A STUDY OF RISK MANAGEMENT ON CONSTRUCTION PROJECTS SUCCESS IN QATAR

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
OSAID ALLAH GAFAR AHMED YOUSEF

In Partial Fulfillment of the Requirements for the Degree of Master of Science In Civil Engineering

NICOSIA, 2017

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Approval of Director of Graduate School of Applied Sciences

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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To my Dad and Mum...

ABSTRACT

This thesis is about a study of risk management on construction projects success in the State of Qatar. The aim of the study is to gain understanding of 58 risk factors which are classify in 7 groups. The study also aims to explore the effectiveness of both mitigative and preventive methods. In addition, to examine the usage of risk analysis techniques in construction projects in the State of Qatar.

A closed-ended method of questionnaire with interviews was used to fulfil the objectives of the study. One hundred questionnaires were distributed to the specialists in the construction projects, including consultants, owners, contractors and sub-contractors. SPSS where used to analyze the data. Participants responses concluded that the five most important risk factors are: the sanctions, departure of key staff during the project, financial failure of the owner, delayed payments to the contractor and lack of design coordination between the disciplines. These significant risk factors are mainly related to political and governmental, construction, financial and design groups respectively.

The study found that most of the owners and the contractors suffer from the lack of knowledge about ways of mitigate and prevent risks. In addition, they do not use risk analysis techniques but depend usually on subjective judgment using experience in estimating time and cost.

The study recommended that there is needs for more to be done to eradicate the problems associated with poorly managed construction projects. Consequently, contractors and owners should take the responsibility to manage their relevant risk factors and work from the feasibility stage onwards to address potential risk factors in time.

Keywords: Risk management; risk factors; construction project management; State of Qatar; risks

ÖZET

Bu tez, Katar Devleti'ndeki inşaat projelerinin başarısı konusunda bir risk yönetimi çalışmasıdır. Çalışmanın amacı 7 grupta sınıflandırılan 58 risk faktörünün anlaşılmasını sağlamaktır. Çalışma aynı zamanda hem hafifletici hem de önleyici yöntemlerin etkinliğini araştırmayı amaçlamaktadır. Buna ek olarak, Katar Devleti'ndeki inşaat projelerinde risk analiz tekniklerinin kullanımını incelemeyi amaçlamaktadır

Çalışmanın amaçlarını yerine getirmek için kapalı uçlu bir anket yöntemi ile görüşmeler yapılmıştır. Yüz anket danışmanlık, mülk sahipleri, müteahhitler ve taşeronlar dahil olmak üzere inşaat projelerindeki uzmanlara dağıtılmıştır. Veri analizinde SPSS kullanılmıştır. Katılımcı cevapları sayesinde yaptırımlar, proje sırasında kilit personelin ayrılması, sahibinin mali başarısızlığı, yükleniciye gecikmiş ödemeler ve disiplinler arasında tasarım koordinasyon eksikliği olmak üzere beş önemli risk faktörü olduğu sonucuna varılmıştır. Bu önemli risk faktörleri sırasıyla siyasi ve devlet, inşaat, finans ve tasarım gruplarıyla ilgilidir.

Çalışma, sahiplerin ve yüklenicilerin çoğunun hafifletme ve riskleri önleme yolları hakkında bilgi eksikliği bulunduğu sonucuna ulaşmıştır. Buna ek olarak, risk analiz teknikleri kullanmadıkları ancak zaman ve maliyet tahmininde tecrübeyi kullanan öznel yargıya göre hareket ettikleri bulunmuştur.

Çalışma, kötü yönetilen inşaat projeleri ile ilgili sorunları ortadan kaldırmak için daha fazla hareketin gerektiğini belirtmiştir. Dolayısıyla, yükleniciler ve sahipler ilgili risk faktörlerini yönetme sorumluluğunu almalı ve zaman içinde potansiyel risk faktörlerine hitap edebilmek için fizibilite aşamasından itibaren çalışmalıdır.

Anahtar Kelimeler: Risk yönetimi; risk faktörleri; inşaat proje yönetimi; Katar Devleti; riskler

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LIST OF ABBREVIATIONS

GDP:	Gross Domestic Product
USD:	United States Dollar
QER:	Qatar Economic Review
RM:	Risk Management
CTC:	Central Tenders Committee
IS:	Information System
IT:	Information Technology
NGT:	Nominal Group Technique
TOPSIS:	Technique for Order of Preference by Similarity to Ideal Solution
RII:	Relative Importance Index
RPN:	Risk Priority Number
PEL:	Political, Economic, and Legal
PMI:	Project Management Institute
ADB:	Asian Development Bank
PMBOK:	Project Management Body of Knowledge
APM:	Association for Project Management
SA:	Scenario Analysis
EV:	Expected Value
SPSS:	Statistical Package for Social Sciences

CHAPTER 1
INTRODUCTION

1.1. Introduction

This chapter contains some historical information about State of Qatar economy and construction projects due to the importance of such information to the core of this thesis. In addition, the chapter contains also problem of study, importance of research, objectives of the study, boundaries, hypothesis, research methodology and the thesis structure.

1.2. The Size of the Construction Sector & Economy

The construction sector has been one of the most important sectors that have witnessed very large growth in the State of Qatar, and also is expected to continue to growth significantly to the gross domestic product (GDP) and labor force employment. In 2003, this construction sector witnessed a growth of 3.6%, contributing (750 million USD) to the overall GDP (QER, 2004). This has led to Qatar witnessing a construction boom since 2006 (ongoing construction projects related contracts have tripled in value). Additionally, Qatar's successful bid to host the 2022 FIFA world cup led the government to plan for high levels of investment in infrastructure and real estate development - approximately USD 225 billion between 2011 and 2016, of which USD 125 billion has been unveiled for construction and energy projects alone. Spending directly related to preparations for the 2022 World Cup will amount to an estimated USD 80 billion, encompassing infrastructure projects and hundreds of new construction projects such as stadiums, hotels, residences, hospitals, airports, seaports and railways, among other infrastructure facilities (Construction Week, 2010). According to a study by Oxford Economics and Global Construction Perspectives, the Qatari construction sector is expected to grow by an average of 12.5% a year over the next decade, compared with growth in European countries averaging just 1.7% to 2020 (Qatar construction sector, 2012).

The State of Qatar has been one of the fastest growing economies in the world over the past 10 years. The level of investment and construction spending is expected to lead to a major boom in Qatar's construction sector. Additionally, the magnitude and complexity of planned projects, as is the case with most developing countries, will inevitably require the participation of major international construction RMS. It is most likely that many of these international contractors do not possess any practical experience or knowledge of the local construction industry, which may result in inflated bids to manage or mitigate any risk associated with venturing into an unknown and culturally different environment.

Notwithstanding that construction risk factors may be comparable across the globe, several variables pertaining to a local industry, such as socioeconomic, environment and cultural issues, can further contribute to unknown or unpredictable risks. Similar projects, moreover, may have totally different risk characteristics in different regions (Zhi, 1995).

In view of this challenge, the aim is to gain understanding of risks faced by construction projects in the State of Qatar.

1.3. Problem of Study

The construction projects in the State of Qatar is huge, complex and subject to a high level of risk, making the risk management (RM) is highly required and important. However, construction companies in the State of Qatar, lack the suitable methodologies to determine and evaluate risk factors and reliable approaches to reduce, mitigate or eliminate risks.

1.4. Importance of Research

- Viewing the importance of introducing the risk management in construction projects. In addition to identifies key risk factors and their effects on the projects.
- Risk management practice could be better, if its combined with strong project processes, to reduces costs, improves project quality, and speeds up schedules.
- Studying the relation between risk management and project's success is important because most of projects are operating in a very dynamic and rapidly changing environment not always fixed circumstances and uncertainty factors are surrounding the firm, in such environment adopting changes very quickly is a must for the project overall to grow or even survive.
- Seeking to evaluate the risk factors and better respond to these risks, and present methods that enhances projects risk management.

1.5. Research Objectives

The main objective of this research is to study the impact of risk management on construction projects success in the State of Qatar. The study also aims at:

- Identifying key risk factors that could stand in front of construction projects processes by reviewing the literature and through the additions that could be made by the project managers.
- Definition of risk management concepts and their practical applications.
- Investigating the severity and the allocation of each identified risk factor.
- Clarify the relationship between risk management and construction project success.
- Investigating management awareness of risk management, and applying their knowledge while managing these projects.
- Examining the risk management actions efficiency that are applied in the industry.
- Investigate the effectiveness of risk mitigation and preventive methods.
- Providing practical recommendations and suggestions that pointing toward improving the risk management process in construction and to improve the performance of construction companies and owners in this field.

1.6. Hypothesis

This study analyzed risk factors affecting the construction industry in the State of Qatar.

- With 32 risk factors prepared from literature and distributed into five groups. This research hypothesis was added more 26 risk factors and two more groups (management and construction). Therefore, is to identify, explore, rank the relative importance and determine the prevalent allocation response trends of the construction risk factors considered by projects managers in Qatar.

1.7. Research Boundaries

- The research was concerned with engineering offices and contracting companies in State of Qatar, that are specialists in various construction work.
- Only Classified Civil Engineering and building construction firms by the "Central

Tenders Committee" (CTC) in the State of Qatar, will be included by the study.

- Risk key-variables and the affected processes of projects by these variables will form the core of the study.

1.8. Data Sources

1.8.1. Main sources

In order to address the analytical framework of the study, structured questionnaire was distributed to the target group. Respondents were asked to provide opinions on the variables of this research.

1.8.2. Secondary sources

In order to address the theoretical framework of the study, these secondary resources included: reference books, reports, papers published in scientific journals and magazines, papers from scientific conferences, electronic newspapers articles, unpublished papers, thesis and dissertations that were obtained from universities websites, and some readings and reports from various websites that are related to the study topic.

1.9. Research Methodology

In this research, a quantitative approach was selected to determine the variables and factors that affect the risk management practices in construction projects in the State of Qatar to find out if there was a systematic risk management practices through the contracting companies.

1.10. The Thesis Structure

Six chapters were make up this thesis:

Chapter One: Consists of some historical information about Qatar economy and construction.

Chapter Two: Consists of literature review with some details that have topics are close to this research topic.

Chapter Three: Consists of some necessary definitions and details about the concepts and the practices of risk management in construction projects for full understanding of risk management concepts and practices.

Chapter Four: Consists of information about research strategy and the methodology that used in the research.

Chapter Five: In this chapter, the data analysis and findings of this research were discussed in details.

Chapter Six: Finally, included the conclusions and recommendations of this research.

CHAPTER 2
LITERATURE REVIEW

2.1. Related Researches

Through searching in references, books and on the internet, for the purpose of finding researches and studies that have topics that are close to this research topic, it has been found the following studies:

2.1.1. Edwards & Bowen's Study (1998) "Risk and risk management in construction: a review and future directions for research"

The study conducted an extensive literature review of construction risk management studies, which were published during the period from 1960 to 1997, to identify gaps and inconsistencies in the knowledge and treatment of construction risks.

The findings suggested that political, economic, financial and cultural risk factors deserved greater research attention, compared to factors associated with quality assurance, and occupational health and safety. Temporal aspects of risk, and risk communication, are also important fields for investigation.

2.1.2. Uher & Toakley's Study (1999) "Risk management in the conceptual phase of a project"

The study consisted of a literature review, a survey to examine skill levels and attitudes of key players to risk management, and their attitude to change. moreover, investigated various structural and cultural factors related to the implementation of risk management principles in the conceptual stage of a project life cycle.

They study concluded that while most industry practitioners were familiar with risk management:

- Its application in the conceptual phase is relatively low.
- Qualitative rather than quantitative methods are generally used.
- Risk management implementation was impeded by the shallow knowledge of its

principles.

2.1.3. Nabil Kartam & Saied Kartam's Study (2001) "Risk and its management in the Kuwaiti construction industry: a contractors' perspective"

The study focused on the assessment, allocation and management of construction risks. In addition, this study also presented two types of risk management methods:

- Preventive: Which are effective at the early stages of the project life.
- Mitigative: Which are remedial actions aimed at risk minimization during construction.

The study examined the issue of construction risk management in Kuwait, and found that:

- local contractors were often responsible for most risk factors.
- The implementation of formal risk analysis techniques for managing and controlling risks was limited.
- Contractors mainly relied on coordination with subcontractors, together with an increase of manpower and equipment, to mitigate most of the risks encountered during the construction process.

The study found that contractors show more willingness to accept risks that are contractual and legal-related rather than other types of risks. Also, the study indicated that the application of the formal risk analysis techniques in the Kuwaiti construction industry is limited.

2.1.4. Santoso et al.'s Study (2003) "Assessment of risks in high rise building construction in Jakarta"

The study aimed to identifies, ranks and categorizes high potential risks in high rise building projects in Jakarta. Questionnaire surveys and interviews were conducted on engineers from contracting firms in the city.

The result shows that risks related to management and design are the most significant in high rise construction projects. It is also shown that client interference should be avoided or reduced in tandem with good communication and teamwork between contractors and consultants to minimize defects. Contractors also need to give attention to the maintenance of equipment in order to sustain high productivity levels.

2.1.5. Ghosh & Jintanapakanont's Study (2004) "Identifying and assessing the critical risk factors in an underground rail project in Thailand: a factor analysis approach"

The study investigated the construction risk factors in large construction projects in Thailand, and reported, as most important, the following:

1. unavailability of funds.
2. construction delay.
3. financial failure of contractor.
4. unclear scope of work.
5. economic crisis.
6. delay in solving contractual issues.
7. delay in solving disputes.
8. third-party delays.
9. subcontractor failure.
10. subcontractor lack of adequate number of staff.

A survey questionnaire was conducted to isolate and assess the critical risk factors. consequently, the study identified and categorized the critical risk factors into nine major classes. These are:

- Financial.
- contractual and legal.
- Subcontractors.
- Safety.
- Design.
- force majeure.
- Physical.
- delay.
- operational.

2.1.6. Wiguna & Scott's Study (2005) "Nature of The Critical Risk Factors Affecting Project Performance in Indonesian Building Contracts"

The study aimed to collect information to allow the critical risk factors causing construction time and cost in building projects in Indonesia to be determined. The study was predominantly based on interviews with project managers using a structured questionnaire, which was designed to assess risk levels in terms of time and cost. It consisted of four risk factors in each of four major risk categories giving sixteen risk factors in all. A total of 22 building projects under construction in East Java and Bali provinces were surveyed.

The top critical risk factors affecting the performance of building construction in Indonesia, and determined the following as most critical:

1. High inflation of prices.
2. Defective design.
3. Design change by owner.
4. Delayed payments on contract.
5. Inclement weather.
6. Unforeseen site ground condition.
7. Poor cost control.
8. Defective construction work.
9. Delay in providing detail drawings.
10. Problems with availability of labor, material and equipment.

In addition, the study classified the construction risk factors into four major partitions:

- External and site conditions.
- Economic and financial risks.
- Technical and contractual risks.
- Managerial risks.

The researcher concluded that Most of these risk factors cannot be controlled or managed by the contractors and yet contractors working on most Indonesian construction contracts will be expected to accept the risks relating to inflation, delayed payments, defective construction work and to take some responsibility for adverse weather conditions. Quite what risks a contractor working in Indonesia will have to accept, however, it is not easy to say, as different owners adopt their own contract forms. It would be clearly being wise for any contractor working in this are to check how these most important risks are apportioned for contracts on which he intends to bid.

2.1.7. Enshassi & Abu Mosa's Study (2005) "Risk Management in Building Projects: Owners' Perspective"

The study aimed to identify the severity and allocation of each identified risk factor according to the owners' perspectives. The study investigated the risk factors impacting the performance of building construction in Palestine, and identified the following factors as most influential:

1. Financial failure of the contractor.
2. Working in dangerous areas.
3. Frequent border closure.
4. Defective design.
5. Delayed payments on contract.
6. Segmentation of Gaza strip.
7. Invasions.
8. Poor communications among project parties.
9. Unmanaged cash flow.
10. Awarding the design to unqualified designers.

In addition, the study categorized the risk factors into the following nine main groups:

- Physical.
- Environmental.
- Design.
- Logistics.
- Financial.
- Legal.
- Construction.

- Political.
- Management risks.

The study recommended that:

- Tenders should be awarded to accurate estimated cost and not necessarily to the lowest bidder. This could take the edge of high competition in bids and reduce risks' consequences by providing more profit margins for contractors.
- Exchange rate fluctuation should be considered as a risk factor by owners and donors and they should offer a compensation mechanism if there was any damage due to this risk.
- The contract clauses should be modified and improved to meet the impact of closure and segmentation of Gaza Strip and not to allocate the whole impacts on the contracting companies.
- Owners should conduct continuous training programs with cooperation with Palestinian contractors union to advance managerial and financial practices to explain the internal and external risk factors affecting the construction industry and to initiate the proper ways to deal with such factors.
- The design process is the most important phase in the construction process.
- Design products should be at the highest level of quality, because of that it should have more focus by owners.

2.1.8. Zou et al.'s Study (2007) "Understanding the key risks in construction projects in China"

The study investigated the key risk in construction projects in China in order to develop strategies to manage them. The researcher classifies the risk according to their significance of the influences of typical project objective in terms time, quality, safety and environmental sustainability, and then to investigate from the stakeholder's perspective. The researcher achieved his goal and collected data by questionnaire survey, total 25 key risks were ascertained. And then the researchers compared these risks which found with the same survey in construction projects in Australian to find the unique risks in construction projects in China.

The researcher concluded that the responsibility must be held by the clients, designers and government in order to manage their risk and to address potential risk on time, the risk must be minimized in construction projects ad carried out safe, efficient and quality by the contractors and subcontractors with robust construction and management knowledge.

2.1.9. Ewer & Mustafa's Study (2008) "The Impact of Risk Management on IS Projects Success in Syria"

The study explained the impact of the risk management, on information systems (IS) projects in Syria. It uses questionnaire to get information from IS managers and developers in Syria.

However, the study indicated that most of IS employees have worked without risk management and found that most of the IS Syrian companies:

1. Don't have a person in charge of risk management.
2. Don't have a formal risk management process.
3. Deal with issue by individual or department where the issue occurs.
4. Do not evaluate risks.

The conclusion of this research presents that many of Syrian IS companies don't have a formal risk method, and using risk management will increase the success rate of IS project.

2.1.10. Mudau & Pretorius's Study (2009) "Project control and risk management for project success: A South African case study"

The study aimed to assess the extent to which project control and risk management contribute to, and how it can be used effectively in ensuring project success and identify the factors that contribute to project success. The results of the questionnaire were processed and analyzed by using a spreadsheet application.

The main findings indicated that project controlling and risk management have a significant influence on performance of the project and therefore on the success of the company. It was also found that effective earned value management contributes positively to the project success. By strengthening and focusing more on project controlling and risk management methods and processes, the performance of projects should improve.

2.1.11. Bakker et al.'s Study (2010) "Does risk management contribute to IT project success? A meta-analysis of empirical evidence"

The study focused on a meta-analysis of the empirical evidence that either supports or opposes the claim that risk management contributes to IT project success. In addition, this study also investigated the validity of the assumptions on which risk management is based.

The analysis leads to remarkable conclusions. Over the last 10 years, much has become known about what causes IT projects to fail. However, there is still very little empirical evidence that this knowledge is actually used in projects for managing risks in IT projects.

This study concluded with indicated new directions for research in the relation between risk management and project success. Key elements are stakeholder perception of risk and success and stakeholder behavior in the risk management process.

2.1.12. Ehsan et al.'s Study (2010) "Risk management in construction industry"

The study aimed to identify and evaluate current risks and uncertainties in the construction industry through extensive literature survey. In addition, this study also aimed to make a basis for future studies for development of a risk management framework to be adopted by prospective investors, developers and contractors in Pakistan.

The main findings indicated that a major portion of construction companies in Pakistan deal with project risks on basis of their experience, judgment and intuition. The reasons provided by the companies for not using risk analysis techniques are listed below:

a) The majority of risks are subjective and are related to contracts or construction processes. These risks are better dealt on the basis of previous experience.
b) Risk management techniques require valid data to be available, which is difficult to implement.
c) The clients seldom require risk analysis of construction projects. They expect the project management function to manage and mitigate risks.
d) Doubts are present related to the applicability of risk response techniques to construction industry.
e) The companies are unfamiliar with techniques of risk management.

f) The degree of sophistication involved in the techniques is unwarranted if compared with project size.

The researcher concluded that Formal risk analysis and management techniques are rarely employed by Pakistani construction industry owing to the lack of experience and knowledge in the area. The industry also holds disbelief that these techniques are suitable to be employed in construction projects, much in the same manner as employed in other industries. The perception of risk by contractors and consultants is mostly based on their intuition and experience. The most utilized risk response measures are risk elimination and risk transfer. However, the respondents have revealed that these practices cause the problems of delays, low quality and low productivity in projects.

2.1.13. Karimi et al.'s Study (2011) "Risk assessment model selection in construction industry"

By using the fuzzy TOPSIS method, this study provides a rational and systematic process for developing the best model under each of the selection criteria. Decision criteria are obtained from the nominal group technique (NGT). The proposed method can discriminate successfully and clearly among risk assessment methods.

This study concludes that the identification and assessment of project risk are the critical procedures for projecting success, and this study concluded that there must be in Construction project between dissimilar, yet contractually integrated parties, owners, designers, contractors, sub-contractors, suppliers, manufacturers, and others.

2.1.14. Goh et al.'s Study (2013) "Applying Risk Management Workshop for a Public Construction Project: Case Study"

The study aimed to explore how a risk management workshop can be effectively used in managing project risks, by studying a risk management workshop that was conducted in a public project. An in-depth case study approach was adopted to identify the benefits and challenges of this method of risk management. The subsequent performance of the public organization in managing risks was examined by evaluating its functional risk management implementation. In addition to furthering an organization's understanding of major project risks, a risk management workshop also provides opportunities for team building.

However, a breakdown in the risk communication that eventually resulted in a poor risk management implementation was uncovered in the implementation of the project. Continued efforts to improve risk management implementation are needed to overcome the shortcomings associated with the current practices.

2.1.15. Goh & Abdul-Rahman's Study (2013) "The Identification and Management of Major Risks in the Malaysian Construction Industry"

The study aimed to identify the major risks associated with the Malaysian construction industry and to evaluate the practical measures that the various local construction industry players would take to respond to those risks. A mixed method of questionnaire and interviews was used to investigate the current trend of risk management implementation in the Malaysian construction industry.

The study findings demonstrated that financial risk and time risk are the major risks in the Malaysian construction industry. Both types of risks have a considerable impact on project performance in terms of cost, time and quality. A greater improvement in project performance is more likely to be achieved by focusing on the management of these two major risks, rather than by handling a larger number of minor risks. The construction stage has highest level of risk in its project life cycle because it involves a high investment of money, time and effort in the project completion. The lack of proper risk management practices is most likely one of the reasons the local construction projects are experiencing schedule and time overruns.

Moreover, the findings suggested that a low level of risk management knowledge among local construction practitioners as a factor for local contractors lagging behind their foreign counterparts in risk management application. In addition, the attitudes of local contractors towards risk management are not as encouraging as those in more developed countries. The lack of a positive attitude towards risk management application and a relatively low level in risk management knowledge leaves room and opportunity for improvements in the local construction industry.

The awareness of risk management is still at a relatively low level in the current Malaysian construction industry. A resistance to change and the satisfaction of contractors with the current management system are believed to be the main contributors to the low level of awareness. In conclusion, the researchers recommended that:

- The government should encourage the application of risk management by enforcing it as a prerequisite in tendering construction projects and in the application for the advanced grade promotion of contractors in their tendering capacity.
- It is suggested that an established local construction company should lead in the implementation of risk management in the Malaysian construction industry to prove the remarkable benefits of risk management practices.
- A proper guideline and model should be developed to steer local construction players towards a formal practice for risk management.

2.1.16. Mana Ghahramanzadeh's Study (2013) "Managing Risk of Construction Projects A case study of Iran"

The purpose of this study was to investigate the risk management process in construction projects with a focus on influences of the environment: a case study of Iran. Consequently, the findings about risk management in construction projects have been verified through a systematic investigation (using questionnaire and interview).

The researcher proposed two main categories of risk for the construction projects as follows:

1. Internal: Managerial, Technical, Cultural and Social.
2. External: Political, Governmental, Economical, Financial & Natural.

Through evaluating the opinion of all the participants about the risks, it could be ascertained that the level of criticality for the construction projects" risks in Iran is more than intermediate.

The study found that the most five critical risks which are influencing construction projects significantly are the following risks:

1. Cash flow.
2. Lack of financial resources.
3. Inflation.
4. Price fluctuations.
5. Late payment.

Findings of this study revealed that Economic and Financial risks have the greatest influence on construction projects in Iran. Moreover, there is a serious lack of risk management knowledge and expertise. The conclusion drawn from the evaluation of risk management strategies was that due to high volatility of the economic and political situation of the country, reactive risk management is practiced more than proactive risk management.

