management	0	4	1	0	0	0	0	2	3	0	34.0%	3.6	1.2
37	Bad or insufficient organization for material management	2	3	0	0	0	0	0	0	5	0	22.0%	4.0	0.9

38	Bad site stores management	0	2	2	1	0	0	0	0	5	0	46.0%	4.0	1.8
39	Suppliers bid greater than estimate	0	4	1	0	0	0	0	2	1	2	34.0%	4.0	1.4
40	Bad selection of sub-contractors	1	2	2	0	0	1	1	1	2	0	34.0%	2.8	1.0
41	Lack of communication between different parties(client , consultant , contractor)	2	2	0	1	0	0	0	2	2	1	30.0%	3.8	1.1
42	Bad coordination between sub-contractors	1	2	2	0	0	1	0	1	3	0	34.0%	3.2	1.1
43	Bad of construction tasks definition	1	2	1	1	0	1	0	0	4	0	38.0%	3.4	1.3
44	Earnings volatility (revenue)	4	0	1	0	0	1	1	0	3	0	18.0%	3.0	0.5
45	Reputation risk (company defamation)	1	2	2	0	0	0	0	2	1	2	34.0%	4.0	1.4
46	Bad planning for labor resources	1	4	0	0	0	1	2	2	0	0	26.0%	2.2	0.6
47	Bad identification of equipment and material	3	2	0	0	0	1	2	0	2	0	18.0%	2.6	0.5
48	Shortages of qualified labors	0	3	1	1	0	0	1	0	3	1	42.0%	3.8	1.6
49	Shortages of equipment	2	2	1	0	0	1	0	2	2	0	26.0%	3.0	0.8
50	Low productivity of labors	1	0	3	1	0	0	0	2	2	1	46.0%	3.8	1.7
51	Low productivity of equipment	0	3	2	0	0	0	2	1	2	0	38.0%	3.0	1.1
52	Delay in materials delivery	0	1	4	0	0	0	2	3	0	0	46.0%	2.6	1.2
53	Increase of material waste	2	2	1	0	0	2	1	2	0	0	26.0%	2.0	0.5
54	Defective materials	0	3	1	1	0	0	0	3	2	0	42.0%	3.4	1.4
55	Slow manufacturing process	2	0	3	0	0	2	0	1	2	0	34.0%	2.6	0.9
56	Bad vendor performance	1	2	2	0	0	1	2	0	2	0	34.0%	2.6	0.9
57	Vendor-labor problems	3	1	1	0	0	1	2	2	0	0	22.0%	2.2	0.5
58	Subcontractor default	1	1	1	2	0	1	2	2	0	0	46.0%	2.2	1.0
59	Construction mistakes	0	3	2	0	0	0	1	4	0	0	38.0%	2.8	1.1
		1	2	1	0	0	1	1	1	2	0	36.8%	3.1	1.1