Addis Ababa University

Faculty of Business and Economics

RISK MANAGEMENT IN BUILDING CONSTRUCTION PROJECTS

By Rediat Getachew

A paper submitted to Addis Ababa University, Faculty of Business and Economics in partial fulfillment of the requirements for Masters of Business Administration

June, 2020

AAU, Ethiopia

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By: Rediat Getachew

Approved By: ___________________

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Advisor Signature Date

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Internal Examiner Signature Date

Dr. Getie Andualem July 15,2020

External Examiner Signature Date

DECLARATION

I, the undersigned, declare that this thesis is my work and that all sources of materials that are used for this study have been acknowledged

Rediat Getachew ______________________ ____________________

Name Signature Date

LETTER OF CERTIFICATION

This is to certify that the thesis entitled "Risk Management in Building Construction" done by Rediat Getachew. This work is original in the nature and suitable for submission in partial fulfillment of the requirement for the award of Masters of Business Administration and the student has my permission to present it for assessment.

Advisor: Mohammed Abtew (Dr.)

Here:

Signature: ________________________

Date: ____________________________

Abstract

Construction is susceptible to various types of risks that causes deviation from the objective of the project. To minimize this deviation, application of risk management is an essential part of construction project management. Risk management is an iterative process comprises of risk identification, analyzing and rating of risks, developing a response plan and monitoring the application throughout the process. Although the benefit of practicing risk management is recognized as a crucial part of construction management by several literatures, in Ethiopia, there are several researches that show risk management practices in construction industry is not satisfactory. This study investigated the risks that affect the construction industry identified through literature review. Results of survey, collected from project managers working for ISO certified companies, found risk factors that have highest probability of occurrence and impact on project cost and completion time. Additionally, the risk response methods recommended by the participants that can help in creating a strategy that assist in minimizing the negative effect and maximizing the positive effect of the risks was identified. Thus, the final results of this paper determine which risks have a high probability of affecting the project objectives and the corresponding response methods to be used.

Key Words: Construction project, cost, time, quality, Risk, Risk Management, Risk identification, Risk analysis and Risk response

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1. Introduction

1.1. Background of the study

Construction is unique industry, with complicated process, financial intensity and involves collaboration of participants from different field of studies. This special behavior exposes the industry to various types of risks that causes deviation from the objective of the project, particularly the cost, time and quality of a project. (Bahamid & Doh, 2017). A recent study by Ethiopian institute of Architecture of Addis Ababa University shows that the level of practice in terms of safety, risk (time, quality, cost, etc..) and time management in construction projects was found to be very low. The amount of schedule slippage ranges between 61-80% and that of planed costs deviates 21-40% from predetermined requirements or anticipated at the beginning of the project. (Ayalew, Dakhli, & Lafhaj, 2016).

According to (Zou, Zhang, & Wang, Understanding the key risks in construction projects in China, 2007) 'Managing risks in construction projects has been recognized as a very important management process in order to achieve the project objectives in terms of time, cost, quality, safety and environmental sustainability. The process of accepting or implementing actions to a known risk to minimize the probability of occurrence or the effect of adverse event is called risk management. (Wissem, 2013). Risk management is an iterative process comprises of risk identification, analyzing and rating of risks, developing a response plan and monitoring the application throughout the process. (Schieg, 2006).

Based on the study made by Haddush Hintsay on risk management practices in construction industry, in Ethiopia, it was found that only 28.6% of the questioned general contractors practice formal risk management. (Hintsay, 2016). In another study done by Lidya Erstu on the risk management practices in construction projects, in Addis Ababa Saving House Development Enterprise, it was found that effective risk identification and assessment practices were not being followed properly and as a result created high financial, schedule and quality impacts. (Erstu, 2017). Another similar research done on the risk management practices in construction projects of specific companies in Ethiopia, found that even though risk management is practiced, there is still a need for improvement starting from risk identification to strategical plan for risk responses. (Yirga, 2017). These studies imply that there are shortcomings in implementing the risk management practices in the country which is impacting objectives of the projects.

As mentioned, the construction industry is prone to several risk and to accomplish the major objectives of any project proper risk management should be implemented. And since most of the delays and budget overruns occur due to insufficient risk management, this paper focuses on management of risks, concerned with time and cost. Therefore, the primary aim of this paper is identifying and analyzing the likelihood of occurrence and impacts of the risks on project objectives associated with construction projects. The major risks that usually occur in construction projects are identified through literature review which help analyze the probability of occurrence of the risks and their level of impact on the project cost and schedule. The second aim of this thesis is identifying what risk response methods to be used to minimize the negative effect and to maximize the positive effects of the risks on the overall project.

1.2. Statement of the problem

The construction industry is highly risk-prone and is vulnerable to various technical, external, organizational, and project management risks. The track record to cope with these risks has not been very good in the construction industry especially in developing countries like Ethiopia. As a result, the people working in the industry bear various failures, such as failure of achieving the required quality and operational requirements, cost overruns, and uncertain delays in project completion. (Ayalew, Dakhli, & Lafhaj, 2016) To minimize these losses effective systems of risk management for the construction industry need to be developed.

Risk management in the construction project management context is a systematic way of identifying the risks in a project, analyzing them and managing the risks by developing a proper response plan to achieve the project objectives (Banaitis & Banaitiene, 2012). In the past five years, several studies were done on risk management practices in construction projects. According to these researches, risk management practice in construction projects in Addis Ababa, Ethiopia is not satisfactory and needs improvement. The research papers are consistent with their conclusion that there has been a negative impact on the financial, schedule, and quality of construction projects due to an unsatisfactory risk management system. This conclusion is also supported by a study done on performance and challenges in Ethiopia construction industry in 2016 which claims that there is a schedule slippage that ranges from 61-80% and while there is an increase in the initial project budget that ranges between 21-40%. (Ayalew, Dakhli, & Lafhaj, 2016)

This research aims to identify risks that severely affect the financial and schedule of construction projects and the type of treatment to be used for a different type of risk. The risks will be identified through a literature review and the probability of occurrence and the effect they have on the project's cost and time and the risk responses will be identified by distributing questioner to project managers. Therefore, these findings can contribute to the knowledge database for the use of project managers to identify the major risks that frequently occur in building construction and suggestions on how to treat these risks to minimize cost and time overrun due to these risks.

1.3. Research questions

The main research question of this thesis is: -

How to effectively and efficiently manage risks affecting cost and time in building construction projects?

A sub-question related to the topic emerges from the main research question: -

What are the risks that affect building construction projects?

What is the probability of occurrence of the identified risks?

Which risks are affecting the cost and schedule of the project more severely?

How can we respond to the risks affecting the project completion time and expected budget?

1.4. Objective of the study

In the construction industry, the factors that show the success of a project is that the project is completed without schedule delay, cost overruns, and quality of the final product. The industry is vulnerable to various technical, socio-political, and business risks. A construction risk can be defined as any exposure to possible loss. Because every construction project is different, each offers a multitude of varying risks. To ensure the success of a project, before starting a construction project a contractor must be able to recognize and assess those risks. Since risk can affect productivity, performance, quality, and budget of a construction project, risk management is an important part of the decision-making process in a construction company.

1.4.1. General objective

The main objective of this research is to determine how risk in a construction project can be managed effectively by applying the risk management process, which is Risk identification, analysis, and risk response methods.

1.4.2. Specific objective

The research primarily identifies risks that affect the construction industry through literature review and then analyze the result collected via questioner on the probability of occurrence of the identified risk factors and their effect on project cost and completion time. By analyzing the collected data, the risk factors with the highest rating are identified. Additionally, the questioner was used to determine the risk response method for each risk factor. the responses and create a database that will facilitate project managers in making an informed decision.

1.5. Significance of the study

The construction industry is dynamic in nature due to the increasing uncertainties in technology, budgets, and development process. Several variables can influence the successful completion of building constructions. Some of these variables are cost, time, quality, client satisfaction, health and safety factor, and so-on.

One of the requirements and expectations put on the contractor by stakeholders or clients of the project is to complete the project within the specified budget and time frame. In construction, the budget and time (schedule) is affected by several factors such as inadequate and incomplete design, design change, errors during construction process, estimation and scheduling error and external factors such as inflation rate. To meet deadlines and to complete within the assigned budget, the schedule and cost should be flexible enough to accommodate those risks without affecting the overall project cost and duration.

One way of minimizing the effects of the above-mentioned uncertainty or risks is to develop a proper risk management framework. Risk management is an important decision-making process in a construction company. It helps project managers to identify the risks that a project can have and plan for those risks. The final result of this research is expected to help contractors in avoiding, minimizing, or at the very least help cope with risks that have a high probability of occurrence and highly affect the project objectives.

1.6. Scope of the study

The study focuses on the risk management process, specifically in risk identification, risk assessment, and risk response methods in building construction. Among the different participants of the construction industry, this study focuses on construction companies with ISO certification. The first step i.e. risk identification will be done by reviewing various literature done on the subject. The next step, determining the probability of occurrence of risks and the effect they have on budget and schedule and the response for the risks, will be identified by distributing questioners for project managers and finally, the data collected will be analyzed using SPPS 26 software. The result obtained from the analysis will demonstrate the major risks that affect the budget and schedule of building projects and it will propose response methods on how to minimize the effect of these risks.

1.7. Limitation of the study

One of the shortcomings of the study is that in building construction the risks faced during the process can be widely different and includes unpredictable risks. Therefore, it is hard to conclude that all risks are identified and the responses recommended for the risks are sufficient for the successful completion of the project. Therefore, it is important to understand risk management is a continuous process and should be implemented in every stage of the construction process.

Other limitations of the study are the number of units of analysis used for the research. From a considerable number of contractors in Ethiopia, due to limited time and resources, the study only focused on the ISO certified construction companies in Addis Ababa. Additionally, there were some challenges faced during data collection; such as some of the questioners distributed were not responded to and others responded late which delayed the analysis time of the paper. The researcher was also forced to redistribute the questioner to some of the participants.

1.8. Definition of terms

Project: According to the (PMBOK Guide, 2017), A project is defined as a "temporary endeavor with a beginning and an end and it must be used to create a unique product, service or result".

Construction: is a process of constructing a structure, infrastructure or a building based on client needs. (Bennett, 2003)

Building construction: the techniques involved in the assembly and erection of structures, primarily those used to provide shelter. (Odimabo & Oduoza, 2013)

Quality: In the case of building construction, quality is measure by the degree of requirement meet, the functionality of the building, the completion time and budget and cost of operation and maintenance. (Ali & Rahmat, 2010)

Cost: costs that incur in a project from start to completion which includes costs that are included in the tender documents, costs that arise due to variations and modification during the construction process and other additional costs that may occur such as legal claims. (Hendrickson, 1998)

Completion Time: the elapsed period from the time the site is handed over to the contractor to the time the building is handed over to the client. (Ali & Rahmat, 2010)

Risk: a positive and/or negative deviation from the expected which can affect project objectives is the implication of future uncertainty about deviation from expected earning or expected outcome. (ISO/Guide 73, 2009)

Cost overruns: is an exceeding of cost beyond the budgeted, planned or expected amount. (Wang, Dulaimi, & Aguria, 2004)

Time-delay: the time overrun beyond completion date specified in contract, or agreed between parties. (Wang, Dulaimi, & Aguria, 2004)

Project management: is a set activity that utilize organizational structures and resources for beneficial outcome of the project. (Munns & Bjeirmi, 1996)

Risk management: is an integral part of understanding the advantage and disadvantage of risks that contribute to success and failure of a project objective respectively. (Spikin, 2013)

Risk identification: is the process of determining the risks that could happen throughout the project (PMBOK Guide, 2017)

Risk analysis: is a process of determining the likely hood of occurrence of the identified risks and severity of their effect on the project is determined. (Bahamid & Doh, 2017)

Risk response: are actions taken to address risks by developing options and strategies that increases the success of the project. (REZAKHANI, 2012)

Risk monitoring: is the process of keeping track of the identified risks, identifying of new risks, ensuring the execution of risk plans and evaluating their effectiveness in reducing risk. (PMBOK Guide, 2017)

Project success: is a completion of a project with all the expectation and requirement of the stakeholders and others involved in it is fulfilled. (Atikinson, 1999)

1.9. Organization of the study

The content of the paper into several topics as shown below:

1) Introduction

2) Literature review

3) Research Methodology

4) Result and Discussion

5) Summery, Conclusion and recommendation

The introduction gives the reader the first insight to the research. The introduction includes the background of the study, statement of the problem research question, objective and significance of the study and scope and limitation of the study. This section will also have definitions of major concepts employed in the study. The aim of the introduction is to explain the purpose of the research study, as well as, to provide a logical pathway of the research paper.

The second chapter will comprise of a theoretical research of the concepts of Risk management, the types of risk that are faced in construction, the risks that mainly affect the completion time and cost is defined, how risks are analyzed and evaluated and the current risk management system that is used in construction industry will be discussed . The aim of this chapter is to provide the reader with sufficient understanding of the concepts and therefore, give a profound basis to the research paper as a whole.

The third chapter explains how the research was undertaken. The fourth chapter focuses on the analytical approach of the study in question. The identified risks in construction project are analyzed and evaluated to determine the major risks affecting cost and completion time of the project and finally the response method for the identified risks is determined. In the last chapter the research is summarized and conclusion and recommendation based on the result is discussed briefly.

2. Literature Review

2.1. Introduction

Construction Industry is an industry that is involved in the planning, execution, and evaluation (Monitoring) of all types of physical infrastructure; such as transportation, water, and energy work and buildings. Different parties are involved in a construction project: the primary parties are the client, the consultant, and the contractor and other parties such as insurance companies, banks, suppliers, permitting agencies, and public bodies. For the successful completion of a construction project, the individual effort of each party involved and collaboration work between those parties are valuable. To achieve this, managing each stage of the construction project properly is important.