2.1.17. Jarkas & Haupt's Study (2015) "Major construction risk factors considered by general contractors in Qatar"

The purpose of this study was to identify, explore, rank the relative importance and determine the prevalent allocation response trends of the major construction risk factors considered by general contractors operating in the State of Qatar.

A structured questionnaire survey comprising 37 potential risk factors was distributed to a statistically representative sample of contractors. The influence ranks of the factors explored were determined using the "Relative Importance Index (RII)" technique, whereas the prevalent trend of contractors' attitudes toward risk allocation of each factor investigated was quantified and expressed as a percentage, based on the number of respondents who selected a specific option, in relation to the total number of respondents.

The findings suggested that increasing designers' awareness of the significant effect of applying the constructability concept can considerably help reducing the risks concomitant of the construction operation. Policy makers may contribute, moreover, in alleviating the risk of incompetent technical staff and operatives' employment by controlling the migration of inexperienced and unskilled construction workforce into the State.

The dominant respondents' perception that the crucial construction risks are related to clients and consultants suggests that these two parties have an essential role in controlling the negative ramifications of the associated factors.

The results obtained indicate that risks related to the "client" group are perceived as most critical, followed by the "consultant", "contractor" and "exogenous" group-related factors, respectively. The outcomes further show that the "transfer" option is the contractors' prevalent response to "client" and "consultant"-related risks, while the "retention" decision is the principal pattern linked to "contractor" and "exogenous" group-related risk factors.

2.1.18. Firas Jaber's Study (2015) "Establishing Risk Management Factors for Construction Projects in Iraq"

The study aimed to identify and evaluate key risk factors and their frequency and severity and then their impact in different types of construction projects in Iraq. A questionnaire survey was conducted and a total of 65 critical factors were identified and categorized into eight groups. These are:

1. Financial related risk.
2. Legal related risk.
3. Management risk.
4. Market related risk.
5. Political and security related risk.
6. Technical related risk.
7. Environmental related risk.
8. Social related risk.

The study revealed that the most ten important factors are:

- Security measures.
- Loss incurred due to corruption and bribery.
- Loss due to bureaucracy for late approvals.
- Un-official holidays.
- Loss incurred due to political changes.

- Increase of materials price.
- Unfairness in tendering.
- Improper project planning and budgeting.
- Design changes.
- Increase of labor costs.

Finally, the study suggested that what are the importance of risk function and project risk management for project success.

2.1.19. Maina et al.'s Study (2016) "Evaluation of Factors Affecting Effectiveness of Risk Management in Public Housing Construction Projects in Rwanda, Case of Batsinda Housing Project"

The objective of this study was to evaluate the factors affecting effectiveness of risk management in housing construction projects in Rwanda, Case of Batsinda Housing Project. To achieve study objective, descriptive survey design was adopted. The research design involved gathering data that describe events and then organizing, tabulating and describing the data.

Yamane's formula was used to determine the study sample size of 116 from a target population of 164. The primary data for this study was collected using both closed and open ended structured questionnaires.

The study established that low level of top management support where project management failed to develop project procedures from initiation stage, install training programs, affected the effectiveness of risk management in Batsinda Housing project by a factor of 0.633 and p value of 0.03. Incompetent project team members who did not understand project risk management process affected effective risk management by a factor of 0.497and p value of 0.04.

The study recommended that top management should be committed to inclusive and transparent risk management, project team should be trained in risk management and administrative skills, project funding should be linked to the Gantt chart and proper project risk planning should be done to enable structured and systematic risk management in construction projects.

2.1.20. Hannis-Ansah et al.'s Study (2016) "Assessment of Environmental Risks in Construction Projects: A Case of Malaysia"

This study aimed to provide a decision tool for establishing failure modes and their priorities in Malaysian construction projects, thus, avoiding the major costly impact of the risky variables to projects in terms of budget, time and quality considering the scarce resources of construction companies.

In this study, risks associated with external sources have been identified and investigated in a case study. The analysis of the risks has been done by using risk priority number (RPN) to determine the failure modes in projects.

From the results, the top risks included availability of labors, lack of technical know-how , use of old methodologies, inefficient dissemination of information, changes in government regulations, unrealistic contract time frame, licensing, permit, documents approvals, change of government department heads, bribery and corruption, difficulty in accessing credit facilities, obsolete technology and tools, market competition and conditions, inertia in government bureaucracies, changes in taxes, and import and export restrictions.

2.1.21. Ling & Hoang's Study (2016) "Political, Economic, and Legal Risks Faced in International Projects: Case Study of Vietnam"

The study aimed to investigate the political, economic, and legal (PEL) risks faced by foreign firms when undertaking construction projects in Vietnam. In addition, the study investigated the types of PEL risks faced and the risk response techniques adopted.

The data collection instrument was a questionnaire with open ended questions. The data collection method was in-depth face to face interviews with 18 experts from France, Hong Kong, Malaysia, Singapore, and the United States who have managed construction projects in Vietnam.

The major risks faced include corruption, termination of public projects, bureaucratic administrative system to obtain permits and approvals, changing and inconsistent regulations, inadequate legal framework, fluctuation of exchange, and interest and inflation rates.

Ways to respond to these risks are recommended by the experts. Foreign firms undertaking construction projects in Vietnam may make use of these findings to identify their PEL risks and determine the appropriate risk response measures to give their projects a higher chance of success.

2.1.22. Gupta, Sharma & Trivedi's Study (2016) "Risk Management in Construction Projects of Developing Countries"

The study aimed to identify and evaluate current risks and uncertainties in the construction industry through extensive literature survey. For analyzing the levels of various risk factors in construction industry, questionnaire surveys were used to collect data. Based on a comprehensive assessment of the likelihood of occurrence of various risks and their impacts on the project objectives, this study identified twenty major risk factors.

The study found that these risks are mainly related to (in ranking) contractors, clients and designers, with a few related to government bodies, subcontractors/suppliers and external issues. Among them, "Financial Risk" is recognized to influence all project destinations maximally, whereas working in hot areas, closure, defective design and delayed payments on contract are also some important risk factors. This research also found that these risks spread through the whole project life cycle and many risks occur in more than one phase, with the construction stage as the riskiest phase, followed by the feasibility stage.

The study concluded that clients, designers and government bodies must work cooperatively from the feasibility phase onwards to address potential risks in time. Also, contractors and subcontractors with robust construction and management knowledge should be employed early to make sound preparation for carrying out safe, efficient and quality construction activities.

2.2. Comments on Related Researches

Through reviewing the related researches, it can be found that:

- Most of the researches aimed at showing the importance of the risk management in construction projects by identify, explore, rank the relative importance and determine the prevalent allocation response trends of the construction risk factors as it is generally having significance in improving projects' performance.
- The majority of the most researches used the quantitative risk analysis method.

The similarities:

- The current study is consistent with some of the previous studies that studied the impact of risk management on construction project success.
- The current study is consistent with the majority of the most previous studies in terms of the usage of the quantitative risk analysis method.
- The current study is consistent with most of the previous studies in terms of using questionnaires.

The benefits from the related researches:

- It has been benefited from the related researches in determining in the questionnaire's aspects and choosing the methodology of the study.
- The related researches helped in enriching the knowledge and the various ideas that are related with the subject, and this contributed to the crystallization of the current study's problem to be linked to the concepts of risk Management as one of the advanced topics that are imposed by the circumstances and the current developments, and that was reflected on the concepts of the reciprocal relationship between Risk Management and the internal audit.

2.3. Distinguishes the Current Study:

- This study is one of the first studies that study risk management in construction projects and its relationship with the success of construction projects in the State of Qatar.
- This study proposes recommendations for activating the earnest role of the management in the application of risk management.
- Addressing the most influential factors in the application of risk management concept.

CHAPTER 3
RISK MANAGEMENT IN CONSTRUCTION PROJECTS

3.1 Introduction

Risk management has become an important part of the management process for any project. Risk in construction has been the object of attention because of time & cost overruns associated with construction projects. While the importance of risk management is a matter of debate, it is generally accepted that best risk management practice, in combination with strong project processes, improves project quality, reduces costs & speeds up schedules. This chapter defines risk & explains the process of risk management, as well as reviews the literature concerning some of risks faced in the construction projects, some of analysis techniques, risk response practices and risk monitoring and control.

3.2. Risk Definition

The literature offers several definitions of risk. Risk management is a methodical procedure for recognizing, evaluating & controlling project risks (PMI, 2006). This study adopts the definition of risk offered in the Project Management Institute's Body of Knowledge (PMIBOK, 2006): risk is an unknown incident or circumstance which, if it happens, can have favorable or unfavorable effects on a project's objectives.

Risk can be defined as an uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective. A risk has a cause and, if it occurs, a consequence (Office of project management process improvement, 2003). Jaffari (2001) defined risk as the exposure to loss/gain, or the probability of occurrence of loss/gain multiplied by its respective magnitude. In addition, Hertz & Thomas (1983) defined risk as a "variety of situations involving many unknown, unexpected, frequently undesirable & often unpredictable factors". Perry & Hayes (1985) referred to risk as "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective". whereas Abbasi et al. (2005) characterized risk by "the possibility of loss, injury, disadvantage or destruction". On the other hand, Berk & Kartal (2012) described risk as "the potential for unexpected consequences of an activity". The Project Management Institute (1996) introduced a simple definition for risk as a discrete occurrence that may affect the project for better or worse. In order to emphasize the major objectives of survey on risk management actions, risk has been defined as the probability of occurrence of some uncertain, unpredictable and even undesirable events that would change the prospects for the profitability on a given investment (Kartam, 2001). Greene (2001) provide their interpretation of what a risk constituents:

$$\text{Risk} = \text{Hazard} \times \text{Exposure}$$

They defined hazard as "the way in which a thing or a situation can cause harm", and exposure as "the extent to which the likely recipient of the harm can be influenced by the hazard". Harm is taken to imply injury, damage, loss of performance and finance, whilst exposure imbues the notions of frequency and probability. Risk is the triple characteristic of any project decision in the situation of uncertainty. It can be defined as a trinity of risk event (A), risk probability (P) and function of risk losses (u):

$$R = (A,P,u)$$

The risk event (A) is a random event which is connected with any project decision (Titarenko, 1997).

3.3. Certainty and Uncertainty in Risks

Arguments exist regarding whether risk is the same as uncertainty. Some studies see risk and uncertainty as distinct concepts on the grounds that risk can be quantified in terms of its probabilities and impacts, whereas uncertainty is difficult to determine statistically especially in terms of probability (Raftery, 1994). Other studies consider risk and uncertainty to be so closely related as to be synonymous (Ceric, 2003). Risk and uncertainty are invariably described in relation to one another and to differentiate between them may not be helpful. Accordingly, this study takes the view that risk and uncertainty is essentially the same thing.

Decision-making can take place in scenarios of certainty or uncertainty. Certainty refers to a situation where all the risk-influencing variables can be measured and decision- making methods lead to an exactly predictable outcome (Mbachu & Nkado, 2007). However, this happens rarely and then only in closed systems.

Uncertainty is a situation in which a number of possibilities exist and which of them has occurred, or will occur, is unknown. Considering all risks are uncertain but not all uncertainty is risky (Yoe, 2000).

Risks and uncertainties characterize all activities in production, services and exchange. They affect all the fundamental variables that determine planning, implementation, monitoring, adjustment, behavior and explain choices, and bring about decisions (Okema, 2001). Any definition of risk is likely to carry an element of subjectivity, depending upon the nature of the risk and to what is applied.

Certainty exists only when one can specify exactly what will happen during the period that covered by the decision. This is not very common in the construction industry (Flanagan & Norman, 1993). Other writers see no difference between risk and uncertainty; Education and Learning Wales (2001) stated that risk and uncertainty can be defined as follows:

- Risk exists when a decision is expressed in terms of range of possible outcomes and when known probabilities can be attached to the outcomes.
- Uncertainty exists when there is more than one possible outcome of a course of action but the probability of each outcome is unknown.

In some situations, the risk does not necessarily refer to the chance of bad consequences. There may be the possibility of good consequences, and it is important that a definition of risk includes some reference to this point.

Writers such as Flanagan & Norman (1993) differentiated between risk and uncertainty. Risk has place in calculus of probability, and lends itself to quantitative expression. Uncertainty, by contrast, might be defined a situation in which there are no historic data or previous history related to the situation being considered by the decision maker. ADB (2002) stated that in essence, risk is a quantity subject to empirical measurement, while uncertainty is of a non-quantifiable type. Thus, in a risk situation it is possible to indicate the likelihood of the realized value of a variable falling within stated limits-typically described by the fluctuations around the average of a probability calculus. On the other hand, in situations of uncertainty, the fluctuations of a variable are such that they cannot be described by a probability calculus.

The Royal Society, Greene (2001) viewed risk as the probability “that a particular adverse event occurs during a stated period of time, or results from a particular challenge”. The Royal Society also states that “as a probability in the sense of statistical theory risk obeys all the formal laws combining probabilities”. The problem with statistical theory is that it is only ever a guess, or an approximation of what is to occur.

Risk can be considered as a “systematic way of dealing with hazards”. If it is assumed that there is uncertainty associated with any prediction of hazard occurring, then there is only uncertainty because there is only ever a prediction of likely. Therefore, for risk to exist there must be a hazard. The perception of hazards is entirely subjective. What one person find hazardous, his neighbor may not. This perception of hazard is centered around previous experience, cultural values and to some extent the aspect of specialist training in an area of field of expertise to which the hazard relates (Greene, 2001).

Uncertainty occurs in projects with a complex structure; it should be recognized and tracked from the start to the completion of the project to ensure that changes in the risk profile are understood and mitigated as far as possible at all stages (Zeng & Smith, 2007).

In the modern business environment, one of management’s key roles is to collect adequate data (and to have the experience) to change uncertainty risk into certainty risk, thereby making it easier to reach a decision.

3.4. Causes of Risk as Threats

There exists no comprehensive study explaining the causes of risks among construction companies, moreover research covering the subject matter has tended to identify the symptoms rather than causes, a number of authors have attempted in their studies to ascertain the causes of threats in the construction industry, Rwelamila & Lobelo (1997) ascribed the high threats to:

- A highly-fragmented industry.
- Industry highly sensitive to economic cycles.
- Fierce competition as result of an over-capacitated market.
- Relative ease of entry.
- Management problems.
- Trading including:
    - Competitive quoting.
    - Outsize projects.
    - High gearing.
    - Resistance to change.
- Accounting, where inconsistencies occur in the financial data generated for management.
- Increase in project size.
- Unfamiliarity with new geographic area.
- Moving into new type of construction.
- Change in key personnel.

3.5. Sources of Risks

Checklist of risk drivers (Learning wales, 2001):

- Commercial risk.
- Financial risk.
- Legal risks.
- Political risks.
- Social risks.
- Environmental risks.
- Communications risks.
- Geographical risks.
- Geotechnical risks.

- Construction risks.
- Technological risks.
- Operational risks.
- Demand/product risks.
- Management risks.

A lot of studies worldwide aim to define the sources of studies. Research Week International Conference (2005) categorized the sources of risks into two groups:

(1) Internal Source: The internal (controllable) sources are client system, consultants, contractors and subcontractors and suppliers.
(2) External Sources: The external sources are economic and globalization dynamics, Unforeseen circumstances, government/ statutory/ political controls, environmental constraints, health and safety issues outside the control of the project team and socio-cultural issues

The obvious problem with categorizing risk, apart from the cultural perceptions noted by the royal society report, is that there is a danger of confusing sources, causes, effects and fields of study for the risk domain. A source approach to risk categorizations is shown in Figure (3.1). It is proposed that the risks can be considered with respect to six categories: financial and economic, political and environment, design, site construction, physical and Environmental factors. While the list of potential risks in every category is neither complete nor exhaustive, it does represent the majority of typical project risks and demonstrates the advantage of a logically developed classification scheme (Enshassi & Mayer, 2001).

3.6. Types of Risks

Risks can be associated to technical, operational or business aspects of projects. A technical risk is the inability to build a product that complies with the customer's requirement. An operational risk arises when the project team members are unable to work cohesively with the customer.

Risks can be either acceptable or unacceptable. An unacceptable risk is one which has a negative impact on the critical path of a project. Risks can either have short term or long term duration. In case of a short-term risk, the impact is visible immediately, such as a requirement change in a deliverable. The impact of a long-term risk is visible in the distant future, such as a product released without adequate testing.

Risks can also be viewed as manageable and unmanageable. A manageable risk can be accommodated, example being a small change in project requirements. An unmanageable risk, on the other hand, cannot be accommodated, such as turnover of critical team members. Finally, the risks can be characterized as internal or external. An internal risk is unique to a project and is caused by sources inherent in the project; example can be the inability of a product to function properly. Whereas, an external risk has origin in sources external to the project scope, such as cost cuts by senior management (Ehsan et al., 2010).

3.7. Risk Management Process

A number of variations of risk management process have been proposed. Raz & Michael (2001) suggested a process consisting of two main phases: risk assessment, which includes identification, analysis and prioritization, and risk control which includes risk management planning, risk resolution and risk monitoring planning, tracking and corrective action. Tummala & Burchett (1999) identified risk management approach as a multiphase `risk analysis' which covers identification, evaluation, control and management of risks.

Simmons (1998) provided a definition for the risk management as the sum of all proactive management-directed activities, within a program that is intended to acceptably accommodate the possibly failures in elements of the program. "Acceptably" is as judged by the customer in the final analysis, but from a firm's perspective a failure is anything accomplished in less than a professional manner and/or with less than-adequate result.

Ahmed et al. (1999) defined the risk management as a formal orderly process for systematically identifying, analyzing, and responding to risk events throughout the life of a project to obtain the optimum or acceptable degree of risk elimination or control.

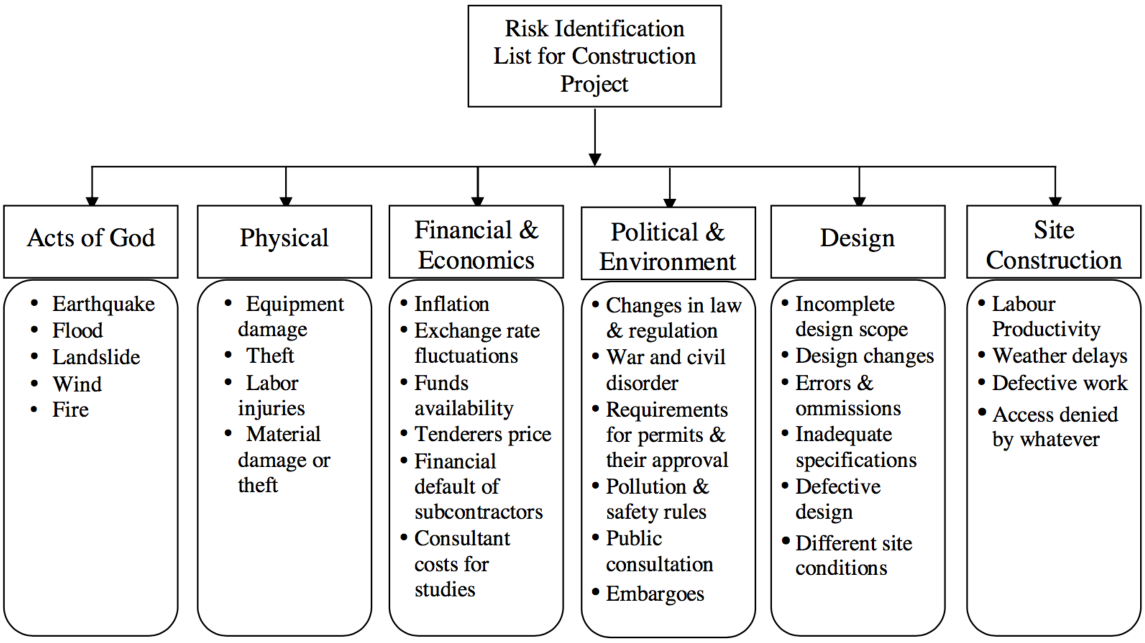


Figure 3.1: Risk categorization list, adapted from (Enshassi & Mayer, 2001)

It is possibilities that are being accommodated. It is management's job to do the planning that will accommodate the possibilities. The customer is the final judge, but internal goals should be to a higher level than customer expectations. Risk management as a shared or centralized activity must accomplish the following tasks (Simmons,1998):

- Identity concerns.
- Identify risks & risk owners.
- Evaluate the risks as to likelihood and consequences.
- Assess the options for accommodating the risks.
- Prioritize the risk management efforts.
- Develop risk management plans.
- Authorize the implementation of the risk management plans.
- Track the risk management efforts and manage accordingly.

Chapman and Ward (1997) outlined a generic risk management process consisting of nine phases:

1. Define the key aspects of the project.

2. Focus on a strategic approach to risk management.
3. Identify where risks may arise.
4. Structure the information about risk assumption and relationships.
5. Assign ownership of risks and responses.
6. Estimate the extent of uncertainty.
7. Evaluate the relative magnitude of the various risks.
8. Plan response.
9. Manage by monitoring and controlling execution.

According to the Project Management Body of Knowledge, PMI (1996) risk management forms one of the so-called nine functions of project management (the other eight being integration, communications, human resources, time, cost, scope, quality and procurement management). The traditional view is that these functions should form the basis of planning and that each should be the focus of attention in each phase of the project. In the PMBOK, PMI (1996) presents four phases of the risk management process: identification, quantification, responses development and control. Risk Management covers the process of identification, assessment, allocation, and management of all project risks (APM, 2000). Shen (1997) suggested a systematic process including risk identification, risk analysis and risk response, where risk response has been further divided into the four actions: risk retention, risk reduction, risk transfer and risk avoidance. Risk management is also seen as a process that accompanies the project from its definition through its planning, execution and control phases up to its completion and closure (Raz & Michael, 2001).

Risk management is not synonymous with insurance, nor does it embrace the management of all risks to which a project is exposed. In practice, the truth lies somewhere between the two extremes. A risk management system must be practical, realistic and must be cost effective. The depth to which you analyze risk obviously depends upon your circumstance. Only you can judge the importance to be placed on a structured risk analysis. Conventional education does little to foster an awareness of how unpredictable reality can be (Flanagan & Norman, 1993). Risk management measures the potential changes in value that will be experienced in a portfolio as a result of differences in the environment between now and some future point in time (Dembo & Freeman, 1998).

3.7.1. Construction risk management approach-Conceptual model

This model placed risk management in the context of project decision making while considering the over-lapping contexts of behavioral responses, organization structure, and technology. The objectives of project and construction risk management should be clearly established within the context of project decision-making, and will be governed largely by the risk attitude of the project proponent. In discussing human judgments in decision-making, proposes a sociological and organizational context for risk analysis. The construction risk management conceptual model provides an effective systematic framework for quantitatively identifying, analyzing, and responding to risk in construction projects. With this model emphasis is placed on how to identify and manage risks before, rather than after, they materialize into losses or claims (Enshassi & Mayer, 2001).

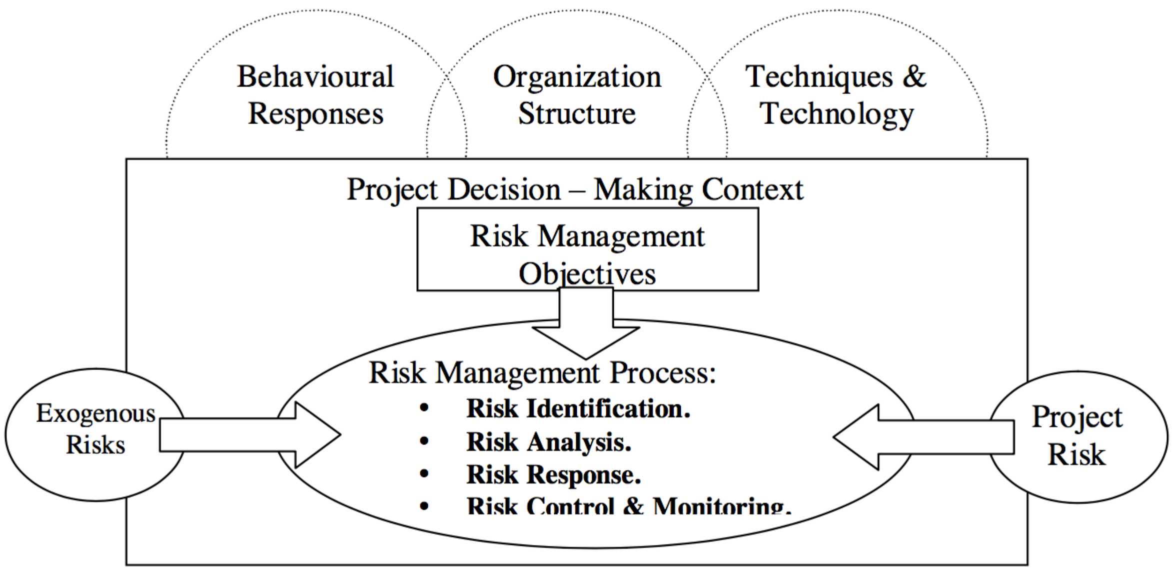


Figure 3.2: Conceptual model of construction risk management, (Enshassi & Mayer, 2001)

3.7.2. Risk identification

This is the first stage in risk management and it entails capturing all the potential risks that could arise within the project. It is commonly acknowledged that of all the stages of risk management process, risk identification stage has the largest impact on the accuracy of any risk assessment (Chapman, 1998). The aim of this phase is to compile a list of risks that are potentially significant for a given project. This involves establishing the likely risk origin, unfavorable scenarios and their undesirable effects. To facilitate risk identification, risks can also be broadly categorized as controllable and uncontrollable risks (Flanagan and Norman, 1993). Further, controllable risks are those risks which a decision maker undertakes voluntarily and whose outcome is, in part, within our direct control; and uncontrollable risks as those risks which we cannot influence (Chege & Rwelamila, 2000).

Risk identification consists of determining which risks are likely to affect the project and documenting the characteristics of each. Risk identification is not a one-time event; it should be performed on a regular basis throughout the project (PMI, 1996). The identification of risks consists of a method used to generate risks, and guidance on what those risks should look like when written down (Isaac, 1995). In project context, risk identification is also concerned with opportunities (positive outcomes) as well as threats (negative outcomes) (PMI, 1996). At this stage, a broad view should be taken to ascertain without any constraint the risks that are likely to impede the project in meeting its cost target. A failure to recognize the existence of one or more potential risks may result in a disaster or foregoing an opportunity for gain resulting from proper corrective action (Enshassi & Mayer, 2001). When attempting to identify risk, it is rather like trying to map the world. Maps of the world tend to be centered on the location of the map maker.

Much of the world is not visible from where you stand. Some territory which is familiar and obvious to you may not be obvious to everyone. Similarly, looking at a large project from the top, with multiple layers of planning, complex vertical and horizontal interactions, and sequencing problems, resembles looking into the world map through a fog. Management's ability to influence the outcome is limited to what they can see. The great temptation is to focus upon what should happen, rather than what could happen. A clear view of the event is the first equipment, focusing on the sources of risk and effect of the event (Flanagan & Norman, 1993). While extensive catalogues of risk can be devised, these are always likely to be incomplete and therefore inadequate. This may lead to decision-makers failing to consider the full spectrum of potential risks for a project. Developing categories of risk is one way of typifying risks so that this danger can be minimized (Enshassi & Mayer, 2001). Risk identification should address both internal and external risks.

3.7.2.1. Internal risks

Those risks that directly relate to the project and fall under the project management team's control are termed internal (El-Sayegh, 2008). These risks are again divided according to the specific originator such as client system, consultants, contractor, sub-contractors and suppliers.

3.7.2.2. External risks

Internal control systems have no influence on external risks, which may be caused by social, natural, economic, political and cultural factors. Research has associated each of these categories with various risk events.

3.7.2.3. Risk identification techniques

According to Ceric (2003), how the project manager approaches risk identification will depend on his previous experience. If he is experienced and proficient in certain approaches, he will favor these methods; conversely, he will avoid any that he has had bad experiences with. There are various techniques for risk identification, including:

- **Brainstorming.**
- **Delphi technique.**
- **Interviews.**
- **Questionnaires.**
- **Expert systems.**

These techniques are discussed in the following sections:

Brainstorming

Brainstorming involves an open, meaningful discussion in which participants contribute their views regarding possible sources of project risk, manifestations of uncertainty, risk probability, potential impacts and possible risk responses (Ceric, 2003). The discussion is usually chaired by the project manager or risk manager, and their experience in this capacity may well affect how successful the session is – a domineering leader may prevent others from sharing their views. The success of the brainstorming session is also likely to be affected by the number of participants. A very large number of participants may lead to time-wasting and an inefficient discussion.

Interviews

Interviews give the respondents the chance to answer prepared questions and discuss the topic in detail (Ceric, 2003). These answers are then used as the basis for analysis. The questions can be structured or unstructured. Unstructured questions allow respondents to answer as they choose, while structured questions require them to choose an answer from the alternatives given. The project/risk manager responsible for framing the questions and conducting the interviews needs to be highly knowledgeable and experienced in the process.

Questionnaires

Just like interviews, questionnaires can be structured or unstructured. They are the fastest and most efficient way of gathering opinions from all the project members for analysis and comparison (Ceric, 2003). The questions must be formulated so as to ensure high quality answers, but the process is fundamentally limited by the inability of the questionnaire to allow respondents to discuss their answers or to present opinions that go beyond the scope of the questions. Thus, questionnaires may hinder creative thinking.

Delphi technique

The Delphi technique is the use of a subjective discussion in an attempt to obtain objective findings. The project/risk manager hands out questionnaires to all team members, who fill and return them. The manager then updates the team members about the answers collected and they take the opportunity to reconsider their views. Answers can be modified and returned to the managers, and the process continues iteratively until a consensus is reached by all members. The advantage of this method is that it allows team members to give their answers independently and reduces the danger of the discussion being controlled by domineering personalities. On the other hand, repeated rounds of form-filling and discussion may be time-consuming (Ayyub & Haldar, 2007).

Expert systems

An expert system is established using the collective knowledge and experiences of all participants in the project. The system will incorporate all of the stakeholders' experiences from earlier projects (Ayyub & Haldar, 2007), but even so, it may not uncover all the hidden risks. Crucially, expert systems give explanations of how previous problems were solved; in other words, they not only provide knowledge but also give an insight into how this knowledge was developed. As a result, people tend to have confidence in such systems and see them as reliable tools for risk identification.

3.7.3. Risk analysis

Risk analysis, a component of the risk management process, deals with the causes and effects of events which cause harm. The aim behind such analysis is a precise and objective calculation of risk. To the extent that this is possible, it allows the decision-making process to be more certain (Learning wales, 2001). The essence of risk analysis is that it attempts to capture all feasible options and to analyze the various outcomes of any decision. For building projects, clients are mainly interested in the most likely price, but projects do have cost over-runs and, too frequently, the 'what if' question is not asked (Flanagan & Norman, 1993).

Risk analysis involves assessing the identified risks. This first requires that the risks are quantified in terms of their effect on cost, time or revenue. They can be analyzed by measuring their effects on the economic parameters of the project or process. In terms of risk response, three general types of response can be identified (Learning wales, 2001):

- Risk avoidance or reduction.
- Risk transfer.
- Risk retention.

The use of risk analysis gives an insight into what happens if the project does not proceed according to plan. When active minds are applied to the best available data in a structured and systematic way, there will be a clearer vision of the risks than would have been achieved by intuition alone (Flanagan & Norman, 1993).

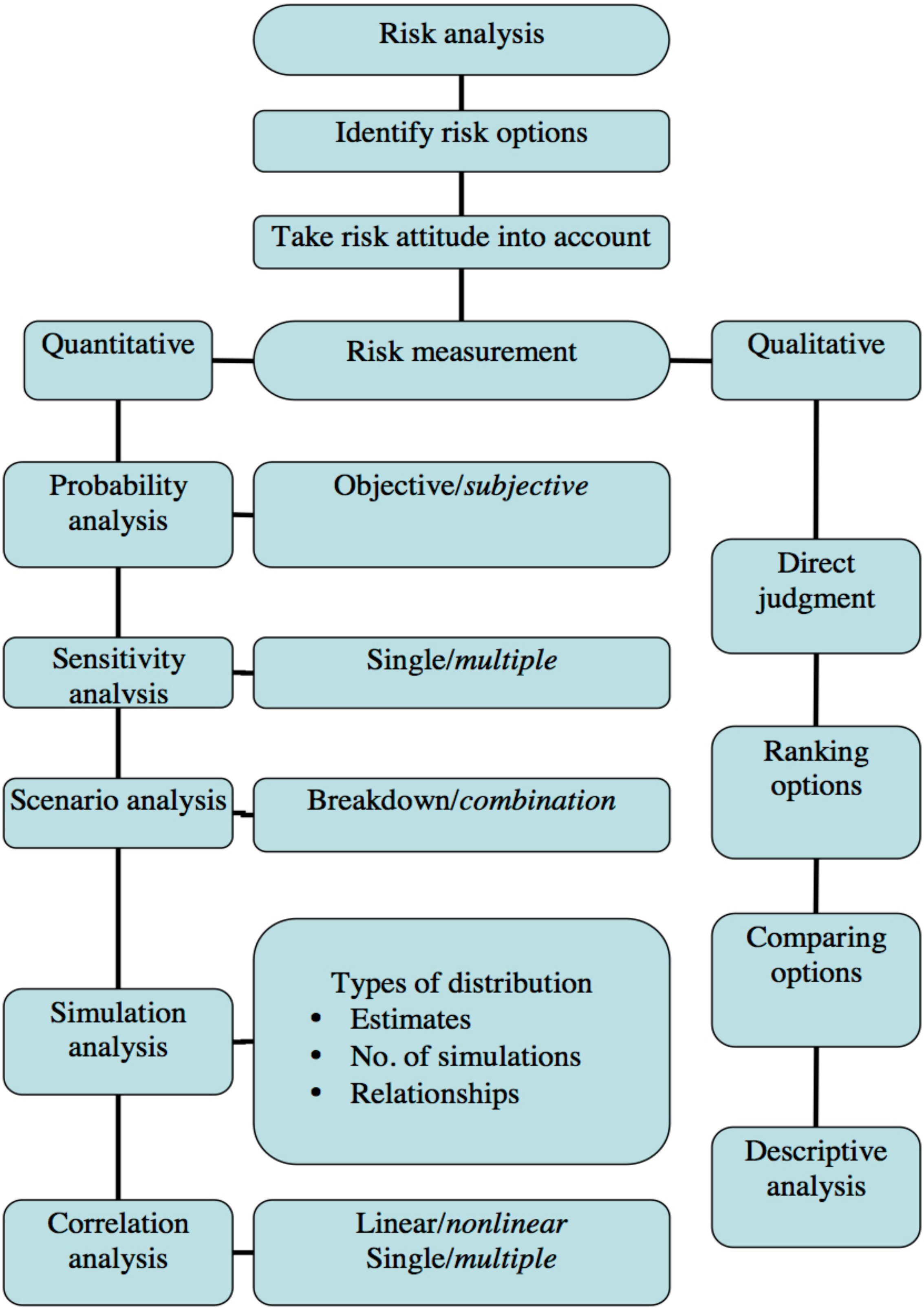


Figure 3.3: Risk analysis sequence (Flanagan & Norman, 1993)

Figure (3.3), detailed by Flanagan and Norman (1993), shows the sequence in risk analysis. The traditional approach to forecasting construction price or construction duration at the design stage of a project is to use the available data and produce a single point best estimate. The risk analysis approach explicitly recognizes uncertainty that surrounds the best estimate by generating a probability distribution based upon expert judgment. Therefore, the understanding about the effects of uncertainty upon the project will be improved. Risk analysis must not be viewed as a stand-alone activity; any strategies developed must not be seen as cast in stone commandants. Rather, these should be seen as a component of all decisions made continually to respond to project dynamics (Jaffari, 2001). Risk analysis involves evaluating risks and risk interactions to assess the range of possible project outcomes. It is complicated by a number of factors including, but not limited to (PMI, 1996):

- Opportunities and threats can interact in unanticipated ways (e.g., schedule delays may force consideration of new strategy that reduces overall project duration).
- A single risk event can cause multiple effects, as when late delivery of a key material produces cost overruns, schedule delays, penalty payments, and a lower quality product.
- The mathematical techniques used can create a false impression of precision and reliability.

What is needed is an application of risk analysis to help project managers control cost that is relatively simple to apply, can be used throughout the life cycle of a construction project, accounts for the tendency of construction professionals to apply risk in linguistic terms, and apply their experience (Bender & Ayyub, 2001).

3.7.3.1. Methods of risk analysis

The analysis of risks can be quantitative or qualitative in nature depending on the amount of information available (APM, 2000). According to Chapman (2001):

- Qualitative analysis focuses on identification together with assessment of risk.
- Quantitative analysis focuses on the evaluation of risk.

Indeed, there may be so little information about certain risks that no analysis is possible. Table (3.1) summarizes the various techniques used for risk analysis.

Table 3.1: Various risk analysis techniques, adapted from (Ward and Chapman, 1997)

Risk Analysis	
Qualitative	**Quantitative**
• Direct judgment	• Probability analysis
• Ranking options	• Sensitivity analysis
• Comparing options	• Scenario analysis
• Descriptive analysis	• Simulation analysis

3.7.3.1.1. Qualitative risk analysis

Lowe (2002) introduced a definition for the qualitative assessment of risk involves the identification of a hierarchy of risks, their scope, factors that cause them to occur and potential dependencies. The hierarchy is based on the probability of the event and the impact on the project. In qualitative risk analysis risk management acts as a means to registering the properties of each risk (Kuismanen et al., 2002). Qualitative risk analysis assesses the importance of the identified risks and develops prioritized lists of these risks for further analysis or direct mitigation. The management team assesses each identified risk for its probability of occurring and its impact on project objectives. Sometimes experts or functional units assess the risks in their respective fields and share these assessments with the team (Office of project management process improvement, 2003). (Kindinger &Darby, 2000) Introduced the Components of risk analysis as follow:

- List activities, tasks, or elements that make up the project.
- Identify applicable risk factors.
- Develop risk-ranking scale for each risk factor.
- Rank risk for each activity for each risk activity.
- Document the results and identify potential risk-reduction actions.

Qualitative risk ranking guidelines

A method to systematically document the risk for each qualitative risk factor identified in Figure (3.4) is needed to perform a consistent evaluation of risk across the different project or program activities. To make this possible, qualitative definitions of risk factors are defined for three categories of risk (none/low, medium, and high). A simple example of a completed evaluation is shown in Figure (3.5).

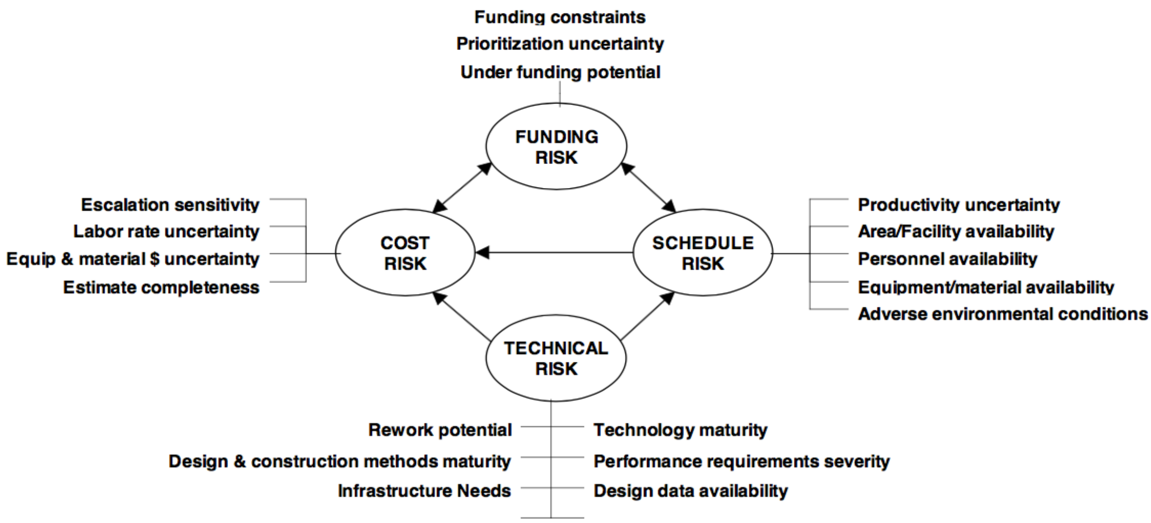
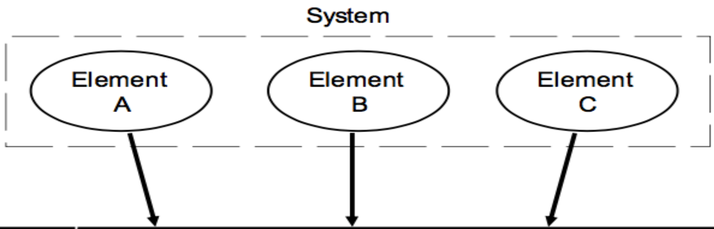


Figure 3.4: Qualitative risk factor ranking criteria, adopted from (Kindinger & Darby, 2000)



Risk Factor	A	B	C	Risk Factor Total
I	Low (1)	Low (1)	High (3)	5
II	Medium (2)	High (3)	Medium (2)	7
III	Low (1)	Low (1)	High (3)	5
Activity Total	4	5	8	

Figure 3.5: Risk factor evaluation (Kindinger & Darby, 2000)

Uses of Qualitative Risk Analysis Results

Qualitative risk analysis results are used to aid the project management team in three important ways (Kindinger & Darby, 2000):

- The qualitative risk analysis factor rankings for each project activity provide a first-order prioritization of project risks before the application of risk reduction actions. This general ranking process is shown in Figure (3.5).
- The more meaningful, result from conducting a qualitative risk analysis is the identification of possible risk-reduction actions responding to the identified risk factors. Risk reduction recommendations are often straightforward to make when the risk issue is identified.
- The final use of the qualitative risk analysis is the development of input distributions for qualitative and quantitative risk modeling. The integrated qualitative and quantitative risk analysis is shown below in Figure (3.6).

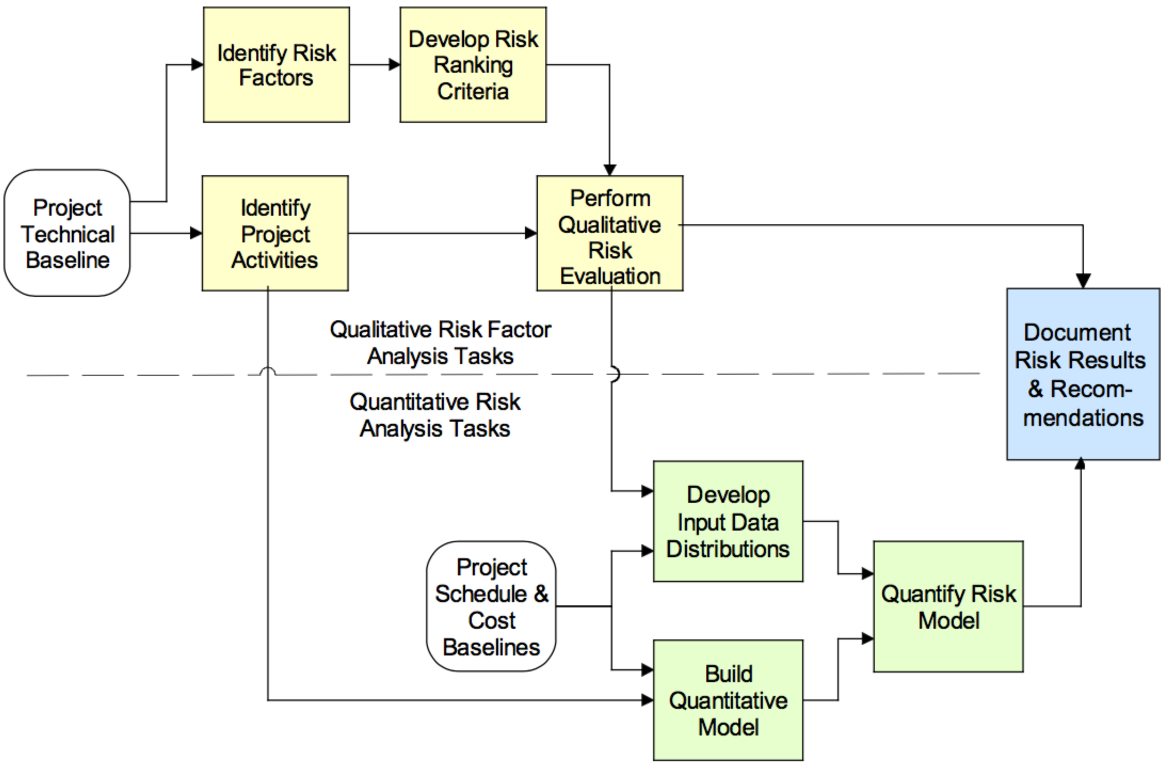


Figure 3.6: Integrated qualitative and quantitative risk analysis, (Kindinger & Darby, 2000)

3.7.3.1.2. Quantitative risk analysis

Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impact of all identified and quantified risks. The result is a probability distribution of the project's cost and completion date based on the risks in the project (Office of Project Management Process Improvement, 2003). The quantitative methods rely on probability distribution of risks and may give more objective results than the qualitative methods, if sufficient current data is available. On the other hand, qualitative methods depend on the personal judgment and past experiences of the analyst and the results may vary from person to person. Hence the quantitative methods are preferred by most analysts (Ahmed et al., 2001). Quantitative risk analysis considers the range of possible values for key variables, and the probability with which they may occur. Simultaneous and random variation within these ranges leads to a combined probability that the project will be unacceptable (Asian Development Bank, 2002). Quantitative risk analysis involves statistical techniques that are most easily used with specialized software (Office of Project Management Process Improvement, 2003). Quantitative risk analysis is to assign probabilities or likelihood to the various factors and a value for the impact then identify severity for each factor (Abu Rizk, 2003). When thorough quantitative risk analysis is necessary it can take two alternative approaches (Kuismanen, 2001):

1. Risks can be quantified as individual entities while looking at the big picture. This way can include the cumulative effects (to certain accuracy) into each individual risk and thus make more accurate estimations of the net value of the risks.
2. Alternatively modeling the mathematical properties of the interrelations from the bottom up can be started and then calculate the net impact of each risk including the effects of interrelations.

In Figure (3.7) the basic steps of a quantitative risk analysis and a simplified relationship between risk analysis, risk assessment and risk management is presented (Abrahamsson, 2002).

Basic Steps of Quantitative Risk Analysis

As discussed previously, the aim of risk analysis is to determine how likely an adverse event is to occur and the consequences if it does occur. When quantitative risk analysis is to be done, it is attempted to describe risk in numerical terms. To do this, it should go through a number of steps (Kelly, 2003):

1. Define the consequence; define the required numerical estimate of risk.
2. Construct a pathway; consider of all sequential events that must occur for the adverse event to occur.
3. Build a model - Collect data; consider each step on the pathway and the corresponding variables for those steps.
4. Estimate the risk; once the model has been constructed and the data collected the risk can be estimated. Included in this estimation will be an analysis of the effects of changing model variables to reflect potential risk management strategies.
5. Undertake a sensitivity and scenario analysis; Undertaking a risk analysis requires more information than for sensitivity analysis.

Techniques of Quantitative Risk Analysis

Any specific risk analysis technique is going to require a strategy. It is best to begin by providing a way of thinking about risk analysis that is applicable to any specific tool might be used. There are various techniques of quantitative risk analysis, including:

- **Probability Analysis** is a tool in investigating problems which do not have a single value solution, Monte Carlo Simulation is the most easily used form of probability analysis.
- **Monte Carlo Simulation** is presented as the technique of primary interest because it is the tool that is used most often.
- **Sensitivity Analysis** is a tool that has been used to great extent by most risk analysts at one time to another.
- **Breakeven Analysis** is an application of a sensitivity analysis. It can be used to measure the key variables which show a project to be attractive or unattractive.

- **Decision trees** is method, which aims at determining an expected value for each response action, is particularly recommended when considering the cost implications of the various available construction methods.
- **Scenario Analysis (SA)** is a rather grand name for another derivative of sensitivity analysis technique which tests alternative scenarios; the aim is to consider various scenarios as options.

These techniques are discussed in the following sections:

Probability analysis

This more complicated statistical method is used to compute the exposure for each risk separately or collectively for the entire project (Jaffari, 2001). The method has an advantage over sensitivity analysis as it provides the probability distribution specific to each variable where one or all the variables can simultaneously change their initial values (Oztas & Okmen, 2005). To use this method, optimistic, most probable and pessimistic costs must first be estimated and time estimates for individual events must be provided (Jaffari, 2001).

This method is still relatively simple and easy to understand, although it is subject to the experience and knowledge of the user. It is also used to predict possible outcomes and their probabilities. Like the sensitivity method, probabilistic analysis depends on a range of subjective variables (Jaffari, 2001). Thus, it is recommended that time ranges and construction cost estimates grouped together while considering high chances of overruns in order to increase sensitivity.