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Generally, project management is concerned with ten knowledge areas. One of the knowledge areas is risk management. Risk management in the construction project management context is a systematic way of identifying the risks in a project, analyzing them and managing the risks by developing a proper response plan to achieve the project objectives (Banaitis & Banaitiene, 2012).

The construction industry plays an important role in the development of the country's economy and to fully tap that potential a better management system should be developed. This paper will focus on the management of risks, concerned with time and cost. In the following section; books, journals, and articles that are related to building construction and risk management will be reviewed.

2.2. Building construction Project

Project is a collection of various tasks that are performed to create a product or a service. It is temporary in nature i.e. it has a starting and ending point. A project is said to be completed when the project goal and objectives are completed or in some cases when the objective cannot be accomplished or no longer needed. Project have interdependent constraints: cost, scope, quality, risk resource and time. Keeping these interdependent constraints balanced will increase the success of a project (Watt, 2014).

Construction project is process of constructing a structure, infrastructure or a building. The proses is made up of different phases. In building construction theses phases can be divided into six and these phases are discussed as follow: (Bennett, 2003), (Eby, 2019) and (Guo, Li, & Skitmore, 2010).

1. Initiation (pre- project phase): This is the start of the project, and the goal of this phase is to define the project at a broad level and research whether the project is feasible and if it should

be undertaken. In this stage the purpose and requirements of the project will be clarified. (Bennett, 2003)

2. Design and planning: During this phase, the scope of the project is defined and a project management plan is developed. It involves identifying the cost, quality, available resources, and a realistic timetable. The project plans also include establishing baselines or performance measures. These are generated using the scope, schedule and cost of a project. A baseline is essential to determine if a project is on track. At this time, roles and responsibilities are clearly defined, so everyone involved knows what they are accountable for. (Eby, 2019)
3. Execution (construction phase): This is the phase where deliverables are developed and completed. Tasks completed during this phase includes Tasks completed during the execution Phase include: assigning resources and assigning tasks, executing and managing project management plans, procurement management if needed, tracking and updating project schedule and modifying project plans if needed. (Guo, Li, & Skitmore, 2010)
4. Monitoring: occurs simultaneously with the execution phase of the project and is phase where the project progression and performance is measured. In this phase the project objective, quality, schedule and budget and the overall performance of the execution is checked based on the project management plan. (Bennett, 2003)
5. Project closeout and termination: This phase represents the completion of the project. In this phase the project managers will need to create a project punch list of things that didn't get accomplished during the project and work with team members to complete them. Perform a final project budget and prepare a final project report. Finally, they will need to collect all project documents and deliverables and store them in a single place. (Eby, 2019)

As mentioned above the initiation phase encompasses the demands of the client and based on the needs of the client the consultant design and plans the project according to specifications and requirements. The execution and monitoring phase align with each other (i.e. while the contractor does the actual construction (execution) the consultant monitor the work progress and check that the construction is being done based on the contract agreement, approved design, and required quality.). The last phase of the project is done with the cooperation of the three parties (client, consultant and contractor).

The Ethiopian economy had showed 9.3 percent average annual growth during 2013/14 - 2017/18 fiscal years. The growth in real GDP was mainly attributed to 8.8 percent growth in services, 3.5 percent in agriculture and 12.2 percent in industrial sectors. Construction industry accounted for 71.4 percent of the industrial output and expanded by 15.7 percent signifying the leading role of the construction sector in terms of roads, railways, dams and residential houses expansion. (National Bank of Ethiopia, 2018)

In addition to the construction industry contribution to economic growth it is one of the main facilitators towards urbanization. Ethiopia's urban growth rate have shown an increase in recent years and is projected to increase from 21% to 39% in 2050 (United Nation, Department of Economic and Social Affairs, Population Division, 2019).This rapid rise in urbanization increased demand for infrastructure and service, job opportunities and housing. Currently the housing quality in Ethiopia is very low; an estimated 70-80 percent of the urban population lives in slums (World Bank Group, 2015). To accompany this increase in demand of improved housing and to facilitate urbanization suitable management should be applied during every stage of building construction.

2.3. Building construction management

As discussed above the construction project have several phases and requires the collaboration of different parties until the end of the project. Therefore, to satisfy the needs of the client and to complete the scope of the works with in the budget, schedule and required quality discipline of project management need to be applied for every phase of the construction process. Mainly the responsibility of construction management teams includes planning, budgeting, coordinating and supervision of the project from the beginning to the end.

2.3.1. Project management

Project management seeks to utilize organizational structures and resources for beneficial outcome of the project. Project management defines work requirements, extent of works, allocation of resources planning and monitoring the execution of work and adjusting the deviation of the work from the plan. In the case of a construction project, project management is concerned with on-time delivery, within-budget expenditures and required performance standards. (Munns & Bjeirmi, 1996)

According to the PMBOK guide there are 10 knowledge areas of project management which are: integration, scope, schedule, cost, quality, resource, communication, risk, procurement and stockholder management (PMBOK Guide, 2017).

Construction projects are exposed to uncertain settings because of such factors as planning, design and construction complexity, presence of various interest groups (owner, consultants, contractors, suppliers, etc.), resources (manpower, materials, equipment, and funds) availability, environmental factors, the economic and political environment and statutory regulations. (Banaitis & Banaitiene, 2012) Managing risks in construction projects has been recognized as a very important process in order to achieve project objectives in terms of time, cost, quality, safety and environmental sustainability (Zou, Zhang, & Wang, Understanding the key risks in construction projects in China, 2007). In the following section we will discuss theories and concepts of risk and risk management.

2.4. Concept of risk and risk management

2.4.1. Risk

The word 'risk' is used with many different meanings. The European Commission suggests that ‘a risk is any factor, event or influence that threatens the successful completion of a project in terms of time, cost or quality’. The international organization for standardization defines risk as a positive and/or negative deviation from the expected which can affect project objectives (ISO/Guide 73, 2009). In the 1980s risk was defined as measure of hazard: threats to people (Kates & Kasperson, 1983) and as the product of adverse event and the consequence of the event (Wilson & Crouch, 1987)

According to (Aven & Renn, 2009) ‘risk is defined in two ways: risk is a situation or event where something of human value (including humans themselves) is at stake and where the outcome is uncertain; (2) risk is an uncertain consequence of an event or an activity with respect to something that humans value.’ Generalizing the definition of risks mentioned above, ‘Risk is a situation or an event where something of human value is at stake and where the outcome is uncertain.’ (Pidgeon, Kasperson, & Slovic, 2003). While several literatures focus on the negative aspects if risk (Eiser, 2004) includes positive aspects of risk in his definition by defining risk as human action that result in uncertain benefit or cost.

The above literatures define risk based on its source and effect of risk. (Crnković & Vukomanović, 2016) define and classify risk based on the knowledge of the risk factors: known and unknown. The first types are risks that have been identified and analyzed and can be planned for. While the second type of risk cannot be planned for. The uniqueness, complexity, and the high degree of uncertainty (inflation, market competition, the political situation in the country, etc..) make construction projects highly prone to risk. But, since all kinds of risks cannot be avoided, all participants will have to accept some type of risk. Nonetheless, before accepting a project the risks should be compared to the benefits of the project. Therefore, a proper risk management system should be developed to minimize the chances of project delay or failure that could lead to high economic and time loss. (KarimiAzari , Mousavi, Mousavi, & Hosseini , 2011)

2.4.2. Risk management

The concept of risk management stared after World War II and it was mostly associated to market insurance, which is used as compensation price for losses due to accidents. But after 1950s, due to the high cost and the incomplete protection of insurance, other alternatives began to arose. The use of other forms of risk management, other that insurance, expanded rapidly in the 1970’s and 1980s

During the 1990s the concept became more relevant and essential, which lead to the development of international risk regulations and financial firms started developing internal risk management models. Currently, nearly all types of firms practice risk management by focusing on developing and/or following a framework that will allow companies to withstand the effect of risks. (Dionne, 2013)

Literature written in 1960 lack consistencies in defining risk management. While some consider it a way to manage pure risks through insurance others argued that risk is management is more than determining the right type of insurance program rather it is a way of dealing with risks that are not also covered by insurance. In the 1970s theoretical models for financial risk management started being developed and one of the most popular models was Black and Scholes' model. The model proposed an explicit formula for pricing risk coverage derivatives, namely an option which was implemented by several financial firms. During the 1980s and 1990s, implementation of insurance derivatives rose and there was an increase in demand for the service by market players (including non-financial companies) which lead banks and insurance agencies to develop statistical tools to select clients and manage credit risks. The tool facilitated credit risk and risk pricing. During the 1990s, risk management concept became more relevant and essential, and the partial coverage of risk by insurance wasn't satisfactory for companies, as a result, some companies in the US to consider alternative forms of risk management; such as risk retention groups (a group of companies works together to protect themselves from common risk) and finite insurance. (Dionne, 2013)

Although risk management has been always part of human kind and their organizations, it took several decades to be considered as an integral part of organizations and their processes. This integrated perspective of risk management started initially in the 90' and was formalized in 2004 by the Committee of Sponsoring Organizations of the Treadway Commission (COSO, 2018). In this era, risk management discipline had a comprehensive approach which is often entitled Enterprise risk management (ERM). Accordingly, under this approach risk management would contribute to increase the possibility of success and reducing both, the probability of failure and the uncertainty of achieving the organizations overall objectives. The main objective of risk management would be then, to understand in advance the impact of risks and develop a structured framework that will assist managers in decision making.

Prior to comprehensive or enterprise risk management, the responsibility to handle a particular risk would be only assigned to units "threatened" by the risk (Lam, 2003). Under this approach sharing of information among departments was minimal and organizations mainly focus on analyzing and treating "pure" risks (Spikin, 2013). According to (Kenton, 2019), 'Enterprise risk management (ERM) is a plan-based strategy that aims to identify, assess, and prepare for all type of risks that may interfere with an organization's operations and objectives.'. The discipline not only calls for corporations to identify all the risks they face and to decide which risks to manage actively, but it also involves making that plan of action available and calls for cooperation of all the operational and business area of the organization for the implementation and monitoring of risk management.

2.4.2.1. Risk management Framework

Risk management is an integral part of understanding the advantage and disadvantage of risks that contribute to success and failure of a project objective respectively. (Spikin, 2013). Most literatures agree that it is the systematic and iterative process that needs to be conducted throughout the project lifetime and that the main aim of risk management is to minimize the cause and effect of events that can adversely affect the project objectives by developing a framework to assist decision makers to manage the risks effectively and efficiently. (Jayasudha, Vidivelli, & Surjith, Risk Assessment and Management in Construction Projects, 2014)

A risk management framework is a set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management throughout an organization. (Organizational Risk Management Framework, 2018) Some of the common risk management frame works currently being used by organizations are presented below:

2.4.2.1.1. ISO 31000: 2009 Risk Management Framework

The success of risk management will depend on the effectiveness of the management framework providing the foundations and arrangements that will embed it throughout the organization at all levels. The framework assists in managing risks effectively through the application of the risk management process at varying levels and within specific contexts of the organization. The framework ensures that information about risk derived from the risk management process is adequately reported and used as a basis for decision making and accountability at all relevant organizational levels. (ISO 31000, 2009)The necessary components of the (ISO 31000, 2009) framework for managing risk are shown in the figure below.

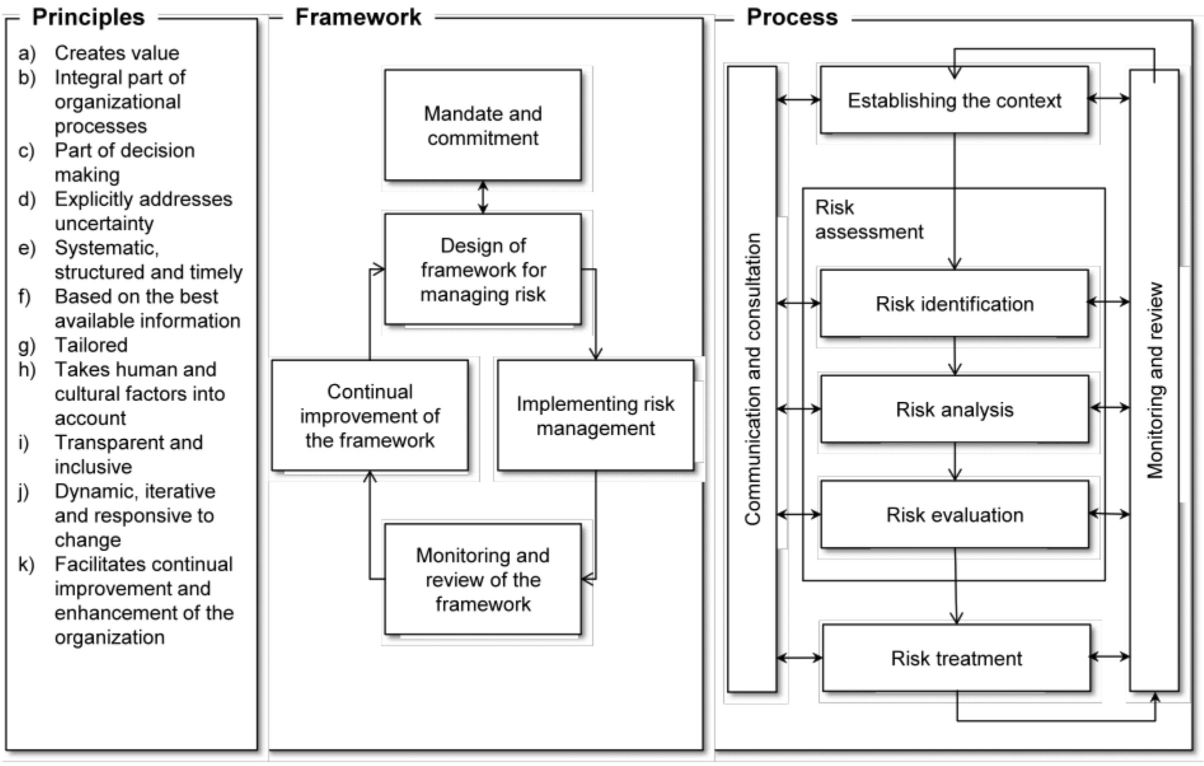

Figure 1: Relationship between the components of the framework for managing risk ISO 31000:2019

2.4.2.1.2. Project Management Institute's Risk Management Framework

The following table taken from (PMBOK Guide, 2017)provides an overview of the Project Risk Management processes. The Project Management Risk processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in this PMBOK® Guide.