Sensitivity Analysis

Sensitivity analysis is a deterministic modeling technique which is used to test the impact of a change in the value of an independent variable on the dependent variable. Sensitivity analysis identifies the point at which a given variation in the expected value of a cost parameter changes a decision. Sensitivity analysis is performed by changing the values of independent risk variables to predict the economic criteria of the project (Merna & Stroch, 2000). Sensitivity analysis is an interactive process which tells you what effects changes in a cost will have on the life cycle cost (Flanagan & Norman, 1993). Sensitivity Analysis is the calculating procedure used for prediction of effect of changes of input data on output results of one model (Jovanovich, 1999). It does not aim to quantify risk but rather to identify factors that are risk sensitive. Sensitivity analysis enables the analyst to test which components of the project have the greatest impact upon the results, thus narrowing down the main simplicity and ability to focus on particular estimates (Flanagan & Norman, 1993). The advantage of sensitivity analysis is that it can always be done to some extent. Specific scenarios of interest can be reasonably well described. Extreme outcomes, like the maximum or minimum possible costs, can often be estimated.

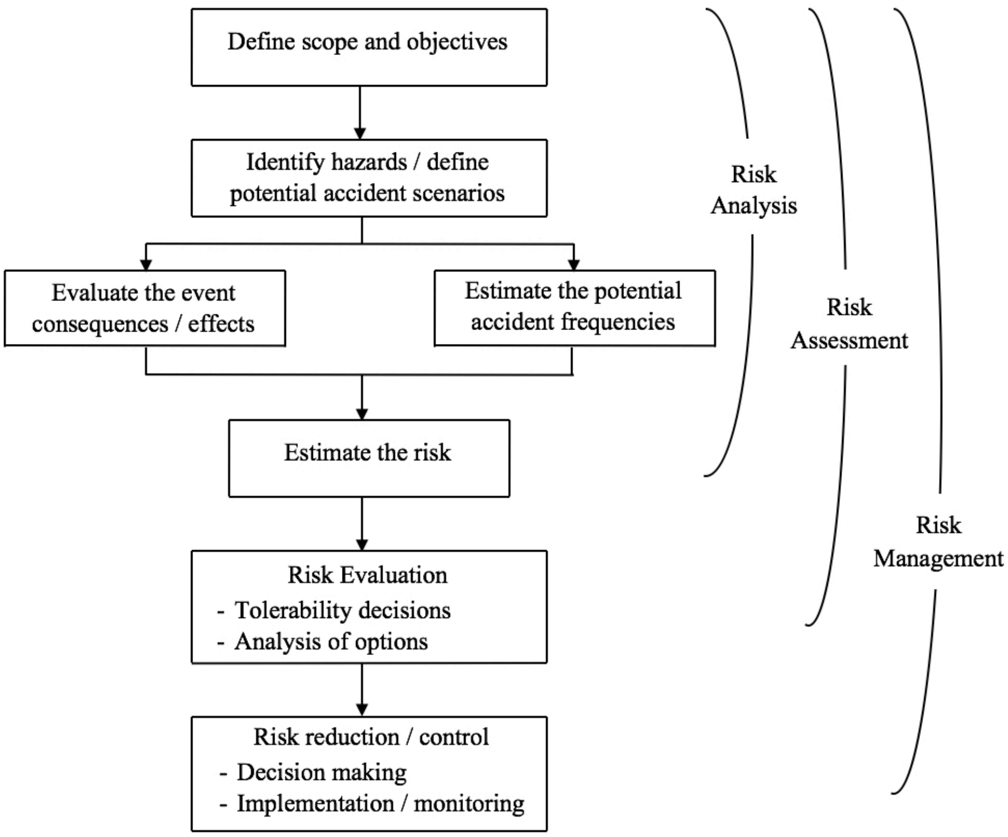


Figure 3.7: Simplified relationship between risk analysis, risk assessment and risk management. Adapted from Abrahamsson (2002)

The major disadvantage of sensitivity analysis is that the analyst usually has no idea how likely these various scenarios are. Many people equate possible with probable, which is not the case with sensitivity analysis (Yoe, 2000).

Monte Carlo Simulation

Simulation is a probability-based technique where all uncertainties are assumed to follow the characteristics of random uncertainty. A random process is where the outcomes of any particular process are strictly a matter of chance (Flanagan, 2003). The Monte Carlo process is simply a technique for generating random values and transforming them into values of interest, the methods of generating random or pseudo random numbers are more sophisticated now and the mathematics of other distributions is more complex (Yoe, 2000). Different values of risk variables are combined in a Monte Carlo simulation. The frequency of occurrence of a particular value of any one of the variables is determined by defining the probability distribution to be applied across the given range of values. The results are shown as frequency and cumulative frequency diagrams. The allocation of probabilities of occurrence to each risk requires the definition of ranges for each risk (Merna & Stroch, 2000). Lukas (2004) presented risk analysis simulation steps:

1. Start with a project estimate done for each cost account.
2. Decide on the most likely cost, pessimistic costs, and optimistic costs.
3. Insert data into simulation software, then run the model.
4. Determine contingencies based on desired risk level.
5. Prioritize “risky” cost accounts for risk response planning.

This method of sampling (i.e. random sampling) will, lead to over- and under-sampling from various parts of the distribution. In practice, this means that in order to ensure that the input distribution is well represented by the samples drawn from it, a very large number of iterations must be made. In most risk analysis work, the main concern is that the model or sampling scheme we use should reproduce the distributions determined for the inputs (Abrahamsson, 2002). On the other hand, Lukas (2004) stated some of the simulation benefits:

- Improves estimate accuracy, it helps determine a contingency plan for an acceptable level of risk.
- Helps determine the bigger cost risks for risk response planning.

Decision trees

This is a graphical means of collating information about possible current and future courses of action (Dey, 2001). Decisions are made when there are several existing alternatives. Each alternative branch out into sub-alternatives; these divide further, resulting in a tree-like image revealing all likely decision pathways. The consequences of each branch can then be analyzed in subjective or objective terms to determine the risk exposure (or the Expected Value (EV) of the risk level for each alternative). The method, which aims at determining an expected value for each response action, is particularly recommended when considering the cost implications of the various available construction methods. It has now become a fundamental part of risk analysis.

Scenario analysis (SA)

Scenario analysis is a name given to the development of descriptive models of how the future might turn out. It can be used to identify risks by considering possible future developments and exploring their implications. Sets of scenarios reflecting (for example) “best case,” “worst case,” and “expected case” may be used to analyze potential consequences and their probabilities for each scenario as a form of sensitivity analysis when analyzing risk. The power of scenario analysis is illustrated by considering major shifts over the past 50 years in technology, consumer preferences, social attitudes, etc. Scenario analysis cannot predict the probabilities of such changes but can consider consequences and help organizations develop strengths and the resilience needed to adapt to foreseeable changes. Scenario analysis can be used to assist in making policy decisions and planning future strategies as well as to consider existing activities. It can play a part in all three components of risk assessment. For identification and analysis, sets of scenarios reflecting (for example) “best case,” “worst case” and “expected case” may be used to identify what might happen under particular circumstances and analyze potential consequences and their probabilities for each scenario (Valis & Koucky, 2009).

3.7.4. Risk response practices

PMI (1996) suggested three ways of responding to risk in projects, they are as follows:

- Avoidance: eliminating a specific threat, usually by eliminating the cause. The project management team can never eliminate all risks, but specific risk events can often be eliminated.
- Mitigation: reducing the expected monetary value at risk events by reducing the probability of occurrence (e.g., using new technology), reducing the risk event value (e.g., buying insurance), or both.
- Acceptance: accepting the consequences. Acceptance can be active by developing a contingency plan to execute should the risk event occur or passive by accepting a lower profit if some activities overrun.

Abu Rizk (2003) suggested some actions to be taken in response to residual risks. Actions can include:

- Reduce uncertainty by obtaining more information, this leads to re-evaluation of the likelihood and impact.
- Eliminate or avoid the risk factor through means such as a partial or complete re-design, a different strategy or method etc.
- Transfer the risk element by contracting out affect work.
- Insure against the occurrence of the factor.
- Abort the project if the risk is intolerable and no other means can be undertaken to mitigate its damages.

Ahmed et al. (2001), Akintoyne and MacLeod (1997), Enshassi and Mayer (2001), and Education and Learning Whales (2001) argued that there are four distinct ways of responding to risks in a construction project, namely, risk avoidance, risk reduction, risk retention and risk transfer. Those ways are discussed in below briefly.

3.7.4.1. Risk avoidance

Risk avoidance is sometimes referred to as risk elimination. Risk avoidance in construction is not generally recognized to be impractical as it may lead to projects not going ahead, a contractor not placing a bid or the owner not proceeding with project funding are two examples of totally eliminating the risks. 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 biding on the high-risk portion of the contract (Flanagan & Norman, 1993).

3.7.4.2. Risk transfer

This is essentially trying to transfer the risk to another party. For a construction project, an insurance premium would not relieve all risks, although it gives some benefits as a potential loss is covered by fixed costs (Tummala & Burchett, 1999) Risk transfer can take two basic forms:

- The property or activity responsible for the risk may be transferred, i.e. hire a subcontractor to work on a hazardous process;
- The property or activity may be retained, but the financial risk transferred, i.e. by methods such as insurance and surety.

3.7.4.3. Risk retention

This is the method of reducing controlling risks by internal management (Zhi, 1995); handling risks by the company who is undertaking the project where risk avoidance is impossible, possible financial loss is small, probability of occurrence is negligible and transfer is uneconomic (Akintoyne & MacLeod,1997). The risks, foreseen or unforeseen, are controlled and financed by the company or contractor. There are two retention methods, active and passive:

A. **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.

B. **Passive retention** (sometimes called non-insurance), however, occurs through negligence, 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.

3.7.4.4. Risk reduction

This is a general term for reducing probability and/or consequences of an adverse risk event. In the extreme case, this can lead to eliminate entirely, as seen in “risk avoidance”. However, in reduction, it is not sufficient to consider only the resultant expected value, because, if potential impact is above certain level, the risk remains unacceptable. In this case, one of the other approaches will have to be adopted (Piney, 2002).

3.7.5. Risk monitoring and control

Increasing productivity and reducing the project’s risk exposure to schedule escalations and costs are the responsibility of the risk management team (White, 2008). Any risk within construction projects should be monitored and controlled, beginning with the development of the risk management plan.

Risk monitoring and control is required in order to:

1. Ensure the execution of the risk plans and evaluate their effectiveness in reducing risk.
2. Keep track of the identified risks, including the watch list.
3. Monitor trigger conditions for contingencies.
4. Monitor residual risks and identify new risks arising during project execution.
5. Update the organizational process assets.

Purpose of risk monitoring:

- To determine if risk responses have been implemented as planned.
- To determine if risk response actions are as effective as expected or if new responses should be developed.
- To determine if project assumptions are still valid.
- To determine if risk exposure has changed from its prior state, with analysis of trends.
- To determine if a risk trigger has occurred.
- To determine if proper policies and procedures are followed.

- To determine if new risks have occurred that were not previously identified.

3.7.5.1. Inputs to risk monitoring and control

1. **Risk management plan.**
2. **Risk Register.** Contains outputs of the other processes: identified risks & owners, risk responses, triggers and warning signs
3. **Approved Change Requests.** Approved changes include modifications such as to scope, schedule, method of work, or contract terms. This may often require new risk analysis to consider impact on existing plan and identifying new risks and corresponding responses
4. **Work Performance Information.** Project status and performance reports are necessary for risk monitoring and control of risks.

3.7.5.2. Tools and techniques for risk monitoring and control

1. **Risk Reassessment.** Project risk reviews at all team meetings. Major reviews at major milestones Risk ratings and prioritization may change during the life of the project. Changes may require additional qualitative or quantitative risk analysis.

2. **Risk audits.** Examine and document the effectiveness of the risk response planning in controlling risk and the effectiveness of the risk owner.

3. **Variance and Trend Analysis.** Used for monitoring overall project cost & Schedule performance against a baseline plan. Significant deviations indicate that updated risk identification and analysis should be performed. Technical performance measurement.

4. **Reserve Analysis.** As execution progresses, some risk events may happen with positive or negative impact on cost or schedule contingency reserves. Reserve analysis compares available reserves with amount of risk remaining at the time and determines whether reserves are sufficient

5. **Status meetings** Risk management can be addressed regularly by including the subject in project meetings.

3.7.5.3. Outputs from risk monitoring and control

1. **Risk Register Updates.** Risk register is updated to include: Outcomes of risk reassessments, audits, and risk reviews. Update may affect risk probability, impact, rank, response, etc. Actual outcome of risks, and of risk responses that becomes part of the project file to be utilized on future projects.
2. **Corrective action.** Corrective action consists of performing the contingency plan or workaround. Workarounds are previously unplanned responses to emerging risks. Workarounds must be properly documented and incorporated into the project plan and risk response plan.
3. **Recommended Preventive Actions.** Used to direct project towards compliance with the project management plan
4. **Project change requests.** Implementing contingency plans or workarounds frequently results in a requirement to change the project plan to respond to risks. The result is issuance of a change request that is managed by overall change control.
5. **Organizational Process Assets Updates.** Information gained through the risk management processes are collected and kept for use by future projects: Templates for risk management plan, probability-impact matrix, risk register, lessons learned, updated RBS.
6. **Project Management Plan Updates.** Updates to the project management plan as a result of approval of requested changes.

3.8. Risk Management Plan

Ceric (2003) argue that a comprehensive risk management plan incorporates seven stages:

Stage one: Defining objectives. It is important to record the project goals and objectives in a way that can be comprehended by all team members. At this stage, the stakeholders should be identified and the project requirements assessed to ensure that they are realistic. Any assumptions and challenges relating to achieving the project's outcomes must also be reviewed. The expected benefits should also be noted.

Stage two: Production of the risk management document. This should set out the objectives and scale of the risk management process, the roles and responsibilities of the project team, the contracting organization, the devices and techniques to be implemented, details of the reporting cycle, review arrangements and deliverables. All project management team members should work to this document.

Stage three: Identification. Risk identification techniques include interviews, mind mapping, brain storming and fish bone diagrams. Identification should be consistent, comprehensive and meaningful even to those with little knowledge about the subject. Risk is unavoidable in construction projects, so this step is crucial. The main objective of risk identification is to enable project managers to deal with risks proactively rather than reactively.

Stage four: Assessment. Risk assessment, which should be strategic and objective, may be conducted using qualitative or quantitative methods. Quantitative methods describe risk in mathematical or statistical terms and are used to identify the main issues in a fast-track project and to justify a comprehensive risk analysis. Qualitative methods, on the other hand, provide explanation and allow prioritization of the risk issues. This is especially important in large projects, where it should always be given top priority.

Stage five: Planning. When the risk has been identified, the risk management team(s) must develop a response plan that is achievable, appropriate and affordable. Teams are assigned to handle specific activities and a timetable is set.

Stage six: Management. The effectiveness of the chosen response strategy should be monitored as the project progresses. If necessary, better alternatives should be identified in order to sustain the risk management process.

Stage seven: Feedback. Effective feedback is key to helping managers learn from mistakes and successes throughout the lifecycle of the project. It allows for continuous revision and amendment of risk responses to ensure a positive outcome. Many projects allow the project management team to revise their initial risk estimates.

At all stages, communication between team members and the public or other stakeholders is essential to control and reduce risk. The development of a plan containing an estimated schedule and initial cost planning is part of risk analysis. A comprehensive risk management process can be performed using modelling techniques to simulate situations and gain insight into how risk may be minimized (Zack, 2007). Figure 3.8 presents a risk analysis process, incorporating risk engineering.

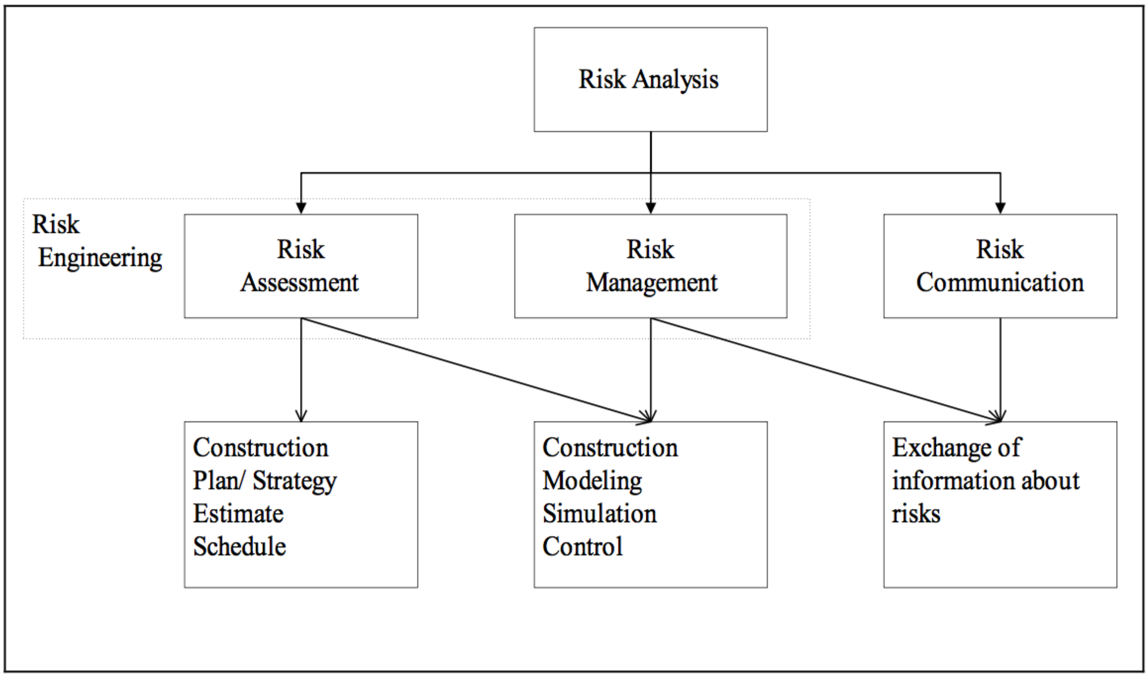


Figure 3.8: Project risk analysis modified (Kumamoto, 2006)

CHAPTER 4
RESEARCH METHODOLOGY

4.1. Introduction

This chapter covers the methodology that was used in this study. This chapter also provides the information about research strategy, research design, target population and sample size. It also discusses some of the practical problems encountered. A detailed methodology and tools used are described.

4.2. Research Strategy

Research strategy can be defined as the way in which the research objectives can be questioned. There are two types of research strategies namely quantitative research and qualitative research (Naoum, 1997).

A quantitative approach is selected to determine the variables and factors that affect the risk management practices in construction projects in the State of Qatar to find out if there is a systematic risk management practices through the contracting companies.

4.3. Research Design

The term "research design" refers to the plan or organization of scientific investigation, designing of a research study involves the development of a plan or strategy that will guide the collection and analyses of data (Polit & Hungler, 1999).

In this research, a closed-ended questionnaire with interview is used to collect data from respondents. In structured interview, the interviewer administers a questionnaire, perhaps by asking the questions and recording the responses, with little scope for probing those responses by asking supplementary questions to obtain more details and to pursue new and interesting aspects (Fellows & Liu, 1997). Figure (4.1) shows the summarized methodology chart.

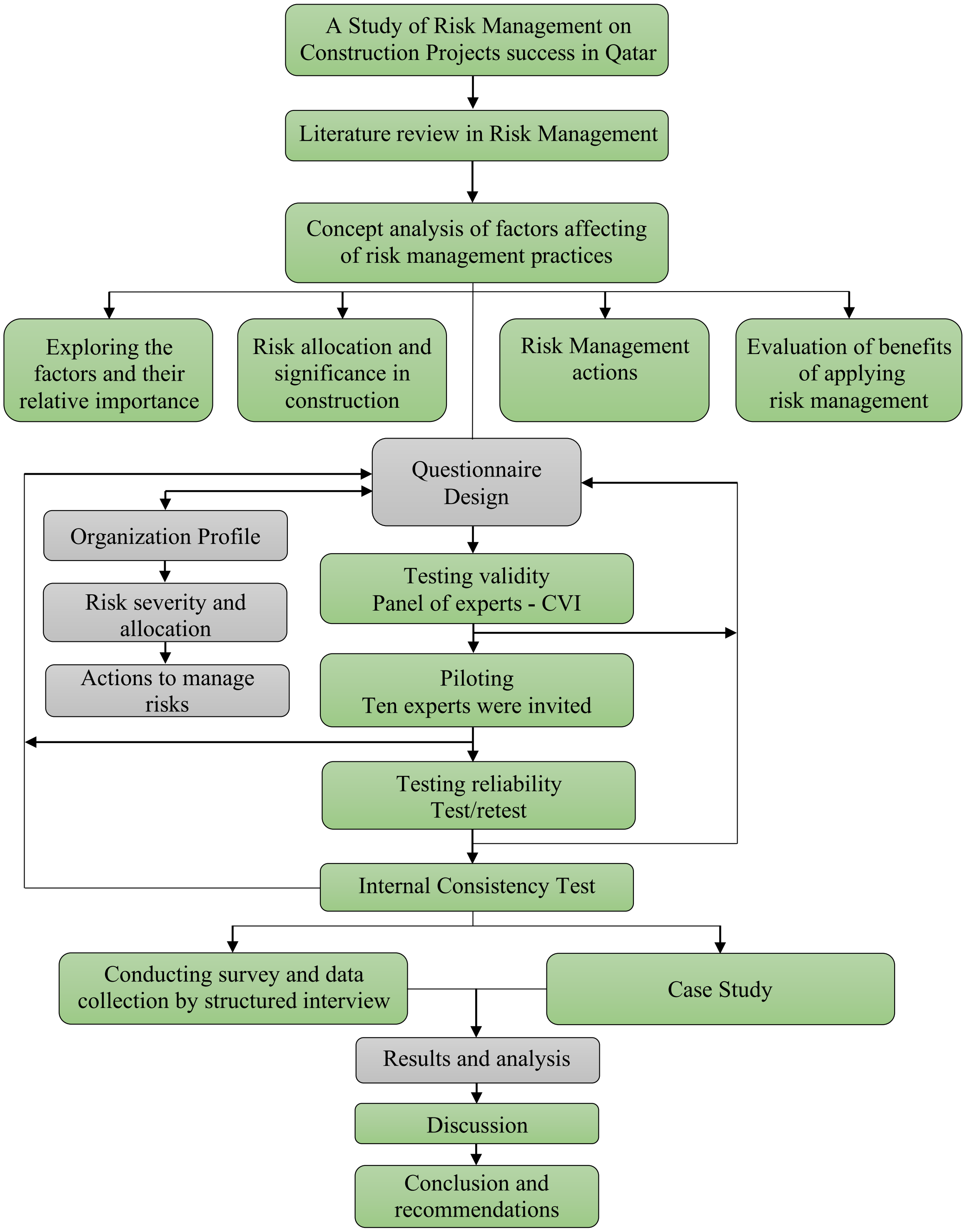


Figure 4.1: Methodology flow chart

4.4. Research Population

A population consists of the totality of the observation with which we are concerned (Walpole & Myers, 1998). The target population included classified civil engineering and building construction firms by the "Central Tenders Committee" (CTC) of the State. The classification criteria for Qatari construction contractors are based on:

- The credentials of the technical and administrative staff employed.
- Equipment and tools available.
- The financial position and strength.
- Previous experience.

4.5. Sample Size

Sampling defines the process of making the selections; sample defines the selected items (Burns & Grove, 1987). Wood and Haber (1997) defined the sampling as the process of selecting representative units of a population for the study in a research investigation. Scientists derive knowledge from samples; many problems in scientific research cannot be solved without employing sampling procedures (Wood & Haber, 1997).

Unfortunately, without a survey of the population, the representativeness of any sample is uncertain, but statistical theory can be used to indicate representativeness (Fellows & Liu, 1997).

Based on the research population in the previous section, a total number of 126 organizations, classified under the first, second and third categories, were identified (CTC, 2011).

A statistical calculation was used in order to calculate the sample size. The formula below was used to determine the sample size of unlimited population (Creative Research Systems, 2001):

$$SS = \frac{Z^2 \times P \times (1-P)}{C^2}$$

where SS = Sample size.

Z = Z Value (e.g. 1.96 for 95% confidence interval).

P = Percentage picking a choice, expressed as decimal, (0.5 used for sample size needed).

C = Confidence interval (0.05) (estimate ± margin of error)

$$SS = \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.05^2} = 384$$

Correction for finite population

$$SS_{New} = \frac{SS}{1 + \frac{SS-1}{pop}}$$

Where pop is the population = 126 classified companies according to the CTC records.

$$SS_{New} = \frac{384}{1 + \frac{384-1}{126}} = 95$$

95 questionnaires are to be distributed to contracting firms; all of them are classified by CTC

4.6. Limitation of this Research

- This study is limited to the construction projects practitioners in the State of Qatar.
- This study is limited only to the Classified Civil Engineering and building construction firms by the "Central Tenders Committee" (CTC) in the State of Qatar.

4.7. Questionnaire Design

The questionnaire survey was conducted to determine the opinion of contractors regarding the risk factors. A six pages' questionnaire accompanied with a covering letter. (owners could be: ministries, municipalities, consultants, and so on).

The letter indicates the objectives of the research and explained to the participants that the results of the questionnaire would be used to improve the ability of contractors to identify, analyze and estimate the risk factors impact on the construction projects.

A close-ended questionnaire was used for its advantages as it is easy to ask and quick to answer, they require no writing by either respondents or interviewer.

The questionnaire was composed of five sections to accomplish the aim of this research, as follows:

1. The organization profile.
2. Risk factors that have been identified by literature, experts and by the researcher.
3. Risk preventive methods which could be used to avoid risk to take place.
4. Risk mitigation methods that could be used to mitigate risk impact or likelihood.
5. Risk analysis techniques that could be used to analyze and estimate risk factors impact.

The questionnaire was prepared in English language (Appendix 1). To ensure obtaining complete and meaningful response to the questionnaire an interview was conducted with each respondent to explain the objective of the study and to get input towards the questionnaire design, especially towards identifying risk types and management actions for controlling these risks. In addition, their analysis is straight forward (Naoum, 1998).

by adding two groups to the literature (Management and Construction) - to best fit the nature of the industry in the state of Qatar was discussed with the knowledge experts and local construction practitioners in the state of Qatar. Content validity was conducted by meeting with three experts to evaluate the content validity of questionnaire, to check readability, offensiveness of the language and to add more factors and information if needed. As a result, good comments regarding the shape and the factors were taken into consideration and 26 additional factors were added. These factors were amalgamated with the original factors and the required modifications have been introduced to the final questionnaire. A total of 58 factors were distributed into seven groups.

4.7.1. Risk allocation

Any construction project involves risk and there is no possibility to completely eliminate all the risks associated with a specific project. All that can be done is to regulate the risk allocated to different parties and then to properly manage the risk.

In this research, the questionnaire included risks allocation to different parties such as: Owner (a), Contractor (b), Shared between (a) & (b). Table (4.1) illustrates different types of risk included in the questionnaire. Some of the literature's risk types such as floods, earthquakes, wind damages and pollution were not included in this study because of inapplicability.

4.7.2. Significance of risk and measurement scales

The degree of impact for each risk type was included in the questionnaire under the heading "Significance". The questionnaire was designed to examine practitioners' observations and judgments in determining the relative significance of each risk category. Although the degree of impact varies from project to project, the questionnaire is expected to elicit a general assessment of the significance of risk.

Each respondent was required to rank each risk on a scale from 1 to 5 by considering its contributions to project delays. Rank 1 is assigned to a risk would give the lowest contributions to risk consequences while Rank 5 is allotted to a risk that would cause the highest contribution. In the same time rank 1 means very low importance risks, rank 2 means low importance risks ranks, rank 3 means medium importance risks, rank 4 means high importance risks and finally rank 5 means very high importance risks.

Table 4.1: Risk factors included in the questionnaire

Construction Project	Financial Risk Factors	Wrong project estimation
		Cash flow difficulties
		Lack of financial resources
		Delayed payments to the contractor
		Fluctuations in exchange rates
		Financial failure of the contractor
		Financial failure of the Owner
		Monopolizing of materials due to the siege and other unexpected political conditions
		Staff strike due to delayed salaries
		Inflation and unforeseen increases in material and equipment prices
	Construction Risk Factors	Poor coordination between the main contractor and his sub-contractors
		Poor performance and poor management of sub-contractors
		Unpredicted technical problems during construction
		Late delivery of materials
		Poor quality of workmanship
		Poor labor productivity
		Undocumented change orders
		Discrepancies between the intended and the executed works due to incomplete or contradictory drawings and specifications
		Poor supervision of site construction
		Disputes in contract variation
		Labor strikes and disputes
		Late changes to the design
		Frequent changes of design by Owner
		Lack of qualified staff
		Departure of key staff during the project
		Unqualified staff in the construction project team
		Delays caused by third-party's
		Shortage of proper equipment
		Shortage of acceptable materials
		Shortage of efficient manpower
	Political & Governmental Risk factors	Changes in laws and regulations
		Corruption and bribery
		Delay in project approvals and permits
		The sanctions
		Threat of war
		Political instability
	Legal Risk Factors	Disputes between Owner and main contractor
		Disputes between main contractor and his subcontractors
		Delays in resolving disputes
		Delays in resolving contractual issues
	Environmental Risk Factors	Ecological damage
		Site access issues
		Adverse weather conditions

	Design Risk Factors	Design deficiencies
		Late issue of drawings and documents
		Lack of design coordination between the discipline (architectural, structural, MEP, HVAC, etc.)
		Deficiencies in drawings and specifications
		Changes to the scope of work
		Inaccurate quantities
		Lack of consistency between bill of quantities, drawings and specifications
		Frequent changes of design by designers
		Inexperienced or unqualified design team
	Management Risk Factors	Poor Procurement management
		Poor Communications management
		Poor initial planning (scheduling)
		Unclear or contradictory information
		Frequent changes in staff
		Frequent Changes in organization chart for the assigned locations for construction project staff

In order to quantitatively demonstrate the relative significance of risks to a project, a weighting approach is adopted. The principle is that the risk with the highest contribution rank would be assigned the largest weight. In Table (4.2) the figures in brackets are weighted scores for each risk at different contribution rank. Each individual's weighted score is obtained by multiplying the number of respondents with the corresponding weight. The figures in the last column of the table give the total weighted scores for each risk. The rank 1 means very low significant risks, rank 2 means low significant risks, rank 3 means medium significant risks, rank 4 means high significant risks and finally rank 5 means very high significant risks.

Table 4.2: An example for contribution of risks to a project (risk significance)

Types of risks	Contribution rank					Total weighted scores
	1	2	3	4	5	
Late delivery of materials	2 (2)	9 (18)	14 (42)	35 (140)	3 (15)	217
Poor supervision of site construction	1 (1)	4 (8)	21 (63)	32 (128)	5 (25)	225

4.7.3. Risk management actions

Managing risks means minimizing, controlling, and sharing of risks, and not merely passing them off to another party (Kartam & Kartam, 2001). The methods of managing risks are retention, transfer, mitigation, and prevention of risks or any combination thereof. There are two kinds of management actions: preventive action and mitigative action. These actions were generated based on related research work on construction risk management.

4.7.3.1. Preventive actions

Preventive actions are used to avoid and reduce risks at the early stage of project construction, yet they may lead to submitting and excessive high bid for a project. Table (4.3) illustrates the seven preventive methods that proposed to respondents to measure the effectiveness for each. The relative degree of effectiveness between the methods will be quantitatively demonstrated as shown previously.

Table 4.3: Relative effectiveness of preventive methods

No.	*Preventive Method*	Effectiveness of preventive methods					Total weighted scores
		Very low	Low	Medium	High	Very high	
		1	2	3	4	5	
1	Utilize quantitative risk analyses techniques for accurate time estimation						
2	Rely on subjective judgment to produce a program (Schedule)						
3	Produce a program (schedule) by actual and current project information						
4	Plan alternative methods as stand-by (Plan B)						
5	Consciously adjust for bias risk premium to time estimation						
6	Transfer or share risk to/with other parties						
7	Refer to previous and ongoing similar projects for accurate program information						

4.7.3.2. Mitigative actions

Whilst some project delay risks can be reduced though various preventive actions at early stages, the delay of progress still occurs in many projects during the construction process. When delay happens, contractors can adopt various mitigative actions to minimize the effects of the delay. Where the study is concerned with the construction phase; the survey addressed mitigative actions are remedial steps aimed at minimizing the effects of risks through the construction phase. Table (4.4) represents the six mitigative methods being proposed to the respondents to measure the effectiveness for each of the methods. The relative degree of effectiveness between the methods will be quantitatively demonstrated as shown previously.

Table 4.4: Relative effectiveness of mitigative methods

No.	***Remedial Method***	**Effectiveness of remedial methods**					**Total weighted scores**
		Very low	Low	Medium	High	Very high	
		1	**2**	**3**	**4**	**5**	
1	Increase manpower and/or equipment						
2	Increase the working hours or shifts						
3	Change the construction method						
4	Change the sequence of work by overlapping activities						
5	Coordinate closely with subcontractors						
6	Increase supervision to minimize abortive work						

4.7.4. Risk analysis techniques

Risk analysis consists of determining the consequences and their probabilities for identified risk events, taking into account the presence (or not) and the effectiveness of any existing controls. The consequences and their probabilities are then combined to determine the level of risk. Table (4.5) below shows the risks analysis techniques. Respondents were asked to determine the relative use of those techniques. Seven methods were included to highlight the construction industry practitioners concerns about risk analysis and its approaches. The same weighing policy is used to measure the weighted score for each technique listed.

Table 4.5: Relative effectiveness of risk analysis techniques

No.	*Risk Analysis Technique*	Use of risk analysis techniques					Total weighted scores
		Very low	Low	Medium	High	Very high	
		1	2	3	4	5	
1	Expert Systems (including software packages, decision support systems, computer-based analysis techniques such as @Risk						
2	Probability analysis (analysis of historical data)						
3	Sensitivity analysis						
4	Simulation analysis specialized software						
5	Subjective judgment using experience, lessons learned and personal skills						
6	Comparison analysis (compare similar projects having similar conditions)						
7	Scenario analysis						

4.8. Validity of Research

Validity means that the degree to which an instrument measures what it is should be measuring. Questionnaire was reviewed by three of experts. As a result:

26 additional risk factors were added to the questionnaire

2 mitigation methods were added

2 risk analysis techniques were added

4.9. Reliability of Research

Reliability of an instrument is the degree of consistency with which it measures the attribute it is supposed to be measuring (Polit & Hunger, 1985). The less variation an instrument produces in repeated measurements of an attribute, the higher its reliability. Reliability can be equated with the stability, consistency, or dependability of a measuring tool. The test is repeated to the same sample of people on two occasions and then the scores obtained were compared by computing a reliability coefficient (Polit & Hunger, 1985). Ten questionnaires were re-distributed among contractors and owners. The reliability coefficient was (0.923) indicates a high level of reliability.

4.10. Data Collection

The data for this research are collected via primary and secondary sources. The primary data was developed by questionnaire which was directed to the employees in the construction projects in order to collect data for statistical analysis of the research in order to test the hypothesis. Secondary Sources containing previous studies, books, references, specialized International Journals, Publications, certified researchers and websites that discussed this topic.

4.11. Data Analysis

Analysis is an interactive process by which answers to be examined to see whether these results support the hypothesis underlying each question.

- In this research, quantitative statistical analysis for questionnaire was done by using Statistical Package for Social Sciences (SPSS). The analysis of data is done to rank the severity of causes of contractor's failure in the State of Qatar. Ranking was followed by comparison of mean values within groups and for the overall sub-factors.
- The opinion of contractors regarding the severity of each cause was checked by analysis of variance (ANOVA).
- The following statistical analysis steps were done:
  1. Coding and defining each variable.

2. Summarizing the data on recording scheme.
3. Entering data to a work sheet.
4. Cleaning data.
5. Mean and rank of each cause.
6. Comparing of mean values for each main group and overall sub-factors.
7. ANOVA test was done to test the difference of answers of contractors regarding to variables.
8. Partial correlation test was done to compare the mean values of different groups.
9. Multi-comparison test was also done when there is a significant difference.

CHAPTER 5
DATA ANALYSIS AND DISCUSSION

5.1. Introduction

The study aimed to determine the risk factors in construction projects, severity and allocation of these risk factors, methods used to deal with risks and finally the techniques used in analyzing these risks. The results of the study are illustrated in this chapter. Mainly, the severity and allocation of each risk factor, methods of dealing with these risks and techniques of analysis. Finally, the results and findings of this research are discussed in detail.

5.2. Participants’ Personal Data in the Questionnaire

5.2.1. Participants' qualifications

As shown in Table (5.1), (89%) of the sample are “Bachelor” and the frequency is (89), (8%) of the sample are " Master " and the frequency is (8) and (3%) of the sample are " PhD " holders and the frequency is (3). As a conclusion, the percent of master participants is higher than PhD but the percent of bachelor is the highest.

Table 5.1: Frequency and percentage of participants’ qualifications

Qualification	Frequency	Percent (%)
Bachelor	89	89
Master	8	8
PhD	3	3

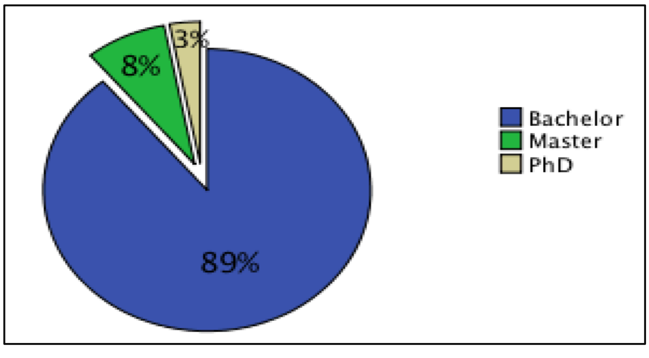


Figure 5.1: Percentage of participants’ qualifications

5.2.2. Participants' job positions

It was found that 5 (5%) participants were directors, 21 (21%) were executive Managers, 59 (59%) were project(s) managers and 15 (15%) were site or office Engineers. The analysis shows that in terms of roles within the construction industry, directors were the smallest group in the sample, and that the majority were in roles other than executive managers, project(s) manager or site engineers. The distribution is shown in Figure 5.2

Table 5.2: Frequency and percentage of participants' job positions

Job Position	Frequency	Percent (%)
Director	5	5
Executive Management	21	21
Project(s) Manager	59	59
Site/Office Engineer	15	15

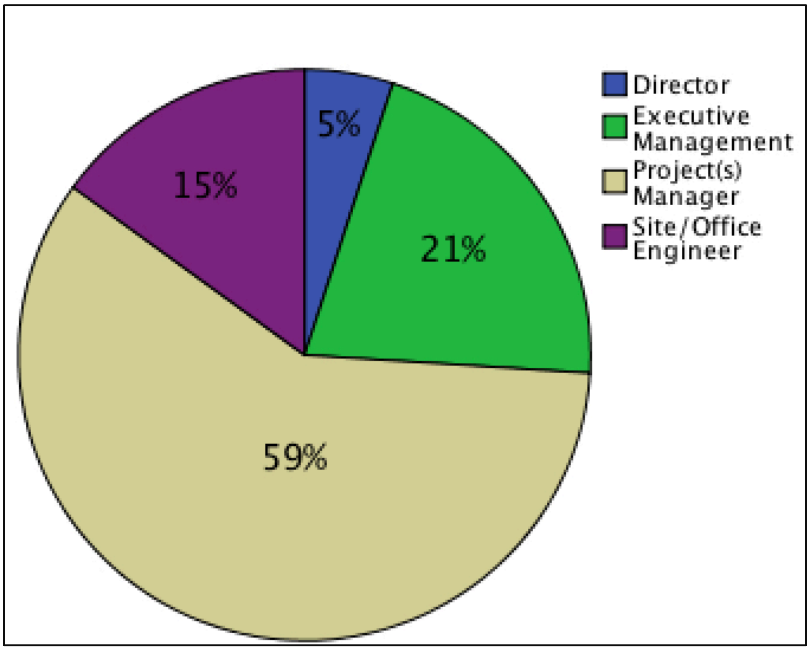


Figure 5.2: Percentage of participants' job positions

5.2.3. Participants' organizations

Participants were asked to indicate what type of company they worked for 16 (16%) responded that they worked for government, 17 (17%) for consultant and 67 (67%) for contractor. Thus, the majority of the participants worked in contractor companies and the fewest worked in government. The distribution is shown in Figure 5.3.

Table 5.3: Frequency and percentage of participants' organizations

Organization	Frequency	Percent (%)
Government	16	16
Consultant	17	17
Contractor	67	67

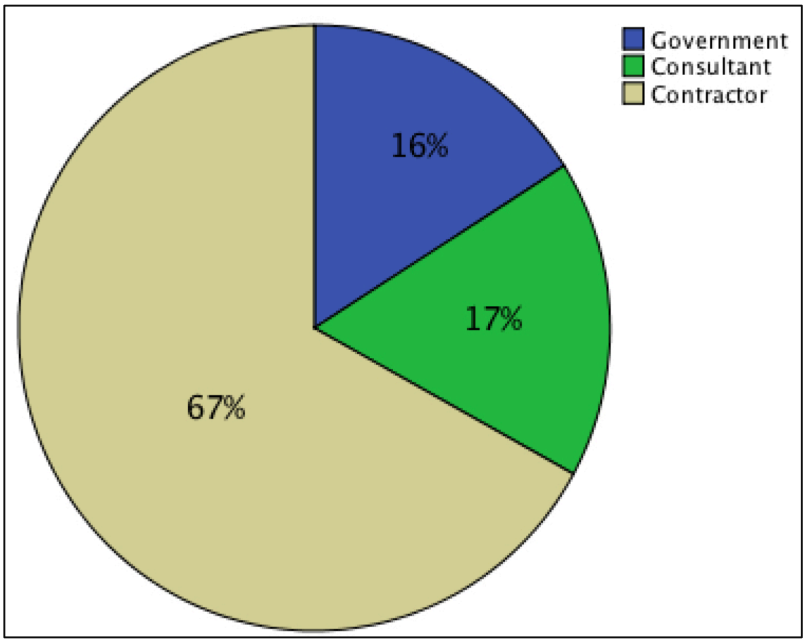


Figure 5.3: Percentage of participants' organizations

5.2.4. Participants' years of experience

It was found that 6 (6%) participants had 31-40 years of construction experience, 32 (32%) had 21-30 years of construction experience, 55 (55%) had 11-20 years and 7 (7%) had 1-10 years of experience. Thus, the majority had over 31 years of construction experience while the fewest had 0-2 years of experience. The distribution according to length of experience is shown in Figure 5.4.

Table 5.4: Frequency and percentage of participants' years of experience

Years of Experience	Frequency	Percent (%)
1 – 10 years	7	7
11 – 20 years	55	55
21 – 30 years	32	32
31 – 40 years	6	6

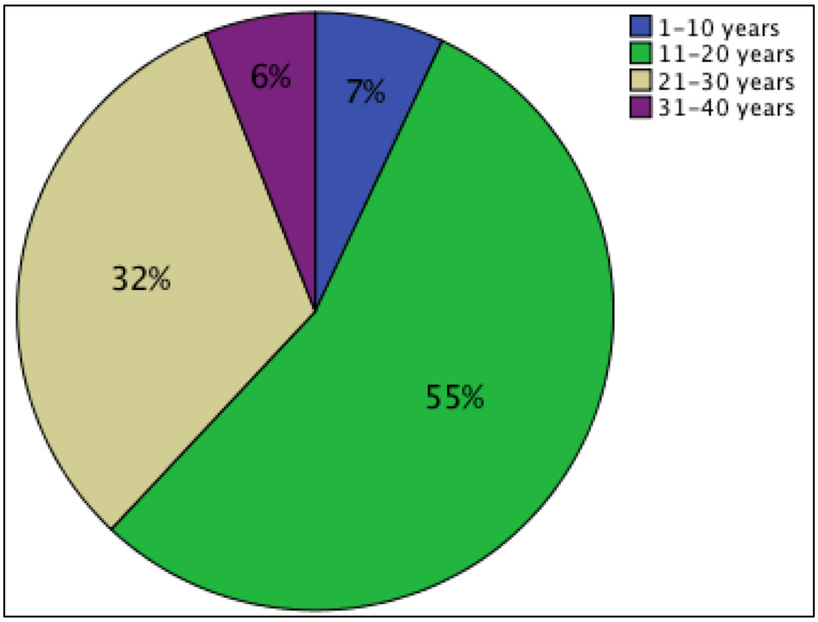


Figure 5.4: Percentage of participants' years of experience

5.3. Risk Factors

The survey questionnaire included 58 risk factors, which have been categorized in seven main groups, these groups were: construction group, political & governmental group, financial group, legal group, environmental group, design group and management group. The factors of each group will be demonstrated in the terms of severity and allocation according to the participants' answers.

5.3.1. Construction group (Group 1)

5.3.1.1. Severity

Results showed that the departure of key staff during the project with severity (4.44) is the most important risk factor in the construction group as shown in (Table 5.5), poor supervision of site construction with severity (3.94) was the second from importance, the third was the unpredicted technical problems during construction with severity (3.87), the forth from importance was poor coordination between the main contractor and his sub-contractors with severity (3.85), the fifth from importance was poor labor productivity with severity (3.80), the sixth from importance was frequent changes of design by Owner with severity (3.70), the seventh from importance was shortage of efficient manpower with severity (3.68), the eighth from importance was shortage of acceptable materials with severity (3.63), the ninth from importance was shortage of proper equipment with severity (3.62), the tenth from importance was late delivery of materials with severity (3.51), the eleventh from importance was late changes to the design with severity (3.44), the twelfth from importance was poor performance and poor management of sub-contractors with severity (3.29), the thirteenth from importance was discrepancies between the intended and the executed works due to incomplete or contradictory drawings and specifications with severity (2.83), the fourteenth from importance was undocumented change orders with severity (2.80), the fifteenth from importance was delays caused by third-party's with severity (2.56), the sixteenth from importance was lack of qualified staff with severity (2.48), the seventeenth from importance was unqualified staff in the construction project team with severity (2.48), the eighteenth from importance was labor strikes and disputes with severity (2.46), the nineteenth from importance was poor quality of workmanship with severity (2.34) and finally, disputes in contract variation with severity (2.24) was the twentieth from importance.

Table 5.5: Ranking of Construction group' risk factors

No.	Construction Group Risk factors	Weight	Severity (1-5)
15	Departure of key staff during the project	444	4.44
9	Poor supervision of site construction	394	3.94
3	Unpredicted technical problems during construction	387	3.87
1	Poor coordination between the main contractor and his sub-contractors	385	3.85
6	Poor labor productivity	380	3.80
13	Frequent changes of design by Owner	370	3.70
20	Shortage of efficient manpower	368	3.68
19	Shortage of acceptable materials	363	3.63
18	Shortage of proper equipment	362	3.62
4	Late delivery of materials	351	3.51
12	Late changes to the design	344	3.44
2	Poor performance and poor management of sub-contractors	329	3.29
8	Discrepancies between the intended and the executed works due to incomplete or contradictory drawings and specifications	283	2.83
7	Undocumented change orders	280	2.80
17	Delays caused by third-party's	256	2.56
14	Lack of qualified staff	248	2.48
16	Unqualified staff in the construction project team	248	2.48
11	Labor strikes and disputes	246	2.46
5	Poor quality of workmanship	234	2.34
10	Disputes in contract variation	224	2.24

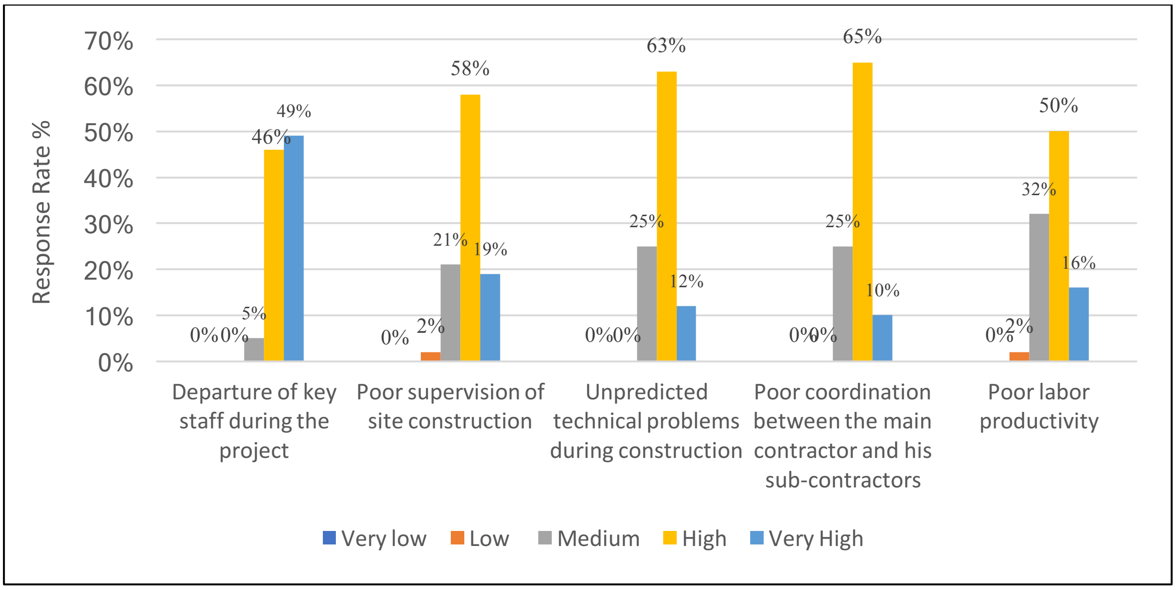


Figure 5.5: Severity of Construction group' top 5 risk factors

5.3.1.2. Allocation

The criterion for a risk to appropriated to a particular category (contractor, owner and shared), was that it should get at least (60%) response rate to achieve the mainstream of the rates. Those that failed to get such response rate in favor of any category were listed as undecided. As shown in Figure (5.6), participants had considered that contractors should bear the risks of poor coordination between the main contractor and his sub-contractors with (99%), poor performance and poor management of sub-contractors with (97%), also, the majority of participants had considered that with (100%) contractors should bear the risks of late delivery of materials, poor quality of workmanship, poor labor productivity, labor strikes and disputes and unqualified staff in the construction project team.