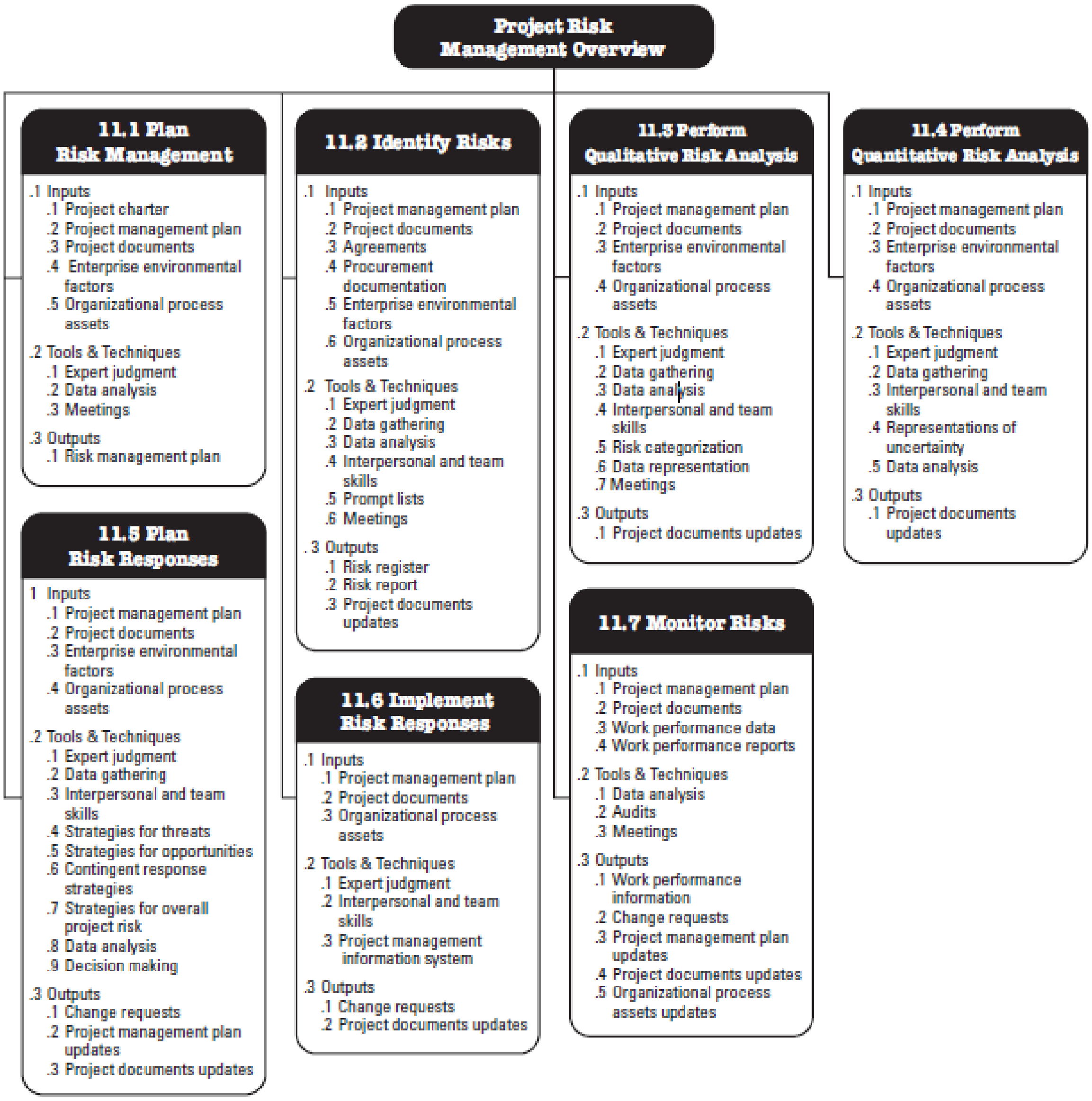

Figure 2: overview of the Project Risk Management processes (PMBOK Guide, 2017)

2.4.2.1.3. The COSO Enterprise Risk Management Framework

The (COSO, 2018)ERM framework consists of five components and 20 principles as shown in the Figure below.

Governance& culture	1. Exercises Board Risk Oversight 2. Establishes Operating Structures 3. Defines Desired Culture 4. Demonstrates Commitment to Core Values 5. Attracts, develops and Retains Capable Individuals
Strategy &Objective-setting	6. Analyzes Business Context 7. Defines Risk Appetite 8. Evaluates Alternative Strategies 9. Formulates Business Objectives
Performance	10. Identifies Risk 11. Assesses Severity of Risk 12. Prioritizes Risks 13. Implements Risk Responses 14. Develops Portfolio View
Review& revision	15. Assesses Substantial Change 16. Reviews Risk and Performance 17. Pursues Improvement in Enterprise Risk Management
Information, Communication & reporting	18. Leverages, Information and Technology 19. Communicates Risk Information 20. Reports on Risk, Culture and Performance

Figure 3: The COSO ERM Framework

2.4.2.1.4. Organizational risk management framework

The key elements of a risk management framework, as outlined in NSW Treasury Policy TPP 15-03, are:

- Mandate and Commitment – agency head and senior management provide and communicate a risk management mandate, establish a risk management policy, assign accountabilities and responsibilities and commit to implement, resource, operate, monitor and continually improve risk management

- Design of the framework for managing risk – a customized framework is designed to provide a structure to embed the use of a consistent risk management process wherever decisions are made in the agency
- Implementing risk management – a risk management plan to implement the risk management framework and policy is developed and implemented
- Monitoring and review of the framework – the risk management framework is monitored and reviewed to ensure it is fit for purpose and remains consistent with the agency's objectives
- Continual improvement of the framework – the framework is continuously enhanced to support the agency moving to a higher level of maturity in risk management.

The diagram below, taken from (Organizational Risk Management Framework, 2018) demonstrates the interaction between these key elements.

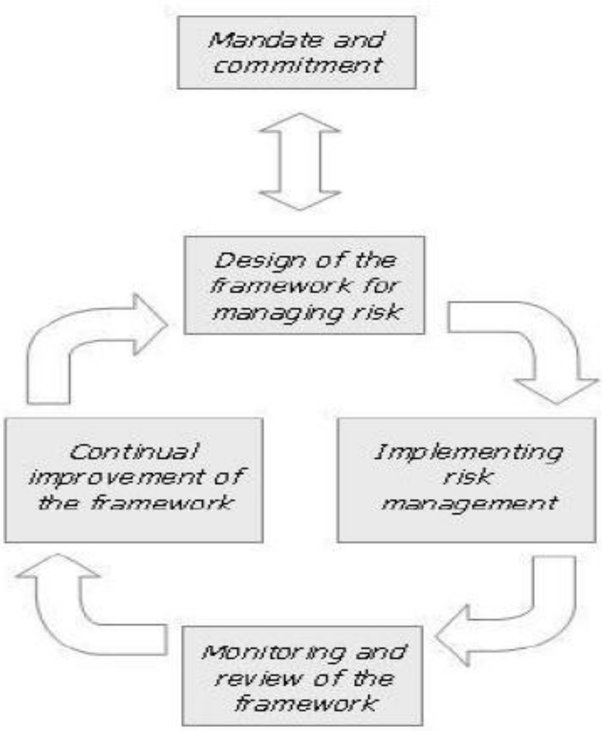

Figure 4: Key elements of a risk management framework (Adapted from AS/NZS ISO 31000:2009: as per TPP 15-03)

2.5. Risk management Process

According to risk management frameworks discussed above and other literatures; (Mhetre, Konnur, & Landage, 2016) , (PMBOK Guide, 2017), (REZAKHANI, 2012), (Bahamid & Doh, 2017), risk management approaches for project can be summarized as

- Risk identification
- Risk Analysis (Qualitative and Quantitative risk analysis)
- Risk response
- Monitoring risk

Below we will discuss each process in detail relating them with building construction industry.

2.5.1. Risk Identification

Most risk management frameworks start with identifying, categorizing and valuing risks. (Yazar, 2002) Risks can be identified by referring past projects that are similar with the current project and distinguishing the conditions that affect the project success. (KarimiAzari , Mousavi, Mousavi, & Hosseini , 2011). Generally, risk identification helps organization or managers to identify crucial risks and the effects of the risks on the project therefore help them allocate appropriate resources to minimize the negative effects and maximize the positive effects. Risks can be identified through brain storming, Delphi method, interview, cause analysis, SWOT analysis, and presumption analysis. (Bahamid & Doh, 2017)

According to several literatures risk can be classified in numerous ways based on source of or characteristics of risk.

- Controllable and uncontrollable: (Flanagan & Norman, 1993), classified risk as controllable and uncontrollable based on the ability of the decision maker to manage the risk. As the name indicates the 1st type of risk is a risk that is partly within the control of the decision maker, such as a lack of coordination between different parties of the project and increased risk associated with new technologies. The 2nd one is the type of risk that cannot be controlled and usually emanate from external environment but contingency can be provided for, such as adverse climate condition, social, political and economic spheres that can affect the construction process.
- Dependent and independent risks. Another way (Flanagan & Norman, 1993) classified risk is based on the effect one risk in a particular part of the project have toward another or

sequencing part of the project, A risk is considered as dependent of the occurrence of one influence the estimate for the other.

- External, internal and legal: (REZAKHANI, 2012) categorized risk factors based on their source and effects on project objectives as external, internal and legal. The following figure shows the grouping of project risks.

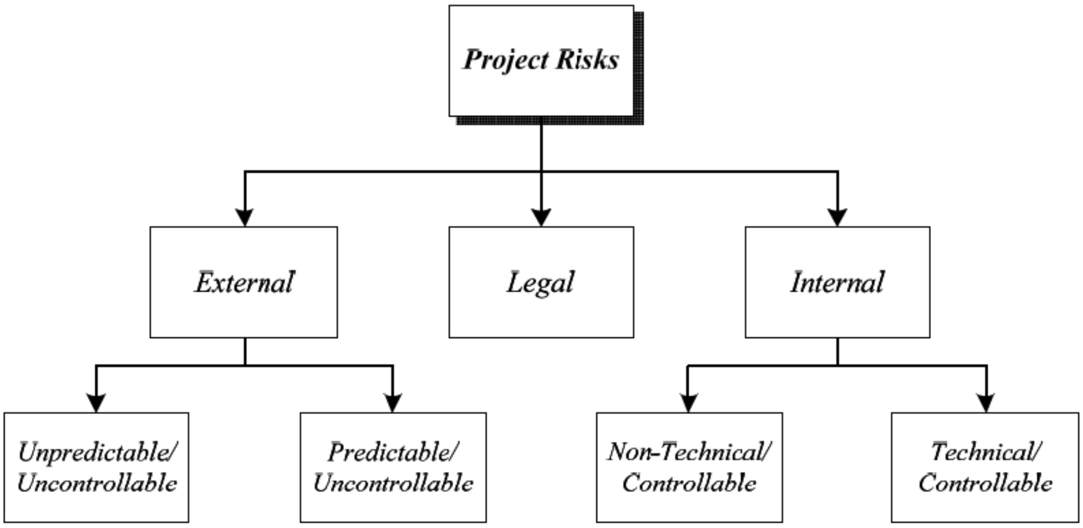

Figure 5 Specific project risks (source (REZAKHANI, 2012))

When identifying risk, the source and the effect of the risk should be distinguished from one another. Accordingly, for construction industry the source and effects of risk can be classifies as follow:

Sources of risk can be

- Inflation rising above the allowance in the estimate
- Unforeseen adverse ground conditions
- Exceptionally inclement weather
- Late delivery of material
- Incorrect design details
- Insolvency of the main contractor
- No co-ordination between drawings of different fields (e.g. Architectural and structural)

Effects of risk

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

- Failure to achieve the required quality
- Failure of the project to meet the required operation needs
- Damage to the property as a result of fire or flood
- Injury to worker due to an adequate system of working

According to (Mhetre, Konnur, & Landage, 2016), (Odimabo & Oduoza, 2013) & (REZAKHANI, 2012) risk associated with construction industry can be broadly categorized into:

a) Technical Risks: are risks associated with the Incomplete Design, Inadequate specification, inadequate site investigation, Change in scope, Construction procedures and insufficient resource availability etc.

b) Construction Risks: are risks which include Labor productivity, Labor disputes, Site condition, Equipment failures, Design changes, too high-quality standard and new technology.

c) Physical Risks: are risks arising from the Damage to structure, Damage to equipment, Labor injuries, Equipment & material fire and theft etc.

d) Organizational Risks: consist of Contractual relations, Contractor's experience, Attitudes of participants, inexperienced work force and Communication.

e) Financial Risks: are related to increased material cost, Low market demand, Exchange rate fluctuation, Payment delays and improper estimation taxes etc.

f) Socio-Political Risks: Changes in laws and regulations, Pollution and safety rules, Bribery/Corruption, Language/Cultural barrier, Law & order, War and civil disorder and Requirement for permits and their approval.

g) Environmental Risks: Natural Disasters and Weather Implications.