On the other hand, the majority of participants had considered that owners should bear the risks of frequent changes of design by owner with (100%)

Finally, unpredicted technical problems during construction with (97%), undocumented change orders with (84%), discrepancies between the intended and the executed works due to incomplete or contradictory drawings and specifications with (65%), poor supervision of site construction with (60%), disputes in contract variation with (96%), late changes to the design with (60%), lack of qualified staff with (100%), departure of key staff during the project with (100%) and delays caused by third-party's with (100%) were considered as shared risks (share the risk between the owner and the contractor).

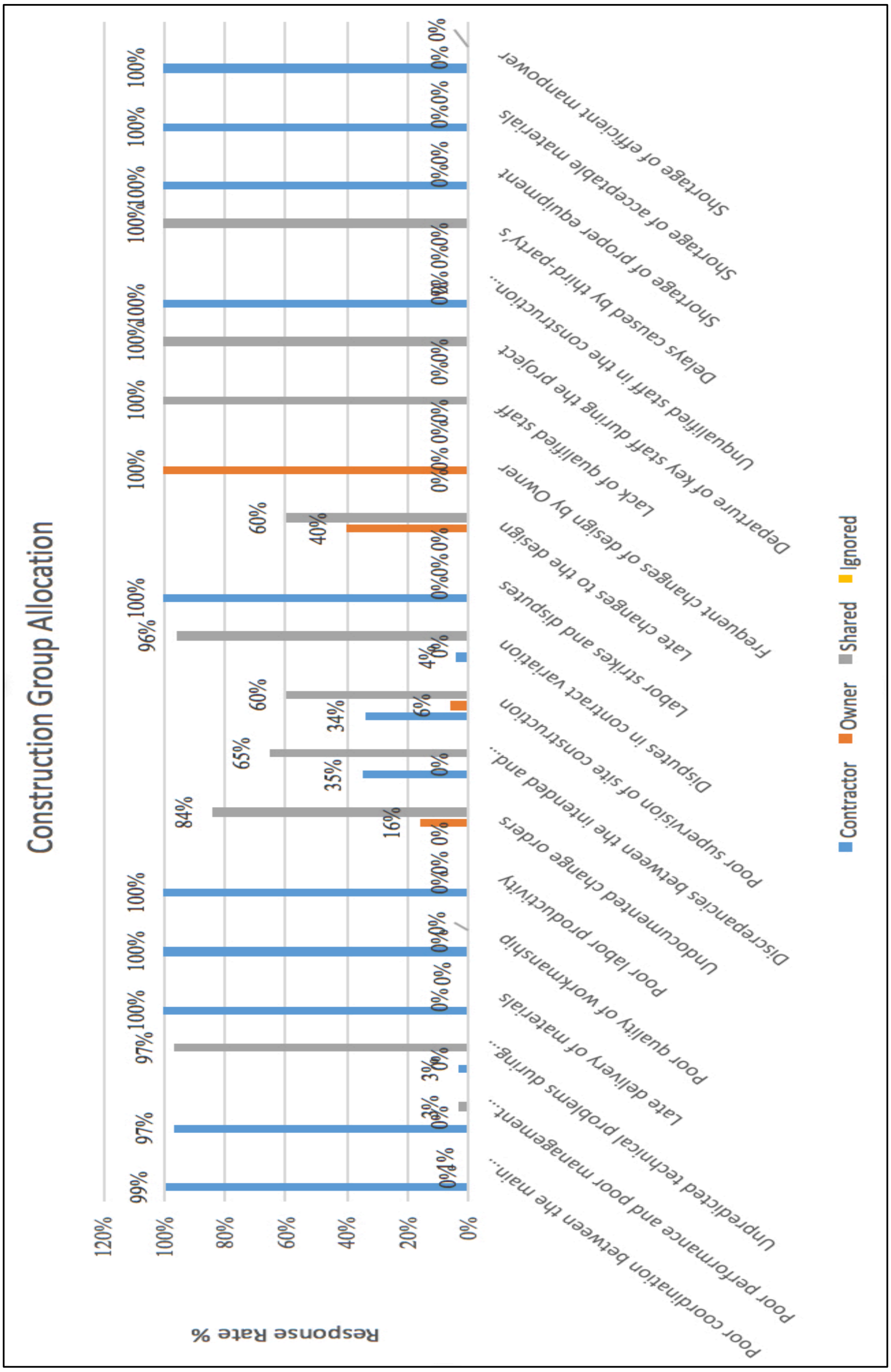


Figure 5.6: Allocation of Construction group' risk factors

5.3.2. Political & Governmental group (Group 2)

5.3.2.1. Severity

Table (5.6) illustrates the ranking of political and governmental group risks. Most of participants considered the sanctions is very high risk factor with severity (4.68), the second from importance was delay in project approvals and permits with severity (3.09), the third from importance was changes in laws and regulations with severity (3.02). In addition, participants appeared that they do not care about threat of war with severity (2.94) and political instability with severity (2.80). The reason is that these factors have limited effects on construction issues. Finally, corruption and bribery considered as a very low risk with severity (1.69).

Table 5.6: Ranking of Political & Governmental group' risk factors

No.	Political & governmental group risk factors	Weight	Severity (1-5)
24	The sanctions	468	4.68
23	Delay in project approvals and permits	309	3.09
21	Changes in laws and regulations	302	3.02
25	Threat of war	294	2.94
26	Political instability	280	2.80
22	Corruption and bribery	169	1.69

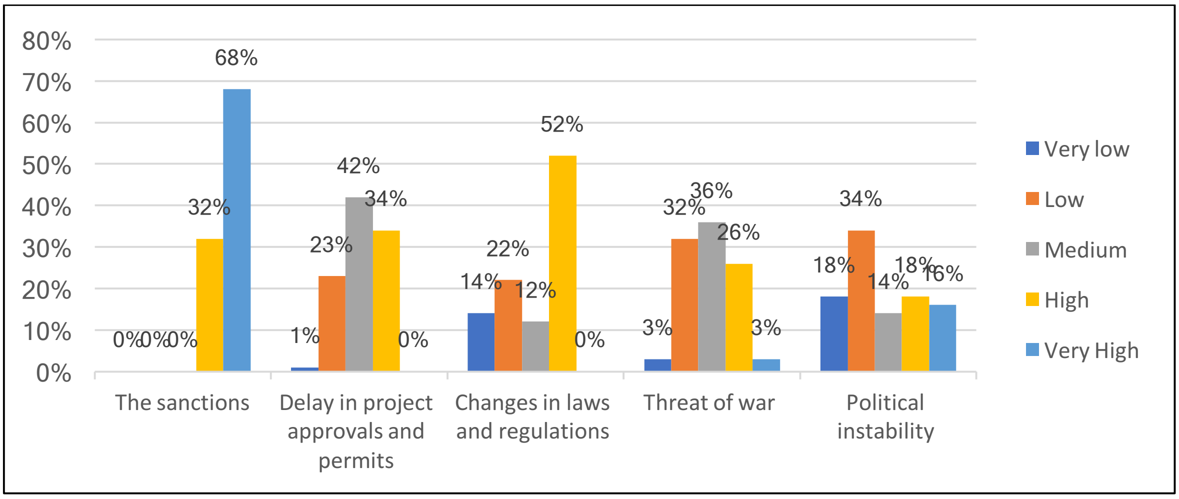


Figure 5.7: Severity of Political & Governmental group' risk factors

5.3.2.2. Allocation

As shown in Figure (5.8), participants had considered with (100%) that the siege, delay in project approvals and permits, threat of war, political instability and corruption and bribery should be shared risks. In addition, they considered changes in laws and regulations is also shared risk with (88%).

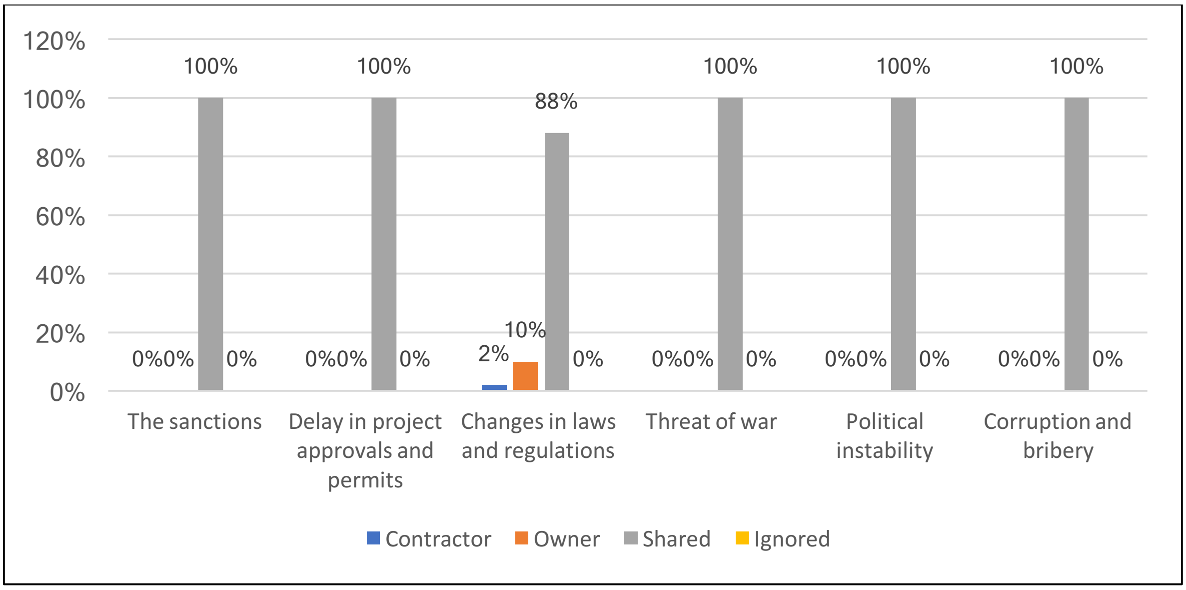


Figure 5.8: Allocation of Political & Governmental group' risk factors

5.3.3. Financial group (Group 3)

5.3.3.1. Severity

Table (5.7) demonstrates the ranking of financial group risks. Most of financial risks got the high scores of surveyed risk factors given by participants. They had considered financial failure of the owner with severity (4.21) is the most important risk factor in the financial group, delayed payments to the contractor with severity (4.10) was the second from importance, the third was financial failure of the contractor with severity (3.97), the forth from importance was monopolizing of materials due to the sanctions and other unexpected political conditions with severity (3.88), the fifth from importance was cash flow difficulties with severity (3.87), the sixth from importance was wrong project estimation with severity (3.75), the seventh from importance was inflation and unforeseen increases in material and equipment prices with severity (3.64), the eighth from importance was lack of financial resources with severity (3.49), the ninth from importance was staff strike due to delayed salaries with severity (2.57) and finally the tenth from importance was fluctuations in exchange rates with severity (1.95).

Table 5.7: Ranking of Financial group' risk factors

No.	Financial group risk factors	Weight	Severity (1-5)
33	Financial failure of the owner	421	4.21
30	Delayed payments to the contractor	410	4.10
32	Financial failure of the contractor	397	3.97
34	Monopolizing of materials due to the sanctions and other unexpected political conditions	388	3.88
28	Cash flow difficulties	387	3.87
27	Wrong project estimation	375	3.75
36	Inflation and unforeseen increases in material and equipment prices	364	3.64
29	Lack of financial resources	349	3.49
35	Staff strike due to delayed salaries	257	2.57
31	Fluctuations in exchange rates	195	1.95

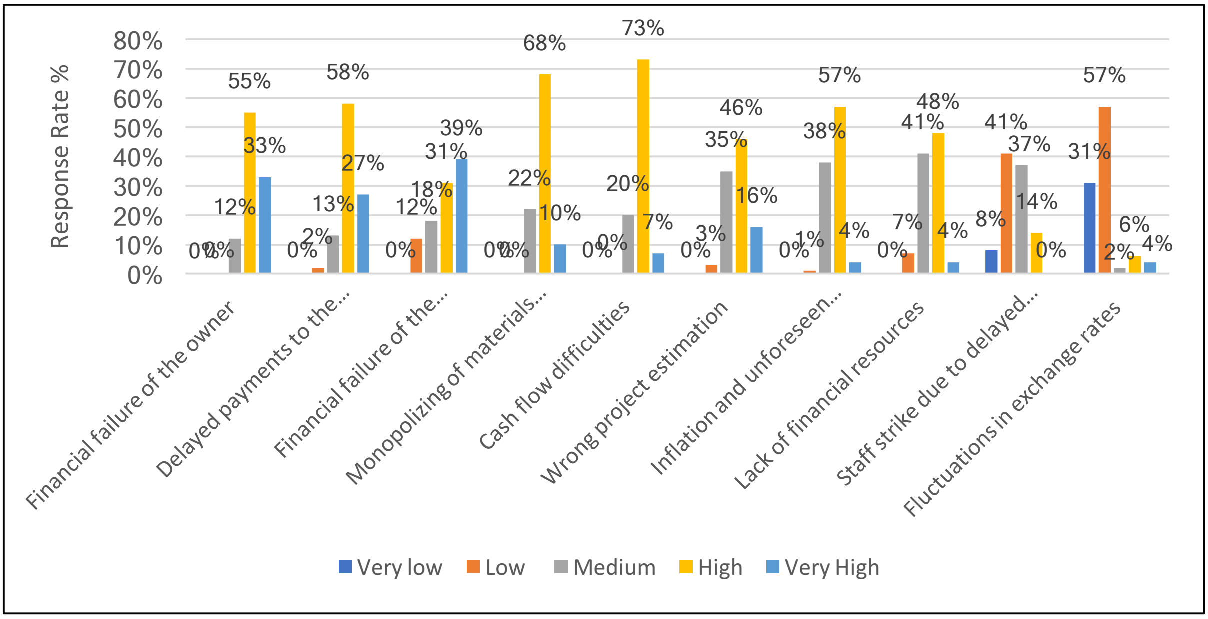


Figure 5.9: Severity of Financial group' risk factors

5.3.3.2. Allocation

Figure (5.10) shows that participants had considered that contractors should bear the risk of financial failure of the contractor with (100%).

On the other hand, they had considered that owners should bear the risks of financial failure of the owner with (93%) and delayed payments to the contractor with (96%).

Finally, the majority of participants had considered that monopolizing of materials due to the sanctions and other unexpected political conditions, Cash flow difficulties, inflation and unforeseen increases in material and equipment prices and fluctuations in exchange rates with (100%) should be shared risks. In addition, wrong project estimation with (89%) and staff strike due to delayed salaries with (80%) were considered as shared risks. furthermore, lack of financial resources had considered as undecided because this risk had failed to get such response rate in favor of any category.

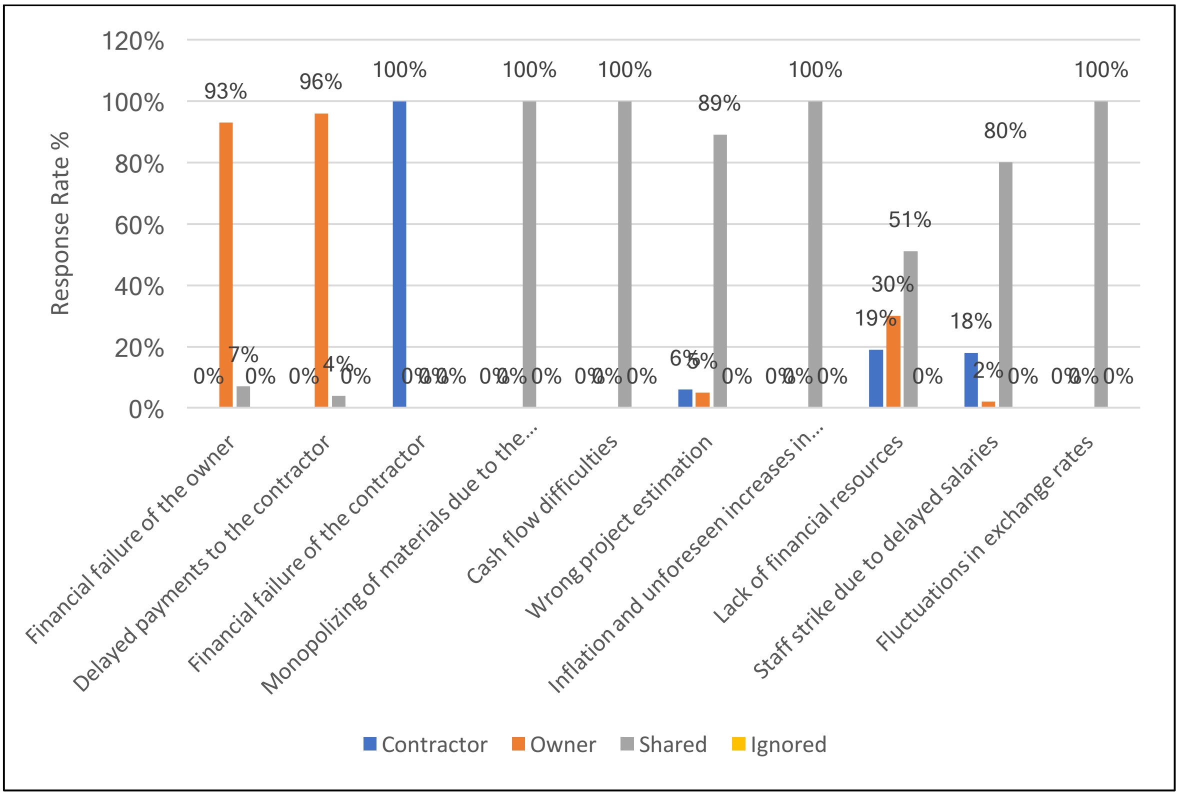


Figure 5.10: Allocation of Financial group’ risk factors

5.3.4. Legal group (Group 4)

5.3.4.1. Severity

Table (5.8) proves that delays in resolving disputes with (3.97) has the highest weight in the legal group, which indicates the importance of it. In addition, participants had considered that the disputes between main contractor and his subcontractors with (3.38) is the second from importance and delays in resolving contractual issues with (3.32) is the third from importance. Finally, disputes between owner and main contractor came in the tail with (2.83). Abu Mousa (2005) and Ahmed et al. (1999) supported these results.

Table 5.8: Ranking of Legal group' risk factors

No.	Legal group risk factors	Weight	Severity (1-5)
39	Delays in resolving disputes	397	3.97
38	Disputes between main contractor and his subcontractors	338	3.38
40	Delays in resolving contractual issues	332	3.32
37	Disputes between owner and main contractor	283	2.83

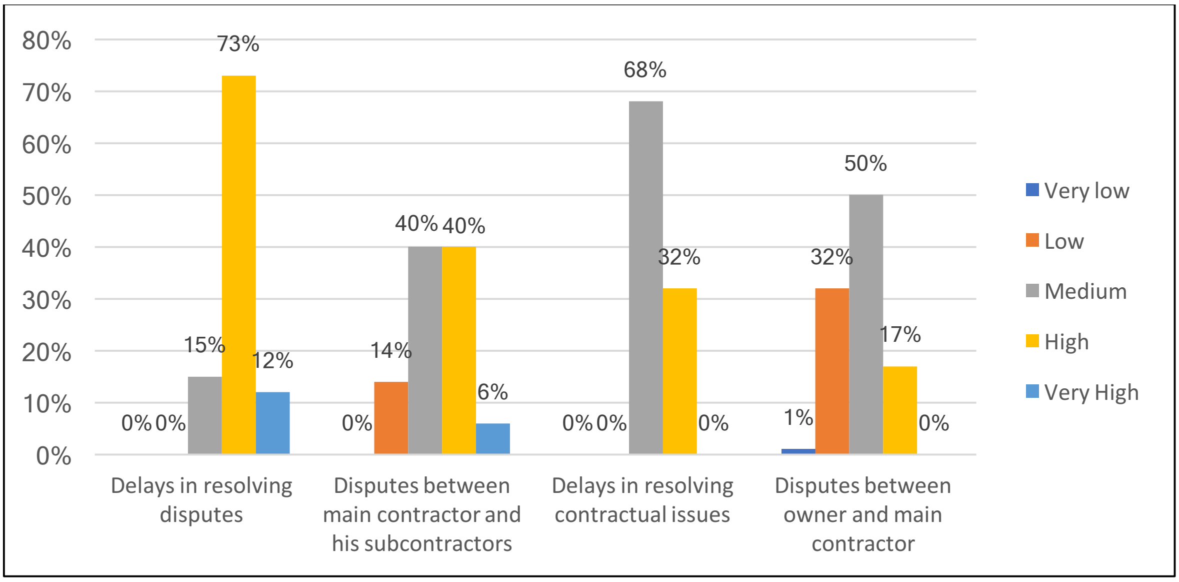


Figure 5.11: Severity of Legal group' risk factors

5.3.4.2. Allocation

Figure (5.12) demonstrates the allocation of legal group risk factors according to the participants. They had considered with (80%) that contractors should bear the risk of disputes between main contractor and his subcontractors. By contrast, (20%) of participants shared this risk.

On the other hand, the majority of participants had considered that owners should not bear any of the legal risks.

Finally, it is obvious that the greatest part of participants deal with legal risk factors as shared risks, they had considered that delays in resolving disputes, delays in resolving contractual issues and disputes between owner and main contractor should be shared risks with (100%).

Enshassi, A. and Abu Mosa, J. (2008) supported these findings. Considering the risk factors of delayed disputes resolutions and legal disputes during the construction phase among the parties of the contract preferred to be shared between contractor and owner by (94%).

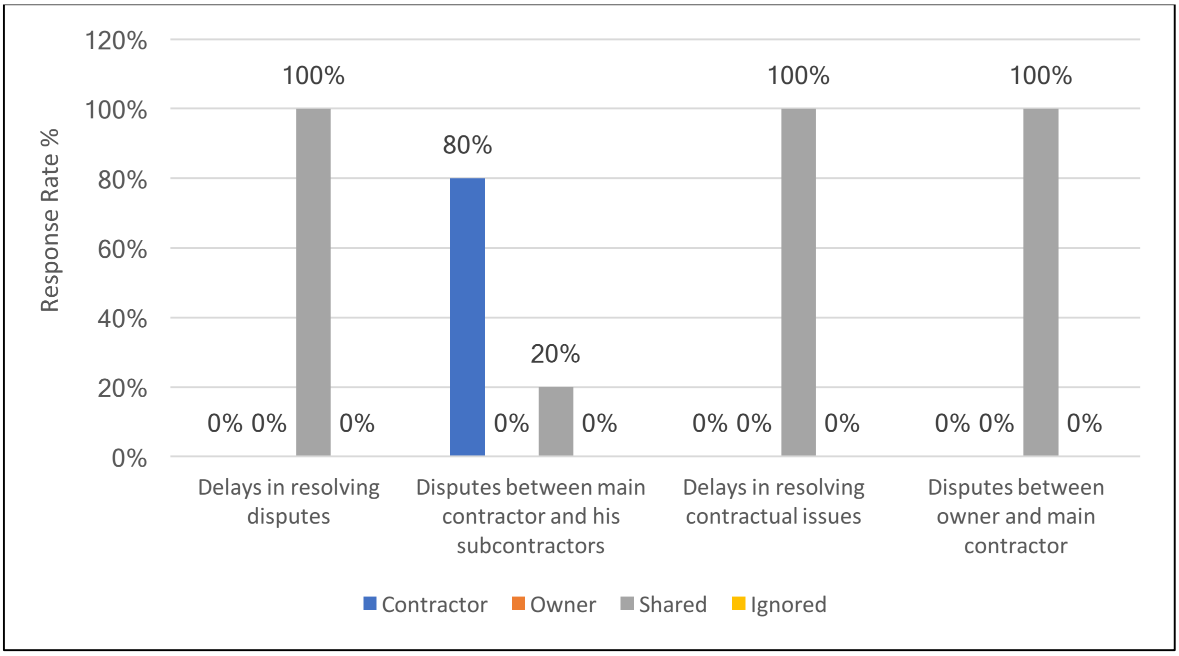


Figure 5.12: Allocation of Legal group' risk factors

5.3.5. Environmental group (Group 5)

5.3.5.1. Severity

Table (5.9) shows the ranking of environmental group risks. Participants had considered adverse weather conditions with severity (1.57) as a main case of delay in environmental group. Secondly, they considered ecological damage with (1.42) the second from importance. These risks categories increase the probability of uncertain, unpredictable and even undesirable factors in the construction site.

However, the risk of difficulty to access the site appear with very low severity (1.16) among the environmental group. Environmental risk factors (catastrophes) occurred hardly ever, that is why the weight of the risk of environmental factors was relatively low. These results are supported with the outcomes of (Kartam, 2001).

Table 5.9: Ranking of Environmental group' risk factors

No.	Environmental group risk factors	Weight	Severity (1-5)
43	Adverse weather conditions	157	1.57
41	Ecological damage	142	1.42
42	Difficulty to access the site	116	1.16

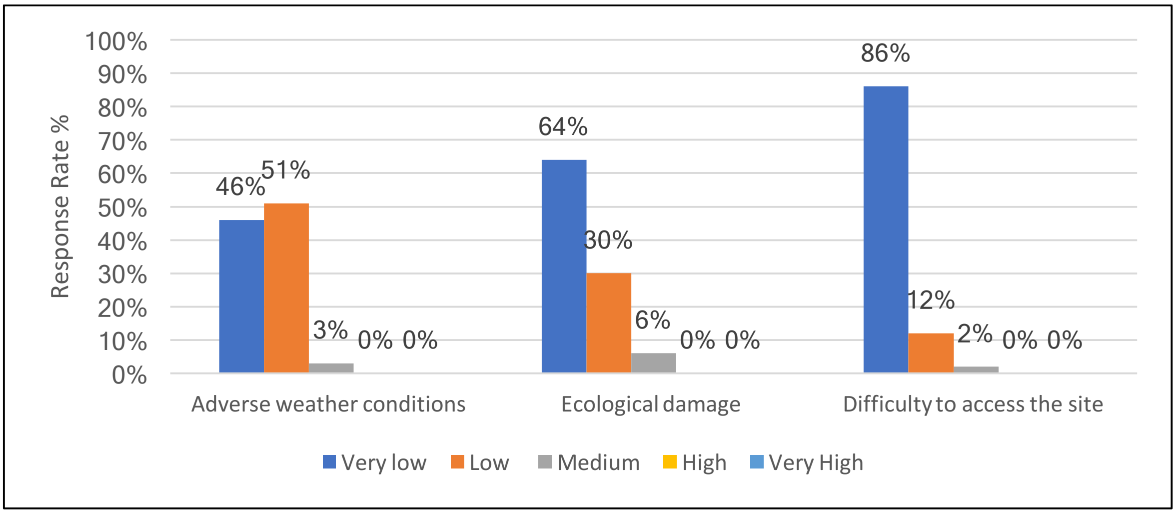


Figure 5.13: Severity of Environmental group' risk factors

5.3.5.2. Allocation

Figure (5.14) shows that contractors and owners were not decided on the allocation of risk of difficulty to access the site. Moreover, a great share of participants (49%) decided to ignored this risk. as a matter of fact, site access risk need to be borne by the owner who should evaluate the needs during the planning phase (Smith & Gavin, cited in Ahmed el al., 1999), but due to the ongoing tense situation, contractors and owners have to coordinate their efforts to get a best handling of such risks.

On the other hand, (12%) of participants considered the risk of adverse weather conditions as a shared risk, while (82%) considered to ignore this risk; in other words, they were not decided on this risk's allocation.

Finally, ecological damage had considered as undecided because this risk had failed to get such response rate in favor of any category. These results are supported with the outcomes of (Abd Karim et al., 2012)

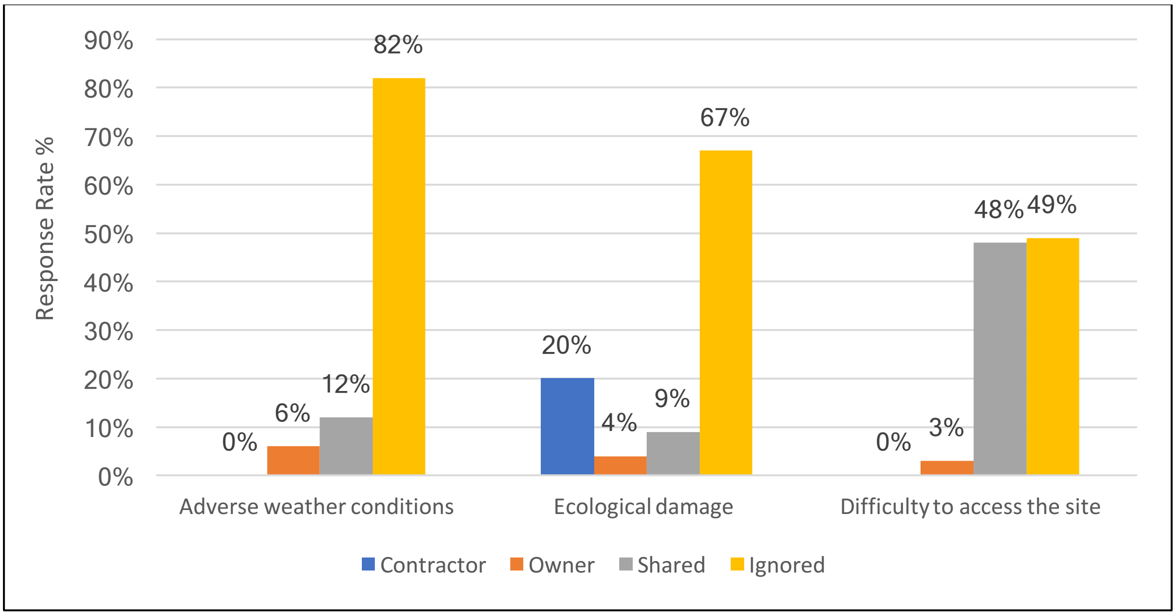


Figure 5.14: Allocation of Environmental group' risk factors

5.3.6. Design group (Group 6)

5.3.6.1. Severity

Design group risk factors included some of the most important surveyed risks. As shown in table (5.10) demonstrates the ranking of design group risk factors, lack of design coordination between the disciplines with severity (4.04) and lack of consistency between bill of quantities, drawings and specifications with severity (4.00) are the most important risk factors in design group. on the other hand, these risks can be overcome by paying true attention and coordinate correctly between design disciplines. Furthermore, participants had considered design deficiencies with severity (3.77) as the third from importance. This result also show that contractors suffer from insufficient or incorrect design information. These results complied with the results of (Lemos et al., 2004) and (Enshassi, 2008). It has to be noted that contractors should concerned about design deficiency issues because they could be responsible about any critical issues could happen due to incorrect design. The forth from importance was Inaccurate quantities with severity (3.59), the fifth from importance was deficiencies in drawings and specifications with severity (3.53), inexperienced or unqualified design team was the sixth from importance with severity (3.48). Other design risk factors considered medium risks by participants.

Table 5.10: Ranking of Design group' risk factors

No.	Design group risk factors	Weight	Severity (1-5)
46	Lack of design coordination between the disciplines (architectural, structural, MEP, HVAC, etc.)	404	4.04
50	Lack of consistency between bill of quantities, drawings and specifications	400	4.00
44	Design deficiencies	377	3.77
49	Inaccurate quantities	359	3.59
47	Deficiencies in drawings and specifications	353	3.53
52	Inexperienced or unqualified design team	348	3.48
45	Late issue of drawings and documents	328	3.28
48	Changes to the scope of work	321	3.21

51	Frequent changes of design by designers	299	2.99

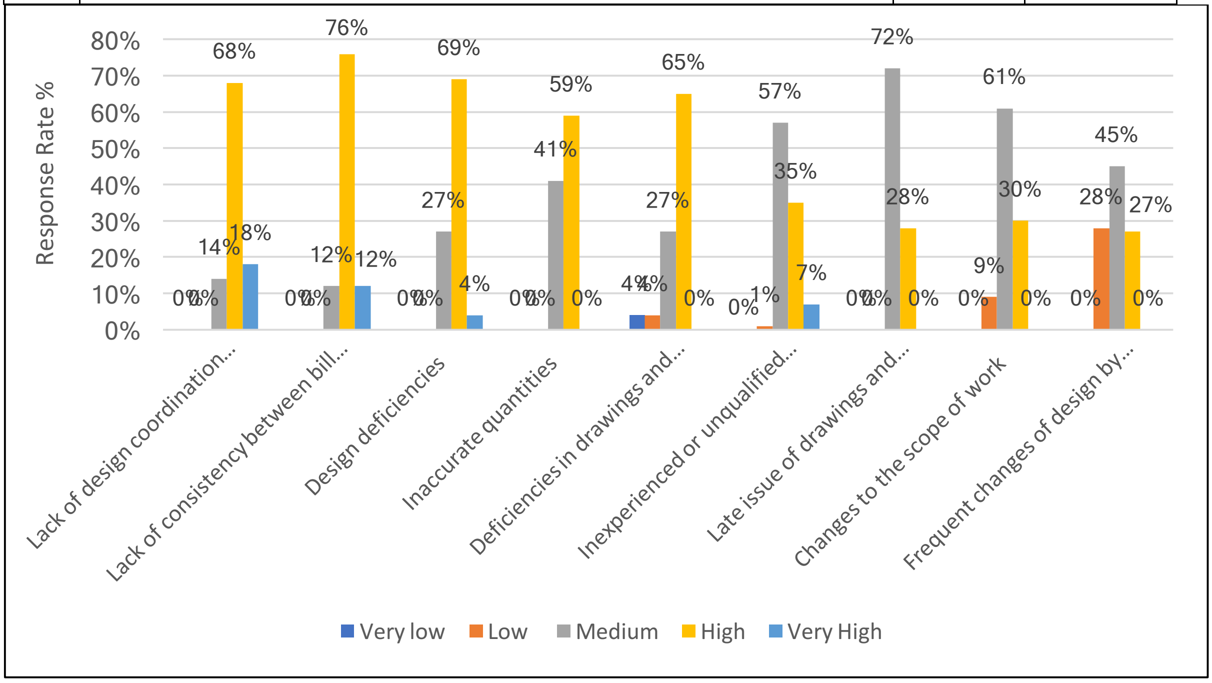


Figure 5.15: Severity of Design group' risk factors

5.3.6.2. Allocation

Figure (5.16) proves that participants had considered that contractors should not bear any of design risk factors.

On the other hand, they had considered that owners should bear the risks of design deficiencies with (70%), deficiencies in drawings and specifications with (81%), inexperienced or unqualified design team with (95%), late issue of drawings and documents with (60%), changes to the scope of work with (93%) and frequent changes of design by designers with (93%). Major allocation percent were heading towards owners who are in a better position to supply sufficient and accurate drawings on the design and services. These findings complied with results of (Ahmed et al., 1999) and (Kartam, 2001) who stated that the owner could best manage deficiencies in specifications and drawings by appointing a capable consultant and providing sufficient design budget. These findings also complied with results of (Enshassi, 2008).

Finally, participants had considered that lack of design coordination between the disciplines (architectural, structural, MEP, HVAC, etc.) with (81%), lack of consistency between bill of quantities, drawings and specifications with (77%) and inaccurate quantities with (72%) should be shared risks.

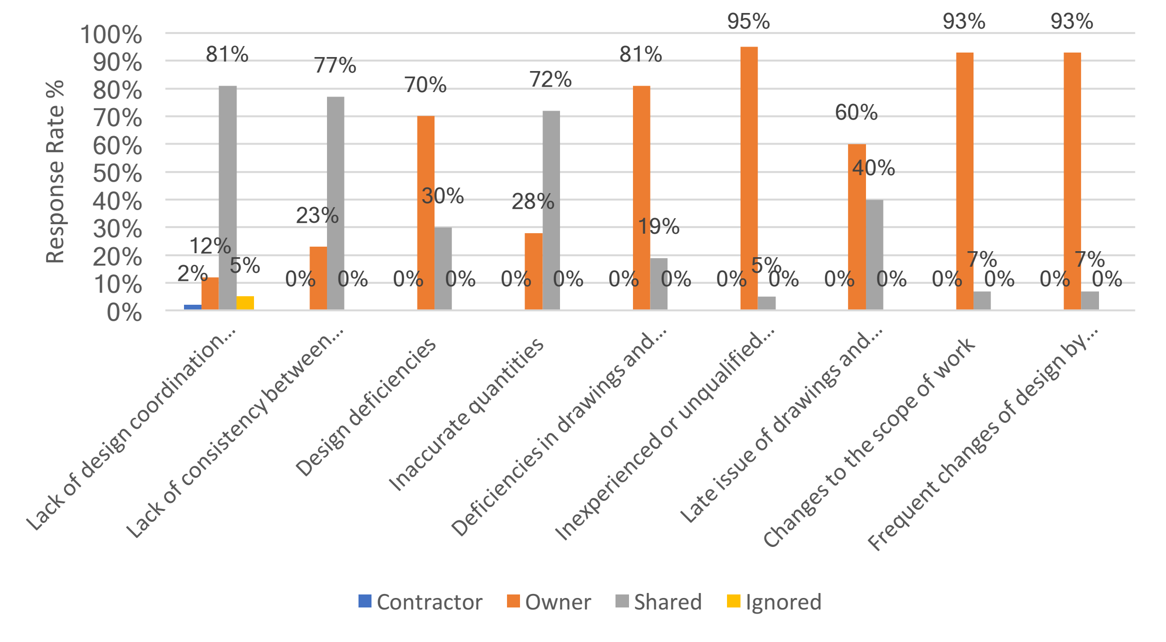


Figure 5.16: Allocation of Design group' risk factors

5.3.7. Management group (Group 7)

5.3.7.1. Severity

Table (5.11) shows the ranking of management group risk factors. Poor initial planning (scheduling) ranked as first from importance with severity (3.90), the second was poor procurement management with severity (3.55), poor communications management with severity (3.21) was the third and the fourth from importance was unclear or contradictory information with severity (3.21). In addition, frequent changes in organization chart for the assigned locations for construction project staff was the fifth from importance with severity (3.20) and finally frequent changes in staff was the last from importance with severity (3.07). These figures indicate the importance of management topics for participants and indicates the existence of these risks, which need more and more applying management rules and training to properly manage projects especially the large ones.

Table 5.11: Ranking of Management group' risk factors

No.	Management group risk factors	Weight	Severity (1-5)
55	Poor initial planning (scheduling)	390	3.90
53	Poor procurement management	355	3.55
54	Poor communications management	321	3.21
56	Unclear or contradictory information	321	3.21
58	Frequent changes in organization chart for the assigned locations for construction project staff	320	3.20
57	Frequent changes in staff	307	3.07

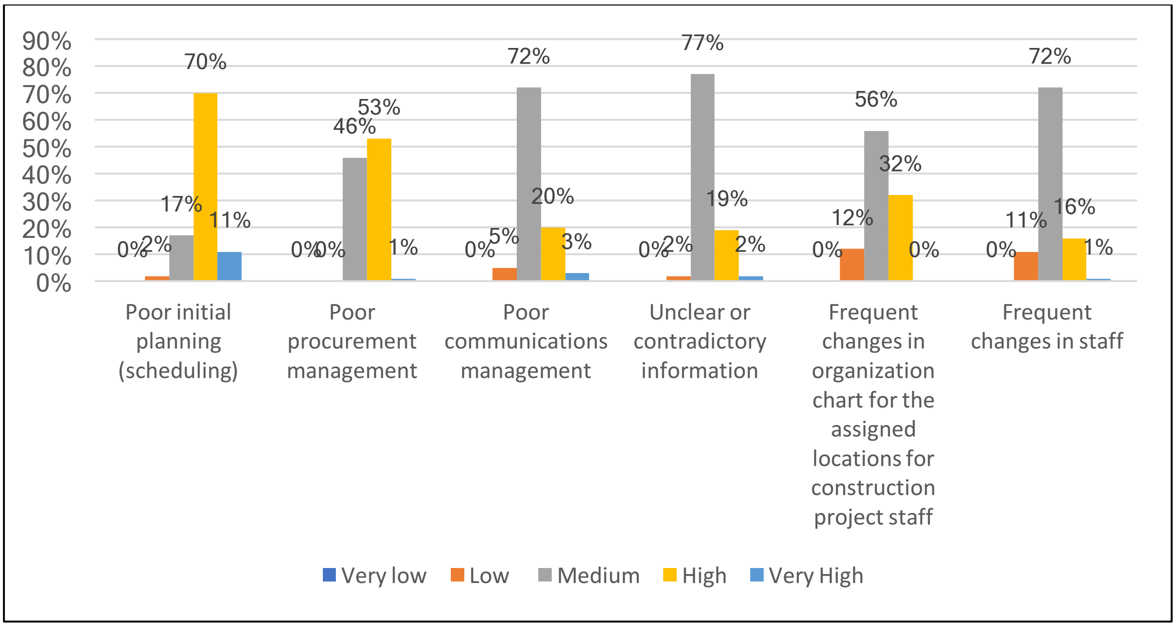


Figure 5.17: Severity of Management group' risk factors

5.3.7.2. Allocation

Figure (5.18) illustrates the allocation of management group risk factors. Participants had considered that contractors should bear the risk of poor procurement management with (99%), frequent changes in organization chart for the assigned locations for construction project staff with (100%) and frequent changes in staff with (87%).

On the other hand, they had considered that owners should bear the risks of poor initial planning (scheduling) and unclear or contradictory information risk factors with (88%) and (73%) respectively.

Finally, the majority of participants had considered that poor communications management with (100%) should be a shared risk. This risk factor should be really considered as shared risk because it's the contractors' and owners' duty to communicate to put a clear and good plan for the project execution, to solve any ambiguous problem and to maintain a good communication in favor of project accomplishment.

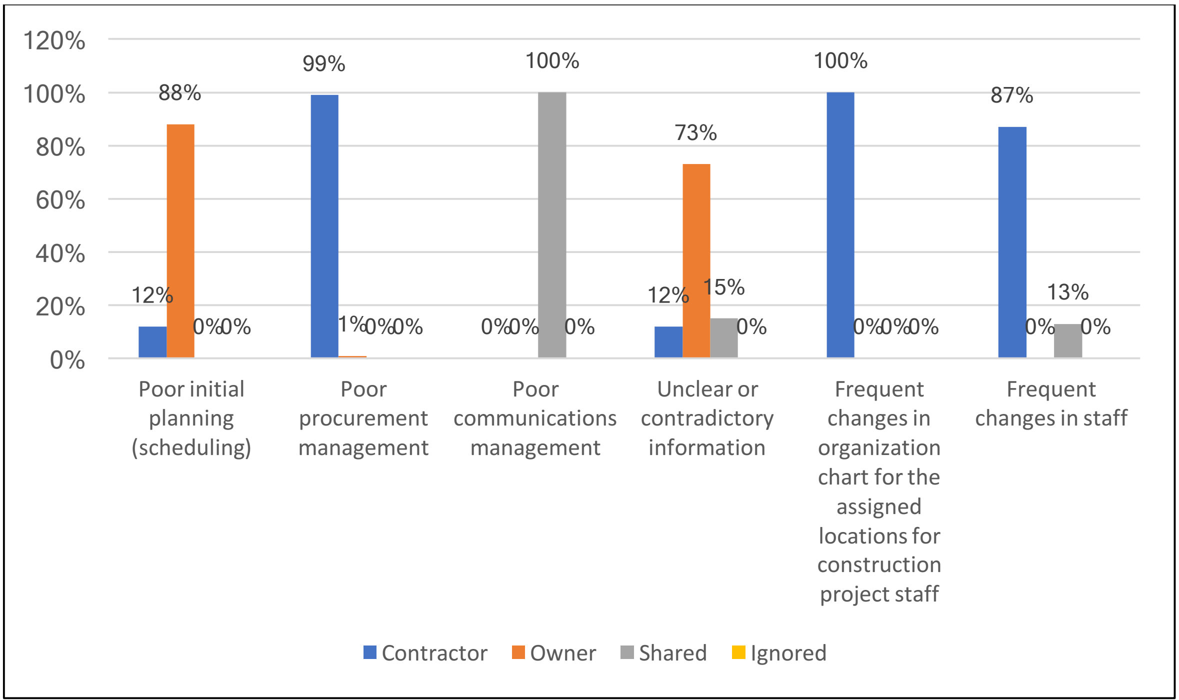


Figure 5.18: Allocation of Management group' risk factors

5.4. Overall Risk Factors Severity and Allocations

5.4.1. Severity

Table (5.12) demonstrates all 58 risk factors included in the survey questionnaire ranked in descending order according to their weight and severity from the participants' perspective. The result shows that State of Qatar participants considered the sanctions to be the most important construction risk factor by giving it a score of (468). Followed by departure of key staff during the project with a score of (444). The scores range of the top 5 important risk factors between (404) and (468). The least important risk factor from participants' perspective is the risk of difficulty to access the site with a score of (116), followed by ecological damage with a score of (142). The scores range of the lowest 5 risk factors between (195) and (116).

The results prove that participants considered (11%) of the risk factors as very high important risks, (59%) of the risk factors as high risks, (22%) of the risk factors as medium risks and finally (8%) of the risk factors as low risks.

Table 5.12: Ranking of overall risk factors

No.	Risk Factors	Weight	Severity (1-5)
24	The sanctions	468	4.68
15	Departure of key staff during the project	444	4.44
33	Financial failure of the owner	421	4.21
30	Delayed payments to the contractor	410	4.10
46	Lack of design coordination between the disciplines (architectural, structural, MEP, HVAC, etc.)	404	4.04
50	Lack of consistency between bill of quantities, drawings and specifications	400	4.00
39	Delays in resolving disputes	397	3.97
32	Financial failure of the contractor	397	3.97
9	Poor supervision of site construction	394	3.94
55	Poor initial planning (scheduling)	390	3.90
34	Monopolizing of materials due to the sanctions and other unexpected political conditions	388	3.88
3	Unpredicted technical problems during construction	387	3.87
28	Cash flow difficulties	387	3.87
1	Poor coordination between the main contractor and his sub-contractors	385	3.85
6	Poor labor productivity	380	3.80
44	Design deficiencies	377	3.77
27	Wrong project estimation	375	3.75
13	Frequent changes of design by owner	370	3.70
20	Shortage of efficient manpower	368	3.68
36	Inflation and unforeseen increases in material and equipment prices	364	3.64
19	Shortage of acceptable materials	363	3.63

18	Shortage of proper equipment	362	3.62
49	Inaccurate quantities	359	3.59
53	Poor procurement management	355	3.55
47	Deficiencies in drawings and specifications	353	3.53
4	Late delivery of materials	351	3.51
29	Lack of financial resources	349	3.49
52	Inexperienced or unqualified design team	348	3.48
12	Late changes to the design	344	3.44
38	Disputes between main contractor and his subcontractors	338	3.38
40	Delays in resolving contractual issues	332	3.32
2	Poor performance and poor management of sub-contractors	329	3.29
45	Late issue of drawings and documents	328	3.28
54	Poor communications management	321	3.21
56	Unclear or contradictory information	321	3.21
48	Changes to the scope of work	321	3.21
58	Frequent changes in organization chart for the assigned locations for construction project staff	320	3.20
23	Delay in project approvals and permits	309	3.09
57	Frequent changes in staff	307	3.07
21	Changes in laws and regulations	302	3.02
51	Frequent changes of design by designers	299	2.99
25	Threat of war	294	2.94
8	Discrepancies between the intended and the executed works due to incomplete or contradictory drawings and specifications	283	2.83
37	Disputes between owner and main contractor	283	2.83
7	Undocumented change orders	280	2.80
26	Political instability	280	2.80
35	Staff strike due to delayed salaries	257	2.57
17	Delays caused by third-party’s	256	2.56
14	Lack of qualified staff	248	2.48
16	Unqualified staff in the construction project team	248	2.48
11	Labor strikes and disputes	246	2.46
5	Poor quality of workmanship	234	2.34
10	Disputes in contract variation	224	2.24
31	Fluctuations in exchange rates	195	1.95
22	Corruption and bribery	169	1.69
43	Adverse weather conditions	157	1.57
41	Ecological damage	142	1.42
42	Difficulty to access the site	116	1.16

5.4.2. Allocation

Table (5.13) appears the allocation of all risk factors included in the survey questionnaire according to the participants. They have allocated 15 risk factors onto contractor, which signifies that (25.8%) of the risk factors the contractor should handle. They have allocated 11 risk factors onto owner, which signifies that (18.9%) of the risk factors the owner should handle. They also considered 28 risk factors as shared risks, which signifies that (48.2%) of the risk factors should be shared. Finally, they were undecided for 4 risk factors with (7.1%).