2.5.2. Risk analysis

The essence of risk analysis is that it attempts to capture all feasible option and to analyze the various outcomes of any decision. It gives an insight into what happens if the project does not proceed according to plan. (Flanagan & Norman, 1993). Risk analysis is a step where risks are evaluated and their probability of occurrences and severity of their effect on the project is determined. (Bahamid & Doh, 2017)

There are mainly two ways in which risks can be analyzed: Qualitatively and Quantitatively (KarimiAzari , Mousavi, Mousavi, & Hosseini , 2011).

2.5.2.1. Qualitative risk analysis:

Qualitative risk analysis is the process of prioritizing individual project risks for further analysis or action by assessing their probability and impact of risk. In this type of analysis, ‘risk is evaluated in more conceptual terms, such as high, medium or low, depending on the collected opinions and risk tolerance boundaries in the organization.’ (Marco & Thaheem, 2014)

Qualitative methods method is often used in case of inadequate, limited or unavailable numerical data as well as limited resources of time and money. (Mhetre, Konnur, & Landage, 2016)The methods are listed as follows:

a) **Risk probability and impact assessment:** is the base for quantitative analysis and helps to evaluate the likelihood of occurrence of a specific risk and assess the positive and negative impacts of risk. For this purpose, clear definitions of scale should be drawn up and its scope depends on the project’s nature, criteria and objectives.

b) **Probability/impact risk rating matrix:** is used to prioritize the results from the previous assessment via various methods of calculation. Westland computes the priority score as the average of the probability and impact. The range of priority score, the rating and color are assigned to indicate the importance of each risk. Threats with high impact and likelihood are identified as high-risk and may require immediate response, while low priority score threats can be monitored with action being taken only if, or when, needed.

c) **Risk categorization and Risk Urgency Assessment:** Risk categorization is a way of systematizing project threats according to their sources, in order to identify areas of the project that are most exposed to those risks. Tools which can be used in this method are work break down structure (WBS) or risk breakdown structure (RBS), and their role is to develop effective risk response. WBS breaks down large activities into small, manageable units and creates linked, hierarchical series of independent activities. RBS categorizes risks and shows their dependencies. The role of the second method, Risk Urgency Assessment, is to prioritize risks according to how quick response they require.

2.5.2.2. Quantitative risk analysis:

Quantitative risk analysis uses numerical techniques to examine the effect of risk on project objectives. Here, the impact of risk is defined by the frequency of its occurrence based on available data. (Marco & Thaheem, 2014)

According to (Mhetre, Konnur, & Landage, 2016) and (Marco & Thaheem, 2014) the method used for this analysis is listed below:

a) Sensitivity Analysis: This is carried out to identify the uncertain project components which will have maximum impact on the outcome of the project. After a risk model is made a sensitivity analysis is carried out to check the sensitivity of different elements of the model on project outcome. To do these the values of one variable at a time is changed and the impact of these changes is then seen on the project.

b) Scenario Analysis: Scenario analysis gives the impact of different scenario of the project or impact of different risk if that occurs simultaneously. A fair decision can be made after this analysis, the option which will give lesser loss or hazards that option can be opted.

c) Probabilistic Analysis (Monte Carlo Simulation): A project simulation is done using a model to show the potential impact of different level of uncertainties on project objectives. Monte Carlo Simulation is generally used for this analysis. It can quantify the effect of uncertainties and risks on project budget and schedule. It simulates the full system many times, each time randomly choosing a value for each factor from its probability distribution. It uses three point estimates like most likely, worst case and best case duration for each task in time management.

d) Decision Trees: This analysis is carried out by decision tree diagram. Decision trees are very helpful to both formulate the problem and evaluate options. In this analysis there are graphical models used to represent a project and can clearly reflect the effects of each decision taken in the project.

2.5.3. Risk response

Risk responses are actions taken to address risks by developing options and strategies that increases the success of the project. (REZAKHANI, 2012) After the risks and their probability of occurrences are analyzed the next step is to determine appropriate ways to promote opportunities and to reduce the negative impacts of project risks. The chosen response corresponding to the risk, should be financially coast effective, timely and acceptable by involved parties. (Bahamid & Doh, 2017)

The responses generally should concentrate on risks that have a high probability of occurrences and/with high financial consequences (Wang, Dulaimi, & Aguria, 2004). Response and allocation of risk chosen depend on the kind of risks. Below risk response methods from several literatures i.e. (PMBOK Guide, 2017), (Flanagan & Norman, 1993) and (Mhetre, Konnur, & Landage, 2016) are discussed.

a) Risk avoidance: is when the project team acts to eliminate the threat or protect the project from its impact by removing the cause of the risk of executing the project in a different direction while still aiming to accomplish project objectives. It may be appropriate for high-priority threats with a high probability of occurrence and a large negative impact. Avoidance may involve isolating project objectives from the risk's impact, or to relax the project objective that is exposed to loss, such as extending schedule or reducing the scope. Examples of avoidance actions may include removing the cause of a threat, extending the schedule, changing the project strategy, or reducing scope. Some risks can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise.

b) Risk transfer: involves shifting ownership of a threat to a third party to manage the risk and to bear the impact if the threat occurs. Transferring a threat does not eliminate it; the threat still exists however it is owned and managed by another party. Transferring risk can be an effective way to deal with financial risk exposure. The aim is to ensure that the risk is owned and managed by the party best able to deal with it effectively. Risk transfer often involves payment of a risk premium to the party taking on the threat. Transfer can be achieved by a range of actions, which include but are not limited to the use of insurance, performance bonds, warranties, guarantees, etc. Agreements may be used to transfer ownership and liability for specified risks to another party.

c) Risk mitigation: action is taken to reduce the probability and/or impact of an adverse risk event to an acceptable threshold. Early mitigation action is often more effective than trying to repair the damage after the threat has occurred. Adopting fewer complex processes, conducting more tests, or choosing a more stable seller are examples of mitigation actions. Where it is not possible to reduce probability, a mitigation response might reduce the impact by targeting factors that drive the severity.

d) Risk acceptance: acknowledges the existence of a threat, but no proactive action is taken. This strategy is adopted when it is not possible to respond to the risk by the other strategies, or a response is not justified by the grandness of the risk. Acceptance can be either active or passive. The most common active acceptance strategy is to establish a contingency reserve, including amounts of time, money, or resources to handle the threat if it occurs. Passive acceptance involves no proactive action apart from periodic review of the threat to ensure that it does not change significantly.

e) Risk exploit: The exploit strategy may be selected for high-priority opportunities where the organization wants to ensure that the opportunity is realized. This strategy seeks to capture the benefit associated with a particular opportunity by ensuring that it definitely happens, increasing the probability of occurrence to 100%. Examples of exploiting responses may include assigning an organization's most talented resources to the project to reduce the time to completion, or using new technologies or technology upgrades to reduce cost and duration.

f) Risk share: allocate risk ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does happen. Risk sharing often involves payment of a risk premium to the party taking on the opportunity. Examples of sharing actions include forming risk-sharing partnerships, teams, special-purpose companies, or joint ventures

g) Risk enhance: aims to alter the "size" of the positive risk. The opportunity is enhanced by increasing its probability and/or impact, thereby maximizing the benefits gained from the project. The probability of occurrence of an opportunity may be increased by focusing attention on its causes. Where it is not possible to increase probability, an enhancement response might increase the impact by targeting factors that drive the size of the potential benefit. Examples of enhancing opportunities include adding more resources to an activity to finish early.

h) Contingency Plan: This involves the use of a fallback plan if a risk occurs. Contingencies can also be in the form of sometime kept in reserve to deal with unknown risks or in the form of costs to deal with unknown risks.

2.5.4. Monitoring risk

Monitoring risk is a process of tracking the implementation of risk response plan, the occurrence of identified risk and identification and analyzation of new risks and evaluate the effectiveness of risk management process. In order to ensure that the project team and key stakeholders are aware of the current level of risk exposure, project work should be continuously monitored for new, changing, and outdated individual project risks and for changes in the level of overall project risk by applying the Monitor Risks process. (REZAKHANI, 2012)

2.6. Risk management in construction project

Managing risks involves a coordinated and economical efforts of decision makers in identifying, assessing and prioritizing risks by monitoring, controlling, and applying managerial resources. (REZAKHANI, 2012). An effective risk management practice helps to understand the type of risks and probability of their occurrence in a given project. In addition, it also helps in the developing a response plan to manage the risks in different phase of the project which leads to successful completion of the project. (Zou, Zhang, & Wang, Understanding the key risks in construction projects in China, 2007)

Even though the view of project success differs from one stakeholder to another, generally the main criteria for project success assessment is the degree of achievement of objectives. There are several criteria to assess the success of a building construction process, the main objectives are quality, cost and time. (Atikinson, 1999)

- Quality

Quality can be understood differently among people, but generally quality can be understood as meeting expectation of the owner or customer. In the case of building construction, quality is measured by the degree of requirement meet, the functionality of the building, the completion time and budget and cost of operation and maintenance. Quality is becoming the major requirement for project success and hence the need to develop international standards and guidelines for quality measurement. One of the most widely used quality management norm for organizations is ISO 9000 which was first developed in 1987. The guide line defines the procedures, control and documentation procedures and systems to be followed to deliver a consistent standard service or product. (Ali & Rahmat, 2010)

Defect and failures in construction projects can be very costly in terms of money and human resource (injuries or even fatality). For this reason, quality control in construction projects is becoming more and more important. To ensure the minimum standards of material and workmanship is meet in the overall stages of the construction (from planning and design to the construction and monitoring stage) standardized documentation, quality goals, planning and implementation and monitoring is required. The most applied standard, worldwide, for this purpose is International Organization for Standardization's ISO 9000 standard. (Hendrickson, 1998)

- Cost:

Cost of a project includes all costs that incur in a project from start to completion which includes costs that are included in the tender documents, costs that arise due to variations and modification during the construction process and other additional costs that may occur such as legal claims. Variance between the initial budget and the total project cost at completion is one way to measure the success of a project (Ali & Rahmat, 2010). In construction projects, cashflow estimates of individual activities of the project is calculated which then are converted to project budget. During the construction, the final detailed cost estimate is used as a baseline to assess the financial performance of the project. The baseline helps project managers identify the exact tasks where there is an overrun or variation from the initial estimate (Hendrickson, 1998).

- Time:

In building construction, the completion time is regarded as the elapsed period from the time the site is handed over to the contractor to the time the building is handed over to the client. The time it takes to complete the project is specified before the construction starts and adherence to this schedule is one of the criteria of measuring project success (Ali & Rahmat, 2010). Delay in completion time can incur additional cost which is additional reason why schedule control is essential. Prior to the start of the project, individual activities in the project are scheduled in the way that the project can be completed within the given time period in a practical way. The forecasted schedule help control the progress of the project and show whether or not the project will be completed withing the dead line with the current performance level. (Hendrickson, 1998)

2.6.1. Discussions of previous researches on risk management in construction projects

In this part, studies that are done on topics related to risk management in construction projects will be discussed.

A study done by (Banaitis & Banaitiene, 2012) in Lithuania, on risk management in construction project categorized risks into two: internal and external risks. According to the study, the risks with the highest effect on construction project were Natural forces, inflation and interest rates, fiscal policy and political from external risks and construction, design and project management risks from internal risks.

A study made in China, by (Zou, Wang, & Zhang, Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder perspectives, 2014) have identified 20 major risk factors based on likelihood of occurrence and their impact on project objectives. The study classified the risks into risks related to clients, designers, contractors, subcontractors and government bodies. According to this study the major risks were: Tight project schedule, Design variations, Excessive approval procedures in administrative government departments, High performance/quality expectations, Inadequate program scheduling, Unsuitable construction program planning, Variations of construction programs, Low management competency of subcontractors, Variations by the client, Incomplete approval and other documents, Incomplete or inaccurate cost estimate, Lack of coordination between project participants, Unavailability of sufficient professionals and managers, Unavailability of sufficient amount of skilled labor, Bureaucracy of government, General safety accident occurrence, Inadequate or insufficient site information (soil test and survey report), Occurrence of dispute, Price inflation of construction materials and Serious noise pollution caused by construction. The study has finally concluded for a successful project the client, designer, government bodies, contractors and subcontractors should work together and proper management knowledge should be applying from the feasibility period of the project.

(Wang, Dulaimi, & Aguria, 2004) have identified 11 major risks in construction industry, in the study intitled “Risk management framework for construction project in developing countries”. The study was done in international construction projects in Singapore and the identified major risks were: Approval and Permit, Change in Law, Justice Reinforcement, Local Partner’s Creditworthiness, Political Instability, Cost Overrun, Corruption, Inflation and Interest Rates, Government Policies, Government Influence on Disputes and Termination of Joint Venture. The research recommended to treat (mitigate) the risks at higher hierarchy level.

In all three above studies the research methods were fairly similar, that is, the first step was identifying risks in construction industry through literature review. Then based on the identified risks, questioner survey was prepared, distributed and analyzed to identify which risks highly affect project objectives. The common major risks identified in the above researches were: inflation, interest rate, political instability, design variations and government policies.

2.6.2. Research gap

Even though risk management body of knowledge establishes a firm basis for assessing construction risks, several works of literature reviewing the actual practice of risk analysis find that there is a gap between theory and practice. While project management literature is rich in papers addressing risk management, few papers have researched the actual practice of risk management and investigated the practitioners' points of view regarding the available tools.

According to a study made by (Hintsay, 2016), risk management is not implemented and practiced in the construction industry in Ethiopia and subsequently revealed that lack of board or senior executive risk management leadership, owners and the board of construction enterprises have been identified as the most important drivers for risk management implementation in construction enterprises. The study also pointed out that there is no established risk management framework that is being used in Ethiopia's construction industry.

In Ethiopia, there are some researches done on risk management in the construction industry. These studies found that there are shortcomings in implementing risk management in the country which is impacting the objectives of the projects. Even though these researches found the current practical use of risk management in the construction industry and the level of deviation of project objective, there isn't much research done on the risk factors that affect the project objectives and the response methods to be followed to minimize their effect.

2.7. Conclusion

The building construction project is made up of different phases and involves different throughout the construction process. The construction industry mainly encompasses 6 phases and requires the collaboration of different parties, the main being: client, consultant, and contractor. To provide the groundwork for collaboration and to fully accomplish the objective of the construction industry basics of project management knowledge areas should be applied.

In the construction industry, the process of taking a project from initial investment appraisal to completion and into use is complex and entails a time-consuming design and production process. It requires a multitude of people with different skills and interests and the co-ordination of a wide range of disparate, yet interrelated activities. Such complexity moreover, is compounded by many external, uncontrollable factors. This property of the industry makes the construction process highly suitable to risk. Risk can manifest itself in many ways, varying over time and across activities. Essentially, it stems from uncertainties which intern is caused by a lack of information. (Flanagan & Norman, 1993)

In this literature review, we have seen the concept of risk and risk management reviewing stages of risk management in detail. Based on several articles written about this topic, we have established the major procedures of risk management include risk identification, risk assessment, response, and implementation and monitoring. While identifying risk, we see that risk can be classified in different forms based on the characteristics and source of the risk. Based on that the main categories of risk in the construction industry were briefly discussed, this includes technical, construction, physical, organizational, financial, socio-political, and environmental risk.

After the identification of risks, the next step is analyzing the occurrence and impact of the risks. This can be done through quantitative and/or qualitative analysis. The methods that can be used for both types of analysis are reviewed in the literature. After the degree of occurrence and the range to which the risk can affect the objective of the project is clarified the next step is planning a response. Some of the responses chosen for risk include avoidance, transfer, mitigation, acceptance, exploit share, enhance, and contingency plan. Selecting strategies and deciding on risk response action is highly dependent on the type of risk. After selecting a response, the next stage is implementing and monitoring risk. Since risk can occur at any stage of construction, risk management is an iterative process performed throughout the project. Then in the end different frameworks for risk management are described.

The construction industry is highly risk-prone and is vulnerable to various technical, external, organizational, and project management risks. The track record to cope with these risks has not been very good in the construction industry especially in developing countries like Ethiopia. As a result, the people working in the industry bear various failures, such as failure of achieving the required quality and operational requirements, cost overruns, and uncertain delays in project completion. To minimize these losses effective systems of risk management for the construction industry need to be developed.

The primary aim of this paper is to identify and analyze the likelihood of occurrence and impacts of the risks associated with construction projects. The major risks that usually occur in construction projects will be identified through additional literature review, survey, and an interview with project managers. After the risks are identified the level of the impacts, they have in the construction process will be analyzed and rated through the quantitative method. The second aim of this thesis will be to resolve those risks, related to time and budget, based on the level of impact they have and develop an applicable framework that will help minimize the impacts of those risks.

3. Research Methodology

The aim of this chapter is to describes the research methods and methodology applied for this study. The chapter will explain first of all the choice of research approach and design used for research followed by discussion on how the selected design and approach assist in meeting the project aims and objectives set by this paper. The chapter then discuss the target population and sampling technique and size and the data analysis methods used. It concludes with a brief discussion on the validity and reliability and ethical issues.

3.1. Research Design and Approach

The purpose of the study is identifying the existing risks and their effects; therefore, the category of research design selected was explanatory (aims to understand phenomena by discovering and measuring causal relations among them). The study then follows a quantitative, descriptive and inferential approach. (Saunders, Lewis, & Thornhill, 2007) defines quantitative research as a method that emphasize on objective measurements that uses any data collection technique (such as a questionnaire) or data analysis procedure (such as graphs or statistics) that generates or uses numerical data. Quantitative research helps to determine the relationship between set of variables. In this case, the relation between the probability of occurrence of identified risk and the effect of the risks on cost and time need to be determined, therefore quantitative analysis was chosen.

According to (Zegeye, Worku, Tefera, Getu, & Sileshi, 2009) 'descriptive research sets out to describe and to interpret what is. It aims to describe the state of affairs as it exists.'. While we use descriptive statistics to summarize the data we collected from the selected sample; we use inferential statistics to make inference about the larger population from which the sample was drawn from (Saunders, Lewis, & Thornhill, 2007) .This research design was chosen because the aim of the study is first to describe the probability of occurrence of the risks and their effect on cost and completion time of the project and determine which risks have high probability of occurrence and highly affect the objectives of the project (cost and time). Next the co-relation between the variables and regression analysis was performed. Thirdly, the risk response method for the risk factors was analyzed and the response methods that have more rating was identified.

3.2. Data Collection method and Design

Both primary as well as secondary data sources were used in this research. First the secondary data obtained from published journals, books, working papers, reports, theses, and the internet was used to identify factors that affect cost and schedule overruns. Secondly primary data was collected through questioner. (Zegeye, Worku, Tefera, Getu, & Sileshi, 2009) defines Questionnaire as 'a type of survey where number of respondents are asked identical questions, in order to gain information that can be analyzed, patterns found and comparisons made.'

The questioner used for this study is made up of three parts: the 1st part enquires general information of the participant; the 2nd part uses Likert scaled questions to determine the probability of occurrence of risk and the effect of risk on cost and completion time of the project. finally, the third part of the questioner which is a multiple-choice type question to determine which type of responses are preferable for each type of risk.

3.3. Population and Sampling Techniques

3.3.1. Target population

The process of selecting a number of study units from a defined population is called sampling. The purpose of this research is assessing risk management in building construction industry. Risk management is an essential management part for a successful completion of project. Even though all parties that are involved in the building construction plays an important role for the completion of the project the contractor and the owner of the project are more associated with high degree of risk due to the nature of the construction industry. (Khattak, et al., 2019) The end aim of this paper is to figure out a way in which the contractor can minimize the effect of risks, therefore the selected sample units are contractors.

As discussed in the literature review, in building construction project, the major objectives are completing the project within budget and schedule while meeting the required quality. Defect and failures in construction projects can be very costly in terms of money and human resource (injuries or even fatality). For this reason, quality control in construction projects is becoming more and more important. To ensure the minimum standards of material and workmanship is meet in the overall stages of the construction (from planning and design to the construction and monitoring stage) standardized documentation, quality goals, planning and implementation and monitoring is required. The most applied standard, worldwide, for this purpose is International Organization for Standardization's ISO 9000 standard (Hendrickson, 1998). The assumption taken in this project is that quality is non-comprisable, therefore the selected construction companies are ISO certified.

As we saw in the literature review, risk management is an iterative process of identifying, assessing responding and monitoring of risk. The whole process requires knowledge of project management and a great understanding of the construction industry. Thus, to get a knowledgeable and rich data, the selected sample units were project managers working in building construction companies that are ISO certified, with experience greater than 5 years and a minimum education level of bachelor's degree was selected.

3.3.2. Sampling technique and sample size

As discussed above, the construction companies from where the participants (project managers) are selected are ISO certified. In Addis Ababa, there are 12 ISO certified construction companies certified by DQS, ECEA, ISO QAR, PJR and ZDH. After identifying the companies, the next step was determining the number of project managers working under them, this helps in identifying our study population. Accordingly,

Total number of project managers working under ISO certified construction companies = 75

After determining the target population, the next step is determining the sample size. For this step, the researcher used Yamane (1967) provides a simplified formula to calculate sample sizes.

$$n = N / [1 + N (e)^2]$$

Where n is the sample size, N is the population size, and e is the level of precision. By substituting the population size (N= 75) and assuming the level of confidence level 95%, i.e. e=0.05;

n = 75 / [1 + 71 (0.05)2]

n=63

According to the calculation, 63 project managers were selected from the target population size.

Target Population	Project managers that work for ISO certified construction companies
Size of target population	75
Sample size	63

Table 1: Sample size

3.4. Methods of Data Analysis

Data collected through questionnaires were analyzed using quantitative descriptive and inferential statistics with the help of IBM SPSS Statistics version 26 statistical computer software. Descriptive analysis is used to reduce raw data collected through questioner into a meaningful summary and graph. While inferential analysis is used to make inference about the larger population from the sample data collected.

3.4.1. Descriptive Analysis

3.4.1.1. Central tendency: mean

Mean is a descriptive method used to explain a set of data in a single number. It is used to measure the middle or center of a data. The response of the 60 participants was summarized by averaging the rating of each participants for each risk factor. In this paper, the mean value of the ratings was calculated using SPSS and from this analysis, the risk factors that have high probability of occurrence and high impact on project cost and completion time was identified.

To analyze the third part of the questioner, the percentage of answers given for each risk response methods corresponding to each risk factors was calculated. The one with highest frequency is, then, identified for each risk factor.

3.4.2. Inferential analysis

3.4.2.1. Correlation

Correlation is a method which evaluates whether there is a of linear relationships between pairs of continuous variables. Correlation is measured by a statistic called the correlation coefficient, which ranges between -1 and +1 and represents the strength of the linear relation between the variables in question. A correlation coefficient value of zero indicates there is no relation, a value that is closer to +1 indicates that the two variables are strong and direct (when one variable increase the other increases too) relation with each other while a value of -1 indicates a strong and inverse (when one variable increase the other decreases) relation between variables. (Mukaka, 2012)

In this paper, the correlation between probability of occurrence of risks and impact of risk on project cost and correlation between probability of occurrence of risks and impact of risk on project completion time was analyzed.

3.4.2.2. Regression analysis

Linear regression analysis is a technique used to predict the value of one quantitative variable by using its relationship with other quantitative variables. To determine the relationship between two variables the regression type used is called simple linear regression. (Al-Hemyari, 2018). In the case of the study simple linear regression was used to quantify the tendency of the dependent variable (1. Impact of risk on project cost and 2. Impact of risk on project completion time) to vary in a systematic way with the independent variable (probability of occurrence of risk). (i.e. we will have two relations, 1. occurrence of risk and project cost and 2 Occurrence of risk and project completion time).

3.5. Validity and Reliability

Questioners in a research are used as a means of collecting relevant and reliable in a valid manner. Thus, the validity and reliability of the questioner/ survey is essential. Validity assures the area of investigation is explained by the collected data while reliability checks whether the questioner provides a stable and consistent result. Therefore, the validity and reliability of the questioner was checked.

The face validity of the questioner was checked by distributing the questioner to managers in construction companies. The Face validity involves the expert looking at the items in the questionnaire and agreeing that the test measures the characteristics or traits of interest (Bolarinwa, 2015). Cronbach's alpha (α) is the most common measure used to check the reliability of a Likert scale question. The Cronbach's alpha, for the questioner used in this research, was determined by running reliability analysis in SPSS.

3.6. Ethical Issues

All of the participants that responded to the questioner of the research were properly informed about the purpose of the research. Their identity as well as the names of the company they belong to has been kept confidential. Additionally, all the secondary data used in this paper have been properly cited all the information collected throughout this research will only be used for the purpose of this study.

4. Result and Discussion

4.1. Introduction

Overall, 68 questioners were distributed for project managers, and out of the 68 questioners, 60 was responded to. In this chapter, the results gained from the responses were discussed as follows. First, the risks that have a high probability of occurrence with high impact on project cost and completion time was distinguished. Then, based on part three of the questioner, the risk response methods with high ratings from participants are identified for each risk factor. Before analyzing the collected data, the validity and reliability of the questioner need to be checked.

To make sure the theoretical construct (face validity) of the questioner will accurately measure and answer the research questions; the questioner was distributed to an adviser and managers in a construction company for their comment. Accordingly, it was verified the risk factors listed in the questioner; even though they have a different level of probability of occurrence, do affect the project outcome. The scaling type used; the Likert scale also allows for degrees of opinion rather than yes/no answer from the respondent. Therefore, quantitative data is obtained, which means that the data can be analyzed with relative ease to answer all the questions at hand (i.e. the probability of occurrence of the risk, their effect on project cost and completion time, and the response methods for each risk factors.)

The reliability of the questioner was checked by checking the Cronbach's alpha in SPSS. Cronbach's alpha (α) is the most common measure used to check the reliability of a Likert scale question. The Cronbach's alpha, for the questioner used in this research, was determined by running reliability analysis in SPSS. As shown in the table below, the alpha value of the reliability analysis is above 0.554 and according to (Taber, 2018) alpha value between 0.45 to 0.98 is satisfactory which makes this questioner reliable.

Risk Factors	Number of questions	Probability of occurrence	Impact on project cost	Impact on project completion time
Design Risk	5	0.794	0.678	0.767
Construction risk	11	0.783	0.665	0.871
Physical risk	5	0.720	0.678	0.692
Organizational and managerial risk	7	0.793	0.822	0.783
Financial risk	6	0.642	0.711	0.621
Socio-political and legal risk	7	0.554	0.765	0,766
Logistic risk	3	0.569	0.675	0.714
Environmental risk	2	0.580	0.594	0.506

Table 2: Reliability test: Cronbach's alpha result

4.2. General information of participants

All 68 questioner were distributed for project managers that work for ISO certified companies. The professional information of the 60 participants, that responded to the questioners, is summarized as follow.