Table 5.13: Allocation of overall risk factors

Allocation	Risk Factors
Contractor	Poor coordination between the main contractor and his sub-contractors
	Poor performance and poor management of sub-contractors
	Late delivery of materials
	Poor quality of workmanship
	Poor labor productivity
	Labor strikes and disputes
	Unqualified staff in the construction project team
	Shortage of proper equipment
	Shortage of acceptable materials
	Shortage of efficient manpower
	Financial failure of the contractor
	Disputes between main contractor and his subcontractors
	Poor procurement management
	Frequent changes in organization chart for the assigned locations for construction project staff
	Frequent changes in staff
Owner	Frequent changes of design by Owner
	Financial failure of the owner
	Delayed payments to the contractor
	Design deficiencies
	Deficiencies in drawings and specifications
	Inexperienced or unqualified design team
	Late issue of drawings and documents
	Changes to the scope of work
	Frequent changes of design by designers
	Poor initial planning (scheduling)
	Unclear or contradictory information
	Unpredicted technical problems during construction
	Undocumented change orders

Shared	Discrepancies between the intended and the executed works due to incomplete or contradictory drawings and specifications
	Poor supervision of site construction
	Disputes in contract variation
	Late changes to the design
	Lack of qualified staff
	Departure of key staff during the project
	Delays caused by third-party's
	The sanctions
	Delay in project approvals and permits
	Changes in laws and regulations
	Threat of war
	Political instability
	Corruption and bribery
	Monopolizing of materials due to the sanctions and other unexpected political conditions
	Cash flow difficulties
	Wrong project estimation
	Inflation and unforeseen increases in material and equipment prices
	Staff strike due to delayed salaries
	Fluctuations in exchange rates
	Delays in resolving disputes
	Delays in resolving contractual issues
	Disputes between owner and main contractor
	Lack of design coordination between the disciplines (Architectural, Structural, MEP, HVAC, etc.)
	Lack of consistency between bill of quantities, drawings and specifications
	Inaccurate quantities
	Poor communications management
Undecided	Lack of financial resources
	Adverse weather conditions
	Ecological damage
	Difficulty to access the site

5.5. Risk Management Actions

5.5.1. Preventive actions

Based on the survey results (Figure 5.19), participants usually depend on rely on subjective judgment to produce a program (Schedule) is the most effective risk preventive actions. Judgment or subjective probability uses the experience gained from similar projects undertaken in the past by the decision maker to decide on the likelihood of risk exposure and the outcomes.

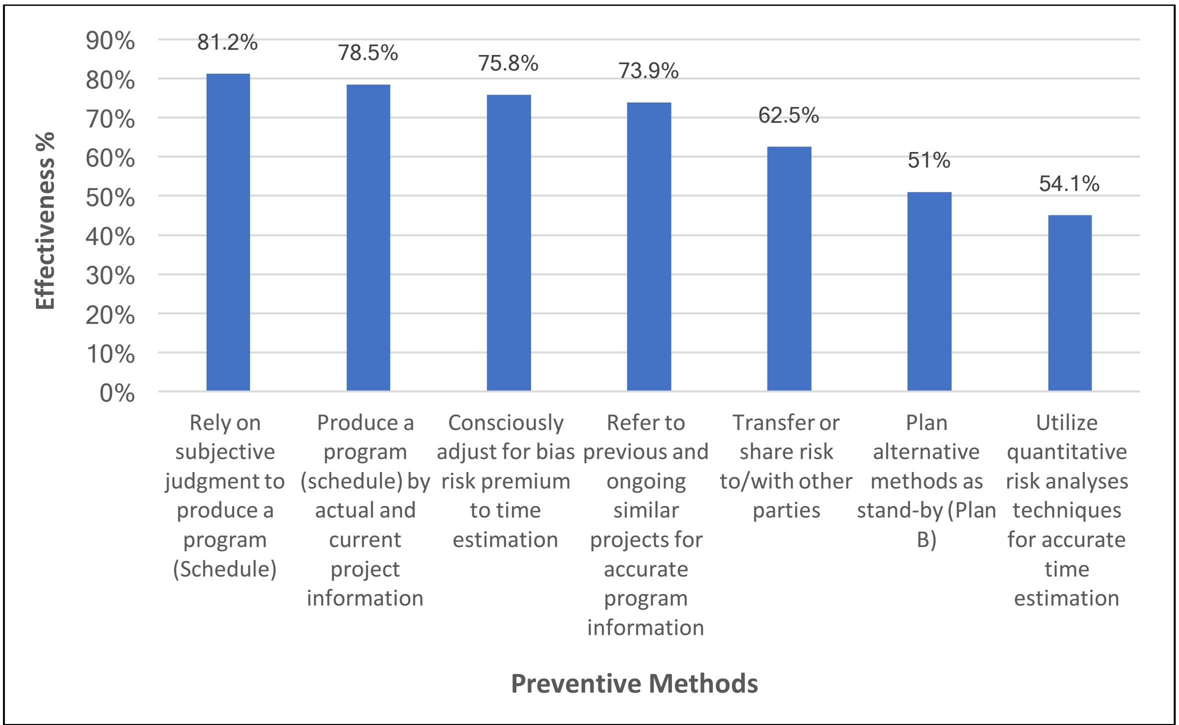


Figure 5.19: Preventive methods effectiveness

These findings are supported by Kartam (2001). Judgment and experience gained from previous contracts may become the most valuable information source for the use when there is limited time for preparing the project program. Construction, however, is subjected to a dynamic environment, that is why risk managers must constantly strive to improve their estimates. Even with near perfect estimates, decision making about risk is a difficult task. Thus, depending only on experience and subjective judgment may not be enough, and updated project information should be obtained and applied. Consequently, participants considered that producing a program (schedule) by actual and current project information and add risk premiums to time estimation at the project planning stage to be effective risk preventive method. Yet, this result was expected since taking into consideration such risks' premiums would increase the priced bid and would consequently decrease the probability of gaining the bid due to the highly competitive in the State of Qatar construction projects market. Make more accurate time estimation through quantitative risk analyses techniques such as Primavera Monte Carlo program was not considered to be an effective preventive method for reducing the effects of risk. This tends to support Kartam (2001) that the approach of risk analysis is largely based on the use of checklists by managers, who try to think of all possible risks. Insufficient knowledge and experience of analysis techniques and the difficulty of finding the probability distribution for risk in practice could be the main two reasons for such result. Referring to similar projects to for accurate program was recommended by the practitioners to be an effective preventive method. The percentage above the column is effectiveness proportion for each method.

5.5.2. Mitigative actions

Figure (5.20) shows the six mitigative methods being proposed. The percentage above the column is effectiveness proportion for each method. The first mitigative method recommended by the participants is increase supervision to minimize abortive work, and the last recommended mitigative method is change the construction method. Increase the working hours or shifts and coordinate closely with subcontractors were the second and the third most effective mitigative methods for minimizing the impacts of delay while change the construction method was rarely used as a mitigative method.

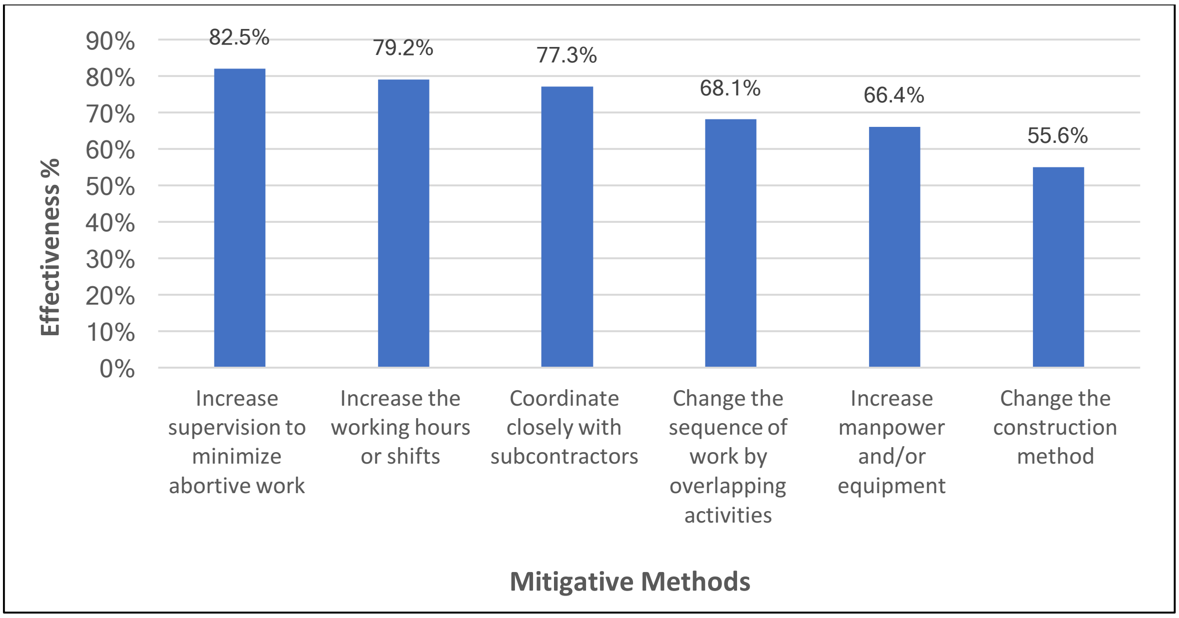


Figure 5.20: Mitigative methods effectiveness

This could mean that the effort driven on site is one of the most important variables to project progress, since construction projects generally include many labor-intensive operations. In fact, as pointed out before, shortage of manpower in subcontractors' firms is one of the most serious risks to project delays. Therefore, increasing the work hours normally speeds up progress subject to the availability of materials and supervisors, physical constraints of the site, and construction sequence.

5.6. Risk Analysis Techniques

Figure (5.21) show the result gained from participants. The first technique used was depend on the subjective judgment using experience, lessons learned and personal skills and the last was simulation analysis specialized software. These results reflected the insufficient knowledge and experience of analysis techniques and the difficulty of applying them. Expert techniques are available such as Risk system, which integrates with time schedules and spread sheets software, should be learned and applied to obtain a precise risk estimation.

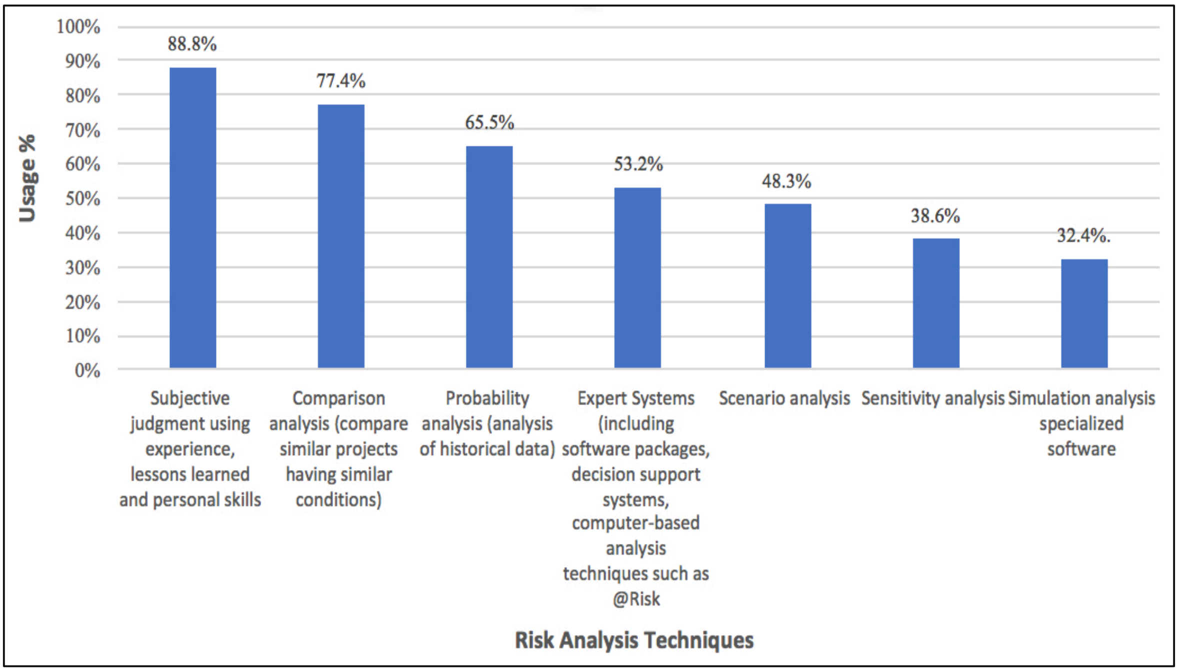


Figure 5.21: Use of risk analysis techniques by participants

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1. Introduction

This final chapter summaries the findings of the research. The main objectives of this study were to identify and classify the risk factors facing construction projects in the State of Qatar, to identify their importance and allocation. Moreover, risk management actions, risk analysis techniques and their effectiveness and usage were settled on. The above topics were explored from participants and finally some actions that may improve risk management practices were recommended.

6.2. Conclusion

An effective risk management process encourages the construction company to identify and quantify risks and to consider risk containment and risk reduction policies. Construction companies that manage risk effectively and efficiently enjoy financial savings, and greater productivity, improved success rates of new projects and better decision making.

This study was conducted in the State of Qatar to identifying the risk factors that faced by construction projects, also It was focused on collecting information about construction risk factors. In addition, to investigated their consequences and corrective actions that may be done to prevent or mitigate the risk factors effects, risk analysis techniques also were investigated. Consequently, the main purpose of this research was to determine the severity and allocation of these risk factors.

The main point of the research was to find, identify and analyze these risk factors to measure their impact on construction projects and to assign each risk factor to the party in the best position to deal with such cases. The top ten risk factors' severity are appeared in Table (6.1).

Table 6.1: Severity and allocation of top ten risk factors

Rank	Risk Factor	Allocation
1	The sanctions	Shared
2	Departure of key staff during the project	Shared
3	Financial failure of the owner	Owner
4	Delayed payments to the contractor	Owner
5	Lack of design coordination between the discipline (architectural, structural, MEP, HVAC, etc.)	Shared
6	Lack of consistency between bill of quantities, drawings and specifications	Shared
7	Delays in resolving disputes	Shared
8	Financial failure of the contractor	Contractor
9	Poor supervision of site construction	Shared
10	Poor initial planning (scheduling)	Owner

The results prove that participants considered (11%) of the risk factors as very high important risks, (59%) of the risk factors as high risks, (22%) of the risk factors as medium risks and finally (8%) of the risk factors as low risks. That reflects the high concern of participants about such issues. See section (5.4.1) for more details. In addition, participants were also specific in allocating risks and were more likely to share these risks between contactors and owners with (48.2%). They were undecided about (7.1%) of these risks. By contrast, participants allocated (25.8%) of the risk factors on contractors and (18.9%) on owners. See section (5.4.2).

Use of probability analysis, expert (computer) systems, scenario analysis, sensitivity analyses or simulation analysis were not practiced by participants, they also depend on subjective judgment and comparison analysis to analyze risk consequences (see section 5.6).

6.3. Recommendations

This section draws on the research outcomes to make recommendations that may be useful to contractors, owners, projects and risk analysts dealing with construction projects.

6.3.1. Recommendations to contractors

Contractors' project managers and project risk analysts should consider the benefits of managing risks in cost reductions and providing their companies with a competitive advantage.

Contractors should learn how to share and shift different risks by hiring specialized staff or specialized sub-contractors.

Contractors should struggle to prevent financial failure by practicing a stern cash flow management and minimizing the dependence on bank loans.

Main contractors should give extra attention to Sub-contractor' risk factors in order to avert potentially devastating effects on the project.

There is a direct link between risk management and enhanced quality, reduced cost and the minimization of unnecessary project delays. Consequently, contractors should implement the risk management strategies as they are applicable in real life project situations.

There is a need for contractors to employ experts in management or improving the abilities of engineers responsible of management and supervision of site by training courses.

6.3.2. Recommendations to owners

Owners should be more focus in the design process, because it is the most important phase in the construction process. Design products also should be at the highest level of quality.

Owners should conduct continuous training programs to advance managerial and financial practices to explain the internal and external risk factors affecting the construction projects and to initiate the proper ways to deal with such factors.

Clients should seek co-investors for support on financial commitment. Stakeholders should work as a team in the execution of project to avoid bottlenecks usually encountered in agreeing contractors' payment.

Owners should be more focus in planning methods by continuous monitoring, financial controlling, labor management, revising schedule, material/ Equipment controlling and usage of planning software are the planning activities proposed to minimize and control delays in the State of Qatar construction projects.

6.3.3. Shared recommendations

The contract clauses should be modified and improved to meet the impact of the sanctions (if its continued) and not to allocate the whole impacts on the contracting companies.

Construction contracts should have a “tiered” dispute resolution process consisting of a series of increasingly formal steps: a consultant decision; followed by negotiations (often involving senior management) and finally, arbitration or litigation.

Policy makers in the State of Qatar can, additionally, contribute in enhancing the performance of projects by controlling the recruitment of inexperienced and unskilled construction workforce by developing an effective screening process, especially for labor visa applications, and imposing minimum prerequisite conditions on the qualifications of applicants.

Training, education, and awareness of managers should be conducted in which the training/education sessions should involve introducing them to different models of risk mitigation, and enable them to test and implement the ones that work best for their type of projects.

All organizations should involve best practices in regards to risk identification, analysis and control. Keeping an updated risk register is a good start. Consulting experts on efficient ways to mitigate these risks is also useful.

Project managers and owners should always use the appropriate methods to identify the risks that are unique to their projects, as well as understand the risks that result from the external environment. It is only through identifying and understanding the real nature of the risks that the right risk mitigation framework can be identified.

Contractors and owners should be coordinating together closely to avoid any lack of design.

Tenders should be awarded to accurate estimated cost and not necessarily to the lowest bidder. This could take the edge of high competition in bids and reduce risks' consequences by providing more profit margin for contractors.

Project managers should be careful thought to the risk concepts and categories to manage them according to their variables, such as sources, priority, impact, and probability among others, to guarantee that the project’s delivery is timely, on budget and to a standard that will satisfy the client(s).

6.4. Recommendations for Future Study

This study was conducted during the ongoing of the sanctions. It is better to repeat this study in ordinary circumstances to compare to what extent the impact of the sanctions has on construction industry.

It is important to repeat this research every 2 years by an authorized institute to survey the new risk factors and their allocation, and publish the results for contractors and owners.

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APPENDICES

APPENDIX 1

SURVEY QUESTIONNAIRE

A study of risk management on construction project success in Qatar

Dear participant,

My name is Osaidallah Gafar Yousef and I am a M.Sc. student at Near East University. As part of my degree programme, I am conducting a study about risk management on construction projects success in Qatar.

I kindly invite you to take part in this survey by filling out the questionnaire, as you have been recognized in the local authority data as being credible consultants, contractors or owner representatives with experience in construction projects.

It will take about 20 minutes to complete the questionnaire and all you need to do is to simply follow the given instructions and answer the questions. Your participation is voluntary and all responses will be treated as anonymous. Do not ponder too long over which answer is right or wrong. Whatever you provide will be treated with strict confidentiality. The findings, if published, will summarize the responses of the sample as a whole; individual answers will not be identified.

Please note that returning this questionnaire will be taken as your informed consent to participate in the study. Your contribution is highly appreciated. Thank you for taking the time to respond to the survey.

Yours sincerely,
Osaidallah Yousef
Email: Osaidallah@yahoo.com

(A questionnaire survey)

Instructions:

- **Please answer all questions.**
- **Tick (X) the relevant answer where applicable.**

PART ONE
Organization Profile

Date: ....

Name of Your Organization: ....

Your Name: ....

Your Email: ....

Your Mobile Number: ....

<u>for random verification purposes only.</u>

1- The position of the respondent

- o Director
- o Executive Management
- o Project(s) Manager
- o Site/Office Engineer

2- Experience and Educational Qualifications of the respondent

Education ....

Years of Experience ....

3- Number of the projects executed by your organization in the last 5 years

- o 10 Projects or less
- o 11-20 Projects
- o 21-30 Projects
- o 31-40 Projects
- o More than 40 projects

4- Experience of your organization in construction (Years)

- o 1 Year or less
- o 2-3 Years
- o 4-6 Years
- o 7-10 Years
- o More than 10 Years

5- Work volume in USD over the last 5 years

- o $10 Million or less
- o $10 - $100 Million
- o $100 - $500 Million
- o $500 Million - $1 Billion
- o More than $1 Billion

PART TWO
Risk Factors Severity and Allocation

From your experience, please assign the severity and allocation of each factor in one of the following parts:

No.	*Risk Category*	*Risk Factor*	Severity					Allocation		
			Very low	Low	Medium	High	Very high			
			1	2	3	4	5	Contractor a	Owner b	Shared a & b
1	Construction Risk Factors	Poor coordination between the main contractor and his sub-contractors								
2		Poor performance and poor management of sub-contractors								
3		Unpredicted technical problems during construction								
4		Late delivery of materials								
5		Poor quality of workmanship								
6		Poor labor productivity								
7		Undocumented change orders								
8		Discrepancies between the intended and the executed works due to incomplete or contradictory drawings and specifications								
9		Poor supervision of site construction								
10		Disputes in contract variation								
11		Labor strikes and disputes								
12		Late changes to the design								
13		Frequent changes of design by Owner								
14		Lack of qualified staff								
15		Departure of key staff during the project								
16		Unqualified staff in the construction project team								
17		Delays caused by third-party's								
18		Shortage of proper equipment								
19		Shortage of acceptable materials								
20		Shortage of efficient manpower								

PART TWO (Cont.)
Risk Factors Severity and Allocation

No.	*Risk Category*	*Risk Factor*	Severity: Very low 1	Low 2	Medium 3	High 4	Very high 5	Allocation: Contractor a	Owner b	Shared a & b
21	Political & Governmental Risk factors	Changes in laws and regulations								
22		Corruption and bribery								
23		Delay in project approvals and permits								
24		The sanctions								
25		Threat of war								
26		Political instability								
27	Financial Risk Factors	Wrong project estimation								
28		Cash flow difficulties								
29		Lack of financial resources								
30		Delayed payments to the contractor								
31		Fluctuations in exchange rates								
32		Financial failure of the contractor								
33		Financial failure of the Owner								
34		Monopolizing of materials due to the Diplomatic Blockade and other unexpected political conditions								
35		Staff strike due to delayed salaries								
36		Inflation and unforeseen increases in material and equipment prices								
37	Legal Risk Factors	Disputes between Owner and main contractor								
38		Disputes between main contractor and his subcontractors								
39		Delays in resolving disputes								
40		Delays in resolving contractual issues								

PART TWO (Cont.)
Risk Factors Severity and Allocation

No.	*Risk Category*	*Risk Factor*	Severity: Very low 1	Low 2	Medium 3	High 4	Very high 5	Allocation: Contractor a	Owner b	Shared a & b
41	Environmental Risk Factors	Ecological damage								
42		Difficulty to access the site								
43		Adverse weather conditions								
44	Design Risk Factors	Design deficiencies								
45		Late issue of drawings and documents								
46		Lack of design coordination between the discipline (architectural, structural, MEP, HVAC, etc.)								
47		Deficiencies in drawings and specifications								
48		Changes to the scope of work								
49		Inaccurate quantities								
50		Lack of consistency between bill of quantities, drawings and specifications								
51		Frequent changes of design by designers								
52		Inexperienced or unqualified design team								
53	Management Risk Factors	Poor Procurement management								
54		Poor Communications management								
55		Poor initial planning (scheduling)								
56		Unclear or contradictory information								
57		Frequent changes in staff								
58		Frequent Changes in organization chart for the assigned locations for construction project staff								

PART THREE
Risk Remedial Methods

A. Risk Preventive Methods (Before construction phase)

In the table below, please indicate the frequency of use of each preventive method:

No.	*Preventive Method*	Never	Rarely	Sometimes	Often	Always
		1	**2**	**3**	**4**	**5**
1	Utilize quantitative risk analyses techniques for accurate time estimation					
2	Rely on subjective judgment to produce a program (Schedule)					
3	Produce a program (schedule) by actual and current project information					
4	Plan alternative methods as stand-by (Plan B)					
5	Consciously adjust for bias risk premium to time estimation					
6	Transfer or share risk to/with other parties					
7	Refer to previous and ongoing similar projects for accurate program information					

B. Risk Mitigation Methods (During construction phase)

In the table below, please indicate the frequency of use of each mitigation method:

No.	*Mitigation Method*	Never	Rarely	Sometimes	Often	Always
		1	**2**	**3**	**4**	**5**
1	Increase manpower and/or equipment					
2	Increase the working hours or shifts					
3	Change the construction method					
4	Change the sequence of work by overlapping activities					
5	Coordinate closely with subcontractors					
6	Increase supervision to minimize abortive work					

PART FOUR
Risk Analysis Techniques

In the shown table, please assign the relative use of each risk analysis technique:

No.	*Risk Analysis Technique*	Never	Rarely	Sometimes	Often	Always
		1	**2**	**3**	**4**	**5**
1	Expert Systems (including software packages, decision support systems, computer-based analysis techniques such as @Risk					
2	Probability analysis (analysis of historical data)					
3	Sensitivity analysis					
4	Simulation analysis specialized software					
5	Subjective judgment using experience, lessons learned and personal skills					
6	Comparison analysis (compare similar projects having similar conditions)					
7	Scenario analysis					

General comments on the impact of risk management on construction projects in the State of Qatar

…………………………………………………………………………..………………………..

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End of questionnaire

Thank you

Signature

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