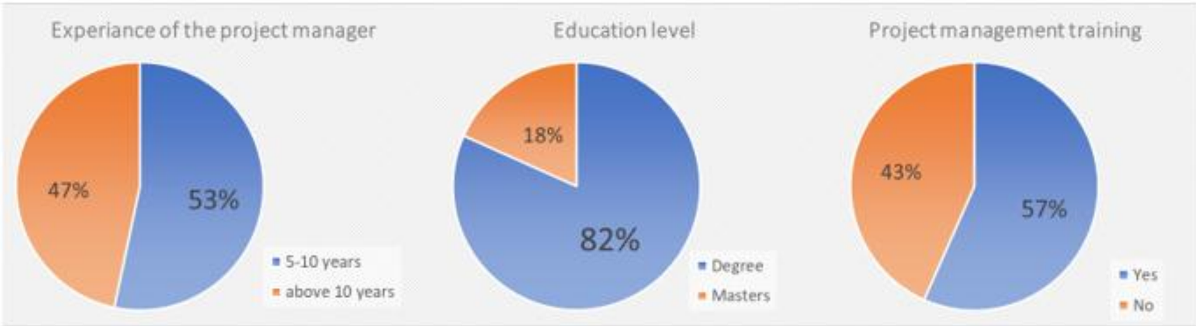

Figure 5: General information of participants

4.3. Risk identification

Risk management is composed of mainly four steps: risk identification, risk analysis, risk response and monitoring risk. In this paper, we are going to focus on the 1st three parts. In this section, the results of descriptive and inferential analysis of the rating of the risks identified through literature review is discussed. The analysis is done via SPSS 26.

4.3.1. Probability of occurrence of risk and risk impact on project cost and completion time

In construction industry, as seen in literature review, there are eight main risk factors. Within these risks there are 41 risks. In this section, we analyze which risks have the highest probability of occurrence, and their effect on project cost and completion time; from the 5-point Likert scaled questioners gathered. The scale ranges from 1 to 5 : 1= Very Low probability, 2= Low probability, 3 = probability of occurrence, 4= Highly probability and 5= Very Highly probability and 0= No Probability 1= Very Low Probability, 2= Low Probability, 3 = Probability, 4= High Probability and 5= Very High Probability.

To determine where the most answer lies, we calculate the mean value of the data. A formula adopted from (Vichea, 2005) was used to break the range distance in measuring the variables.

$(n-1)/n = (5-1)/5=0.8$

Therefore, Mean values falling within

- 4.2 – 5.00 are going to be taken as very high probability
- 3.4 – 4.19 are going to be taken as high probability
- 2.6 – 3.39 are going to be taken as probability
- 1.8 – 2.59 are going to be taken as low probability
- 1-1.79 are going to be taken as very low probability

Accordingly, the results are shown in the table below.

Descriptive Statistics							
Risk Factors	N	Probability of Occurrence		Effect on project cost		Effect on project completion time	
		mean	value	mean	value	mean	value
1. Design Risks							
1.1 Defective design	60	3.63	High	3.75	High	3.97	High
1.2 Not coordinated design (structural, mechanical, electrical, etc.)	60	3.78	High	3.70	High	3.85	High
1.3 Inaccurate quantities	60	3.77	High	3.87	High	3.33	Medium
1.4 consistency between bill of quantities, drawings and specifications	60	3.88	High	3.78	High	3.43	High
1.5 unqualified designers	60	3.03	Medium	3.22	Medium	3.13	Medium
2. Construction risks							
2.1 Rush bidding	60	3.12	Medium	3.35	Medium	3.05	Medium
2.2 Gaps between implementation and Specification	60	3.13	Medium	3.18	Medium	3.05	Medium
2.3 Labor productivity	60	3.53	High	3.48	High	3.58	High
2.4 Design change	60	3.70	High	3.72	High	3.87	High
2.5 Labor disputes	60	2.85	Medium	2.13	Low	2.23	Low
2.6 Site condition	60	2.82	Medium	3.05	Medium	3.23	Medium
2.7 Equipment failures	60	2.77	Medium	2.63	Medium	2.68	Medium
2.8 Lower work quality due to time constraint	60	2.93	Medium	2.60	Medium	2.68	Medium
2.9 Lower work quality due to workman ship	60	3.33	Medium	2.92	Medium	2.85	Medium
2.10 Construction procedures	60	2.73	Medium	2.82	Medium	2.70	Medium
2.11 Actual quantity differ from the contract	60	3.87	High	3.63	High	3.00	Medium
3. Physical risks							
3.1 Damage to structure	60	1.63	Very low	2.68	Medium	2.58	Low
3.2 Damage to equipment	60	2.55	Low	2.67	Medium	2.58	Low
3.3 Labor injuries	60	2.72	Medium	1.97	Low	1.75	Very low
3.4 Supplies of defective material	60	2.38	Low	2.82	Medium	2.60	Medium
3.5 Theft	60	2.65	Medium	2.30	Low	1.95	Low
4. Organizational & Managerial risk							
4.1 Contractual relations	60	2.83	Medium	2.83	Medium	3.00	Medium
4.2 Contractor's experience	60	2.82	Medium	2.95	Medium	3.07	Medium
4.3 Attitudes of participants	60	2.80	Medium	2.47	Low	2.58	Low
4.4 Inexperience work force	60	2.83	Medium	3.03	Medium	3.03	Medium

4.5 Ambiguous Planning due to project complexity	60	3.02	Medium	3.03	Medium	3.23	Medium
4.6 Resource management	60	3.62	High	3.93	High	3.78	High
4.7 Poor communication between involved parties	60	3.37	Medium	3.12	Medium	3.63	High
5. Financial Risk							
5.1 Inflation	60	3.77	High	4.23	Very high	3.82	High
5.2 Payment delays	60	3.85	High	3.25	Medium	3.62	High
5.3 Material cost	60	3.87	High	4.17	High	3.47	High
5.4 Exchange rate fluctuation	60	3.28	Medium	3.65	High	3.25	Medium
5.5 Low market demand	60	2.55	Low	2.35	Low	2.37	Low
5.6 Financial failure of the contractor	60	3.00	Medium	3.55	High	4.02	High
6. Socio- political and legal risks							
6.1 Changes in laws and regulations	60	2.28	Low	2.28	Low	2.42	Low
6.2 Pollution and safety rules	60	1.83	Low	2.02	Low	2.07	Low
6.3 Bribery/Corruption, Language/Cultural barrier	60	3.18	Medium	3.02	Medium	2.98	Medium
6.4 Law & order	60	2.13	Low	2.43	Low	2.67	Medium
6.5 War and civil disorder	60	1.93	Low	3.27	Medium	3.48	High
6.6 Requirement for permits and their approval	60	2.92	Medium	2.40	Low	3.12	Medium
6.7 Legal disputes among the parties in the contract	60	2.73	Medium	2.73	Medium	3.20	Medium
7. Logistics Risks							
7.1 Unavailable labor, material and equipment	60	3.03	Medium	3.37	Medium	3.45	High
7.2 Undefined scope pf working	60	2.83	Medium	3.08	Medium	2.95	Medium
7.3 High competition in bids	60	3.68	High	2.85	Medium	2.48	Low
8. Environmental risks							
8.1 Natural disaster	60	1.45	Very low	3.82	High	3.88	High
8.2 Adverse weather condition	60	2.50	Low	3.65	High	3.62	High

Table 3: Result of the mean values of occurrence of risk and impact on project cost and completion time

4.3.1.1. Probability of occurrence of risk and impact on project cost

As per the literature review in chapter two, managers cannot avoid, be prepare and respond to all risks that occur in a project. Therefore, managing risks involves a coordinated and economical efforts of decision makers in identifying, assessing and prioritizing risks. (REZAKHANI, 2012). Based on Table 3,the rating of occurrence of risk and the effect on cost has been determined. The following chart clarify which risks have high probability of occurrence and high effect on project cost. This will help us on which risks to focus to complete the project under budget.

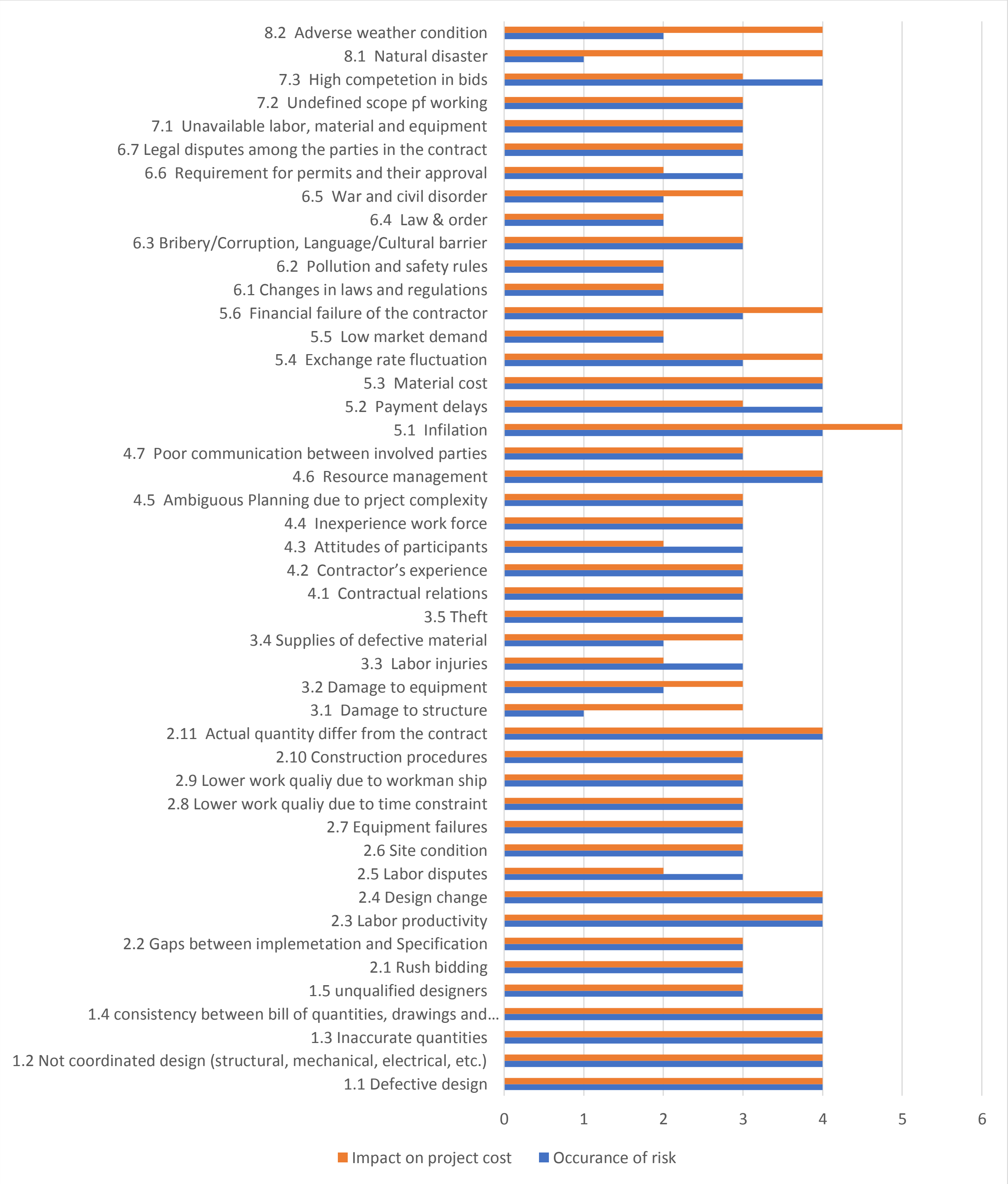

Figure 6: Occurrence of risk and impact on project cost

Based on the chart above, risks that have both high probability of occurrence and high impact on project cost are:

- Defective design
- Non coordinated design
- Inaccurate quantities
- Consistency between bill of quantities, drawings and specifications
- Labor productivity
- Design change
- Actual quantity differs from the contract
- Resource management
- Inflation
- Material cost

4.3.1.2. Probability of occurrence of risk and impact on project completion time

Similarly, the rating of occurrence of risk and the effect on time has been determined. The following chart clarify which risks have high probability of occurrence and high effect on project completion time. This will help us on which risks to focus to complete the project within the planed completion time.

Figure 7: Occurrence of risk and impact on project completion time

Based on the chart above, risks that have both high probability of occurrence and high impact on project completion time are:

- Defective design
- Non coordinated design
- Consistency between bill of quantities, drawings and specifications
- Labor productivity
- Design change
- Resource management
- Inflation
- Payment delays
- Material cost

4.3.1.3. Discussion of results in probability of occurrence of risk and their effect on project cost and time

Based on the analysis of the collected data, 11 risk factors that have a high probability of occurrence and high effect on project cost and time were identified. The first four risks are found under design risks which are: defective design, non-coordinated design, inaccurate quantities, Consistency between bill of quantities, drawings, and specifications. This result is supported by studies done by (Banaitis & Banaitiene, 2012) which divided risks into internal and external risk. The study identifies design risk as one of the internal risks that have a high effect on the project objective. Additionally, a study made in china, by (Zou, Wang, & Zhang, Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder perspectives, 2014) also found that design variation and incomplete or inaccurate cost estimate (which are found under design risk) are major risks that affect project objectives.

Construction risks, specifically, Labor productivity, Design change, Actual quantity differs from the contract are other risks that affect construction projects. This finding is similar to the findings of (Banaitis & Banaitiene, 2012), (Zou, Wang, & Zhang, Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder perspectives, 2014) and (Wang, Dulaimi, & Aguria, 2004). These studies found that construction risks have a high effect on project objectives specifically the Unavailability of a sufficient amount of skilled labor, variation by the client, incomplete cost estimate, and cost overrun.

One of the risk factors identified as having a high probability of affecting the construction project is risk management. Resource management is one of the knowledge areas of project management. A construction project is a type of project that have highly correlated tasks that require timely delivery of materials and human resource. This property makes resource management a very essential part of construction project management. (Banaitis & Banaitiene, 2012) also, acknowledge that there is a gap in project management in construction projects which cause deviation from project objectives.

The remaining three risk factors are found under financial risks. These risk factors are inflation, payment delays, and material cost. Inflation affects both owners and contractors; owners not only have to cover some additional costs due to inflation but also premiums on construction price because of the uncertainty of its effect. And since contractors cannot determine the inflation rate, they cannot accurately forecast long-term costs (labor and material) and returns on investment. Therefore, owners and contractors must plan for these effects and attempt to reduce the risks entailed. Another factor under financial risk is a delay in payment which can retain the contractor from performing as planned due to a shortage of money for labor and material cost. (Stukhart, 2016)

4.3.2. Correlation between Occurrence of risk and project cost and project completion time

Correlation is a method which evaluates whether there is a of linear relationships between pairs of continuous variables. In SPSS correlation is measured by a statistic called the correlation coefficient, which ranges between -1 and +1 and represents the strength of the linear relation between the variables in question. A correlation coefficient value of zero indicates there is no relation, a value that is closer to +1 indicates that the two variables are strong and direct (when one variable increase the other increases too) relation with each other while a value of -1 indicates a strong and inverse (when one variable increase the other decreases) relation between variables. (Mukaka, 2012)

Another method in SPSS to evaluate the correlation between variable is the 2-tailed test. This value will show if there is a statistically significant correlation between two variables. If the 2-tailed value is greater than 0.05 then there is no statistically correlation between the variables while a 2-tailed value of less than or equal to 0.05 indicates a significant relation between the variables.

In this paper, the correlation between probability of occurrence of risks and impact of risk on project cost and correlation between probability of occurrence of risks and impact of risk on project completion time. The results are shown below in their perspective table. The highlighted values in the table are the correlation values between the dependent and independent value.

4.3.2.1. Design risks

Correlations between occurrence of Design risks and their effect on project cost						
		9.1 Impact of Defective design on cost	9.2 Impact of Not coordinated design on cost	9.3 Impact of Inaccurate quantities on cost	9.4 Impact of consistency between bill of quantities, drawings and specifications on cost	9.5 Impact of unqualified designers on cost
1.1 Probability of occurrence of Defective design	Pearson Correlation	**.745****	0.144	.470**	.497**	.457**
	Sig. (2-tailed)	**0.000**	0.272	0.000	0.000	0.000
1.2 Probability of occurrence of Not coordinated design	Pearson Correlation	.401**	**.436****	0.005	.523**	.323*
	Sig. (2-tailed)	0.001	**0.000**	0.969	0.000	0.012
1.3 Probability of occurrence of Inaccurate quantities	Pearson Correlation	0.253	-0.097	**.476****	.442**	.261*
	Sig. (2-tailed)	0.051	0.459	**0.000**	0.000	0.044
1.4 Probability of occurrence of consistency between bill of quantities, drawings and specifications	Pearson Correlation	.400**	0.241	.264*	**.762****	.372**
	Sig. (2-tailed)	0.002	0.064	0.042	**0.000**	0.003
1.5 Probability of occurrence of unqualified designers	Pearson Correlation	.259*	.313*	0.191	.480**	**.448****
	Sig. (2-tailed)	0.045	0.015	0.144	0.000	**0.000**

Table 4: Correlations between occurrence of Design risks and their effect on project cost

Correlations between occurrence of Design risks and their effect on project completion time						
		17.1 Impact of Defective design on time	17.2 Impact of Not coordinated design	17.3 Impact of Inaccurate quantities on time	17.4 Impact of consistency between bill of quantities, drawings and specifications on time	17.5 Impact of unqualified designers on time
1.1 Probability of occurrence of Defective design	Pearson Correlation	**.632****	0.208	.332**	.428**	.398**
	Sig. (2-tailed)	**0.000**	0.111	0.010	0.001	0.002
1.2 Probability of occurrence of Not coordinated design	Pearson Correlation	.323*	**.534****	0.006	.487**	0.218
	Sig. (2-tailed)	0.012	**0.000**	0.964	0.000	0.095
1.3 Probability of occurrence of Inaccurate quantities	Pearson Correlation	.279*	-0.002	**.291***	0.247	0.101
	Sig. (2-tailed)	0.031	0.987	**0.024**	0.057	0.442
1.4 Probability of occurrence of consistency between bill of quantities, drawings and specifications	Pearson Correlation	.302*	.298*	.283*	**.645****	.289*
	Sig. (2-tailed)	0.019	0.021	0.029	**0.000**	0.025
1.5 Probability of occurrence of unqualified designers	Pearson Correlation	0.166	.314*	.349**	.448**	**.388****
	Sig. (2-tailed)	0.206	0.014	0.006	0.000	**0.002**

Table 5: Correlations between occurrence of Design risks and their effect on project completion time

4.3.2.2. Construction risk

Correlations between occurrence of Construction risks and their effect on project cost												
		10.1 Impact of Rush bidding on cost	10.2 Impact of Gaps between implementation and Specification on cost	10.3 Impact of Labor productivity on cost	10.4 Impact of Design change on cost	10.5 Impact of Labor disputes on cost	10.6 Impact of Site condition on cost	10.7 Impact of Equipment failures on cost	10.8 Impact of Lower work quality due to time constraint on cost	10.9 Impact of Lower work quality due to workman ship on cost	10.10 Impact of Construction procedures on cost	10.11 Impact of Actual quantity differ from the contract on cost
2.1 Probability of occurrence of Rush bidding	Pearson Correlation	.526**	.455**	0.177	.424**	-0.016	.377**	.315*	.313*	.531**	-0.048	.514**
	Sig. (2-tailed)	0.000	0.000	0.177	0.001	0.904	0.003	0.014	0.015	0.000	0.713	0.000
2.2 Probability of occurrence of Gaps between implementation and Specification	Pearson Correlation	.481**	.549**	0.203	.635**	-0.082	.359**	.325*	.440**	.428**	0.058	.531**
	Sig. (2-tailed)	0.000	0.000	0.120	0.000	0.532	0.005	0.011	0.000	0.001	0.659	0.000
2.3 Probability of occurrence of Labor productivity	Pearson Correlation	.384**	.409**	.708**	0.190	0.183	.411**	-0.005	0.074	-0.136	.289*	.399**
	Sig. (2-tailed)	0.002	0.001	0.000	0.147	0.161	0.001	0.968	0.574	0.299	0.025	0.002
2.4 Probability of occurrence of Design change	Pearson Correlation	0.150	.354**	0.118	.620**	-0.196	0.151	0.086	-0.042	.283*	-0.060	.423**
	Sig. (2-tailed)	0.252	0.006	0.368	0.000	0.134	0.249	0.515	0.750	0.029	0.647	0.001
2.5 Probability of occurrence of Labor disputes	Pearson Correlation	0.059	-0.058	0.244	0.106	.616**	-0.035	.398**	.344**	0.099	0.246	0.209
	Sig. (2-tailed)	0.654	0.661	0.060	0.419	0.000	0.789	0.002	0.007	0.451	0.058	0.109
2.6 Probability of occurrence of Site condition	Pearson Correlation	.279*	0.113	0.155	0.177	-0.099	.396**	-.304*	0.048	-0.087	0.243	.312*
	Sig. (2-tailed)	0.031	0.388	0.237	0.177	0.450	0.002	0.018	0.714	0.507	0.061	0.015
2.7 Probability of occurrence of Equipment failures	Pearson Correlation	.479**	.435**	.433**	0.022	.336**	0.155	.301*	0.112	0.097	0.137	0.171
	Sig. (2-tailed)	0.000	0.001	0.001	0.869	0.009	0.238	0.019	0.394	0.459	0.298	0.193
2.8 Probability of occurrence of Lower work quality due to time constraint	Pearson Correlation	.395**	.553**	.388**	.255*	.278*	.286*	.410**	.581**	.324*	.258*	.284*
	Sig. (2-tailed)	0.002	0.000	0.002	0.049	0.032	0.027	0.001	0.000	0.012	0.047	0.028
2.9 Probability of occurrence of Lower work quality due to	Pearson Correlation	.497**	.578**	.342**	.301*	0.207	0.223	.280*	.269*	.581**	0.106	.463**
	Sig. (2-tailed)	0.000	0.000	0.007	0.019	0.112	0.086	0.030	0.037	0.000	0.419	0.000
2.10 Probability of occurrence of Construction procedures	Pearson Correlation	.349**	.407**	.283*	.442**	0.077	.337**	.384**	.431**	.651**	.297*	.496**
	Sig. (2-tailed)	0.006	0.001	0.029	0.000	0.556	0.008	0.002	0.001	0.000	0.021	0.000
2.11 Probability of occurrence of Actual quantity differ from the contract	Pearson Correlation	0.163	.298*	-0.003	.471**	-.309*	.258*	0.031	0.245	.534**	0.197	.708**
	Sig. (2-tailed)	0.213	0.021	0.984	0.000	0.016	0.047	0.816	0.059	0.000	0.132	0.000

Table 6: Correlations between occurrence of Construction risks and their effect on project cost

Correlations between occurrence of Construction risks and their effect on project completion time												
		18.1 Impact of Rush bidding on time	18.2 Impact of Gaps between implementation and Specification on time	18.3 Impact of Labor productivity on time	18.4 Impact of Design change on time	18.5 Impact of Labor disputes on time	18.6 Impact of Site condition on time	18.7 Impact of Equipment failures on time	18.8 Impact of Lower work quality due to time constraint on time	18.9 Impact of Lower work quality due to workman ship on time	18.10 Impact of Construction procedures on time	18.11 Impact of Actual quantity differ from the contract on time
2.1 Probability of occurrence of Rush bidding	Pearson Correlation	.583**	.327*	.312*	.372**	0.147	.312*	.397**	0.189	.369**	.363**	.551**
	Sig. (2-tailed)	0.000	0.011	0.015	0.003	0.262	0.015	0.002	0.147	0.004	0.004	0.000
2.2 Probability of occurrence of Gaps between implementation and Specification	Pearson Correlation	.465**	.446**	0.253	.630**	-0.058	.367**	.297*	.363**	.355**	.292*	.498**
	Sig. (2-tailed)	0.000	0.000	0.051	0.000	0.659	0.004	0.021	0.004	0.005	0.024	0.000
2.3 Probability of occurrence of Labor productivity	Pearson Correlation	.377**	.415**	.640**	-0.014	-0.060	.413**	-0.048	.397**	0.160	.428**	0.214
	Sig. (2-tailed)	0.003	0.001	0.000	0.913	0.647	0.001	0.715	0.002	0.222	0.001	0.100
2.4 Probability of occurrence of Design change	Pearson Correlation	.309*	.360**	0.190	.533**	-0.099	0.149	0.087	0.022	.325*	0.232	.388**
	Sig. (2-tailed)	0.016	0.005	0.146	0.000	0.452	0.256	0.508	0.868	0.011	0.074	0.002
2.5 Probability of occurrence of Labor disputes	Pearson Correlation	0.133	-0.011	0.109	0.116	.550**	0.131	.445**	0.194	0.061	.271*	0.084
	Sig. (2-tailed)	0.310	0.934	0.407	0.377	0.000	0.319	0.000	0.137	0.646	0.036	0.525
2.6 Probability of occurrence of Site condition	Pearson Correlation	-0.024	0.047	0.222	0.142	-0.140	.455**	-0.216	0.221	0.208	.327*	-0.031
	Sig. (2-tailed)	0.854	0.720	0.088	0.281	0.286	0.000	0.098	0.089	0.111	0.011	0.812
2.7 Probability of occurrence of Equipment failures	Pearson Correlation	.343**	.378**	.462**	0.109	.285*	.309*	.475**	.440**	.438**	.560**	0.237
	Sig. (2-tailed)	0.007	0.003	0.000	0.409	0.027	0.016	0.000	0.000	0.000	0.000	0.069
2.8 Probability of occurrence of Lower work quality due to time constraint	Pearson Correlation	0.151	.445**	.367**	.406**	0.204	0.230	0.208	.588**	.528**	.452**	0.222
	Sig. (2-tailed)	0.249	0.000	0.004	0.001	0.118	0.077	0.111	0.000	0.000	0.000	0.088
2.9 Probability of occurrence of Lower work quality due to	Pearson Correlation	.419**	.432**	.476**	.313*	.299*	.379**	.506**	.479**	.703**	.709**	.506**
	Sig. (2-tailed)	0.001	0.001	0.000	0.015	0.021	0.003	0.000	0.000	0.000	0.000	0.000
2.10 Probability of occurrence of Construction procedures	Pearson Correlation	.322*	0.184	.398**	.377**	.373**	.402**	.375**	.425**	.466**	.533**	.515**
	Sig. (2-tailed)	0.012	0.160	0.002	0.003	0.003	0.001	0.003	0.001	0.000	0.000	0.000
2.11 Probability of occurrence of Actual quantity differ from the contract	Pearson Correlation	0.111	0.049	0.148	.398**	-0.015	0.204	-0.082	0.186	.401**	0.243	.395**
	Sig. (2-tailed)	0.399	0.708	0.259	0.002	0.911	0.119	0.533	0.155	0.001	0.062	0.002

Table 7: Correlations between occurrence of Design risks and their effect on project completion time

4.3.2.3. Physical risk

Correlations between occurrence of Physical risks and their effect on project cost						
		11.1 Impact of Damage to structure on cost	11.2 Impact of Damage to equipment on cost	11.3 Impact of Labor injuries on cost	11.4 Impact of Supplies of defective material on cost	11.5 Impact of Theft on cost
3.1 Probability of occurrence of Damage to structure	Pearson Correlation	.283*	.343**	.398**	.366**	0.250
	Sig. (2-tailed)	0.028	0.007	0.002	0.004	0.054
3.2 Probability of occurrence of Damage to equipment	Pearson Correlation	0.165	.485**	.605**	.522**	.510**
	Sig. (2-tailed)	0.208	0.000	0.000	0.000	0.000
3.3 Probability of occurrence of Labor injuries	Pearson Correlation	0.251	.454**	0.161	.394**	0.029
	Sig. (2-tailed)	0.053	0.000	0.220	0.002	0.823
3.4 Probability of occurrence of Supplies of defective material	Pearson Correlation	.289*	.434**	.309*	.529**	0.215
	Sig. (2-tailed)	0.025	0.001	0.016	0.000	0.099
3.5 Probability of occurrence of Theft	Pearson Correlation	-0.011	0.243	0.031	0.061	.456**
	Sig. (2-tailed)	0.932	0.062	0.815	0.642	0.000

Table 8:Correlations between occurrence of Physical risks and their effect on project cost

Correlations between occurrence of Physical risks and their effect on project completion time						
		19.1 Impact of Damage to structure on time	19.2 Impact of Damage to equipment on time	19.3 Impact of Labor injuries on time	19.4 Impact of Supplies of defective material on time	19.5 Impact of Theft on time
3.1 Probability of occurrence of Damage to structure	Pearson Correlation	.261*	.344**	.658**	.311*	.316*
	Sig. (2-tailed)	0.044	0.007	0.000	0.016	0.014
3.2 Probability of occurrence of Damage to equipment	Pearson Correlation	0.146	.376**	.436**	.583**	0.168
	Sig. (2-tailed)	0.265	0.003	0.001	0.000	0.200
3.3 Probability of occurrence of Labor injuries	Pearson Correlation	.288*	.282*	.420**	.450**	0.115
	Sig. (2-tailed)	0.026	0.029	0.001	0.000	0.382
3.4 Probability of occurrence of Supplies of defective material	Pearson Correlation	.338**	.360**	.492**	.545**	0.182
	Sig. (2-tailed)	0.008	0.005	0.000	0.000	0.165
3.5 Probability of occurrence of Theft	Pearson Correlation	-0.100	0.059	0.238	0.058	.602**
	Sig. (2-tailed)	0.446	0.655	0.067	0.660	0.000

Table 9:Correlations between occurrence of Physical risks and their effect on project completion time

4.3.2.4. Organizational and Managerial risk

Correlations between occurrence of Organizational and Managerial risks and their effect on project cost								
		12.1 Impact of Contractual relations on cost	12.2 Impact of Contractor's experience on cost	12.3 Impact of Attitudes of participants on cost	12.4 Impact of Inexperience work force on cost	12.5 Impact of Ambiguous Planning due to project complexity on cost	12.6 Impact of Resource management on cost	12.7 Impact of Poor communication between involved parties on cost
4.1 Probability of occurrence of Contractual relations	Pearson Correlation	.349**	.416**	0.122	0.147	0.229	-0.083	0.085
	Sig. (2-tailed)	0.006	0.001	0.355	0.263	0.078	0.526	0.520
4.2 Probability of occurrence of Contractor's experience	Pearson Correlation	0.136	.550**	0.035	.385**	0.207	0.170	0.244
	Sig. (2-tailed)	0.302	0.000	0.790	0.002	0.112	0.195	0.061
4.3 Probability of occurrence of Attitudes of participants	Pearson Correlation	.340**	.319*	.586**	.435**	0.194	0.068	.272*
	Sig. (2-tailed)	0.008	0.013	0.000	0.001	0.138	0.607	0.035
4.4 Probability of occurrence of Inexperience work force	Pearson Correlation	.485**	.718**	.352**	.576**	0.125	.270*	.293*
	Sig. (2-tailed)	0.000	0.000	0.006	0.000	0.341	0.037	0.023
4.5 Probability of occurrence of Ambiguous Planning due to project complexity	Pearson Correlation	.414**	.318*	0.154	0.201	.421**	-0.227	0.134
	Sig. (2-tailed)	0.001	0.013	0.241	0.124	0.001	0.081	0.308
4.6 Probability of occurrence of Resource management	Pearson Correlation	.407**	.270*	0.035	.347**	-0.250	.438**	.374**
	Sig. (2-tailed)	0.001	0.037	0.792	0.007	0.054	0.000	0.003
4.7 Probability of occurrence of Poor communication between involved parties	Pearson Correlation	.351**	.489**	.264*	.340**	-0.016	-0.057	.389**
	Sig. (2-tailed)	0.006	0.000	0.041	0.008	0.904	0.667	0.002

Table 10: Correlations between occurrence of Organizational and Managerial risks and their effect on project cost

Correlations between occurrence of Organizational and Managerial risks and their effect on project completion time								
		20.1 Impact of Contractual relations on time	20.2 Impact of Contractor's experience on time	20.3 Impact of Attitudes of participants on time	20.4 Impact of Inexperience work force on time	20.5 Impact of Ambiguous Planning due to project complexity on time	20.6 Impact of Resource management on time	20.7 Impact of Poor communication between involved parties on time
4.1 Probability of occurrence of Contractual relations	Pearson Correlation	.700**	0.249	.450**	0.135	0.132	-0.049	-0.015
	Sig. (2-tailed)	0.000	0.055	0.000	0.305	0.315	0.710	0.909
4.2 Probability of occurrence of Contractor's experience	Pearson Correlation	.559**	.540**	.279*	.387**	0.204	0.196	0.183
	Sig. (2-tailed)	0.000	0.000	0.031	0.002	0.118	0.133	0.161
4.3 Probability of occurrence of Attitudes of participants	Pearson Correlation	0.167	.307*	.562**	.434**	0.214	0.240	.350**
	Sig. (2-tailed)	0.201	0.017	0.000	0.001	0.101	0.065	0.006
4.4 Probability of occurrence of Inexperience work force	Pearson Correlation	.392**	.476**	.491**	.546**	.294*	.319*	0.067
	Sig. (2-tailed)	0.002	0.000	0.000	0.000	0.023	0.013	0.609
4.5 Probability of occurrence of Ambiguous Planning due to project complexity	Pearson Correlation	0.246	0.230	.440**	0.082	.297*	-0.146	0.085
	Sig. (2-tailed)	0.058	0.077	0.000	0.536	0.021	0.264	0.516
4.6 Probability of occurrence of Resource management	Pearson Correlation	0.132	.289*	0.082	.360**	-0.072	.374**	0.164
	Sig. (2-tailed)	0.314	0.025	0.535	0.005	0.585	0.003	0.210
4.7 Probability of occurrence of Poor communication between involved parties	Pearson Correlation	0.079	.398**	.316*	.312*	0.015	-0.005	.314*
	Sig. (2-tailed)	0.550	0.002	0.014	0.015	0.907	0.969	0.015

Table 11: Correlations between occurrence of Organizational and Managerial risks and their effect on project completion time

4.3.2.5. Financial risk

Correlations between occurrence of Financial risks and their effect on project cost							
		13.1 Impact of Inflation on cost	13.2 Impact of Payment delays on cost	13.3 Impact of Material cost on cost	13.4 Impact of Exchange rate fluctuation on cost	13.5 Impact of Low market demand on cost	13.6 Impact of Financial failure of the contractor on cost
5.1 Probability of occurrence of Inflation	Pearson Correlation	.418**	0.163	.489**	0.185	.322*	0.048
	Sig. (2-tailed)	0.001	0.213	0.000	0.158	0.012	0.718
5.2 Probability of occurrence of Payment delays	Pearson Correlation	0.226	.439**	.539**	.438**	0.105	0.175
	Sig. (2-tailed)	0.083	0.000	0.000	0.000	0.425	0.181
5.3 Probability of occurrence of Material cost	Pearson Correlation	.406**	.325*	.715**	0.146	.271*	0.165
	Sig. (2-tailed)	0.001	0.011	0.000	0.267	0.036	0.206
5.4 Probability of occurrence of Exchange rate fluctuation	Pearson Correlation	0.161	.485**	.321*	.661**	0.150	-0.035
	Sig. (2-tailed)	0.219	0.000	0.012	0.000	0.254	0.792
5.5 Probability of occurrence of Low market demand	Pearson Correlation	0.165	0.059	0.193	0.112	.795**	.358**
	Sig. (2-tailed)	0.206	0.652	0.139	0.396	0.000	0.005
5.6 Probability of occurrence of Financial failure of the contractor	Pearson Correlation	0.000	0.198	0.157	0.215	.344**	.390**
	Sig. (2-tailed)	1.000	0.130	0.232	0.098	0.007	0.002

Table 12: Correlations between occurrence of Financial risks and their effect on project cost

Correlations between occurrence of Financial risks and their effect on project completion time							
		21.1 Impact of Inflation on time	21.2 Impact of Payment delays on time	21.3 Impact of Material cost on time	21.4 Impact of Exchange rate fluctuation on time	21.5 Impact of Low market demand on time	21.6 Impact of Financial failure of the contractor on time
5.1 Probability of occurrence of Inflation	Pearson Correlation	0.220	-0.161	.370**	0.167	.259*	0.052
	Sig. (2-tailed)	0.091	0.219	0.004	0.201	0.045	0.692
5.2 Probability of occurrence of Payment delays	Pearson Correlation	0.134	.376**	.491**	.361**	0.082	0.215
	Sig. (2-tailed)	0.306	0.003	0.000	0.005	0.535	0.099
5.3 Probability of occurrence of Material cost	Pearson Correlation	.385**	0.114	.642**	0.216	.270*	0.096
	Sig. (2-tailed)	0.002	0.386	0.000	0.097	0.037	0.464
5.4 Probability of occurrence of Exchange rate fluctuation	Pearson Correlation	0.022	.315*	0.189	.738**	0.141	-0.123
	Sig. (2-tailed)	0.869	0.014	0.149	0.000	0.283	0.350
5.5 Probability of occurrence of Low market demand	Pearson Correlation	.307*	-0.005	.417**	0.197	.759**	.263*
	Sig. (2-tailed)	0.017	0.970	0.001	0.131	0.000	0.043
5.6 Probability of occurrence of Financial failure of the contractor	Pearson Correlation	0.165	.375**	.258*	0.087	.266*	.372**
	Sig. (2-tailed)	0.207	0.003	0.047	0.508	0.040	0.003

Table 13: Correlations between occurrence of Financial risks and their effect on project completion time

4.3.2.6. Socio-political and legal risks

Correlations between occurrence of Socio-Political and Legal risks and their effect on project cost								
		14.1 Impact of Changes in laws and regulations on cost	14.2 Impact of Pollution and safety rules on cost	14.3 Impact of Bribery/Corruption, Language/Cultural barrier on cost	14.4 Impact of Law & order on cost	14.5 Impact of War and civil disorder on cost	14.6 Impact of Requirement for permits and their approval on cost	14.7 Impact of Legal disputes among the parties in the contract on cost
6.1 Probability of occurrence of Changes in laws and regulations	Pearson Correlation	0.221	.363**	0.054	-0.026	-.257*	-0.091	.335**
	Sig. (2-tailed)	0.089	0.004	0.679	0.845	0.047	0.491	0.009
6.2 Probability of occurrence of Pollution and safety rules	Pearson Correlation	0.196	.713**	.315*	.316*	-0.022	.294*	.284*
	Sig. (2-tailed)	0.134	0.000	0.014	0.014	0.870	0.023	0.028
6.3 Probability of occurrence of Bribery/Corruption, Language/Cultural barrier	Pearson Correlation	-0.093	0.016	.455**	0.142	0.001	-0.086	-0.128
	Sig. (2-tailed)	0.479	0.901	0.000	0.280	0.993	0.511	0.330
6.4 Probability of occurrence of Law & order	Pearson Correlation	0.100	0.185	.366**	.631**	0.032	0.216	0.160
	Sig. (2-tailed)	0.449	0.156	0.004	0.000	0.808	0.097	0.223
6.5 Probability of occurrence of War and civil disorder	Pearson Correlation	0.185	.311*	.405**	0.233	.298*	-0.102	-0.223
	Sig. (2-tailed)	0.157	0.016	0.001	0.073	0.021	0.440	0.087
6.6 Probability of occurrence of Requirement for permits and their approval	Pearson Correlation	0.211	0.099	0.103	.302*	0.183	.506**	0.142
	Sig. (2-tailed)	0.106	0.450	0.435	0.019	0.161	0.000	0.280
6.7 Probability of occurrence of Legal disputes among the parties in the contract	Pearson Correlation	0.189	.297*	-0.017	0.194	0.107	.314*	.718**
	Sig. (2-tailed)	0.149	0.021	0.898	0.137	0.414	0.015	0.000

Table 14: Correlations between occurrence of Socio-Political and Legal risks and their effect on project cost

Correlations between occurrence of Socio-Political and Legal risks and their effect on project completion time								
		22.1 Impact of Changes in laws and regulations on time	22.2 Impact of Pollution and safety rules on time	22.3 Impact of Bribery/Corruption, Language/Cultural barrier on time	22.4 Impact of Law & order on time	22.5 Impact of War and civil disorder on time	22.6 Impact of Requirement for permits and their approval on time	22.7 Impact of Legal disputes among the parties in the contract on time
6.1 Probability of occurrence of Changes in laws and regulations	Pearson Correlation	.402**	.348**	0.126	-0.088	-0.207	0.055	0.058
	Sig. (2-tailed)	0.001	0.006	0.338	0.504	0.112	0.678	0.660
6.2 Probability of occurrence of Pollution and safety rules	Pearson Correlation	.372**	.692**	.309*	.266*	-0.024	0.185	0.163
	Sig. (2-tailed)	0.003	0.000	0.016	0.040	0.856	0.156	0.212
6.3 Probability of occurrence of Bribery/Corruption, Language/Cultural barrier	Pearson Correlation	0.103	-0.037	.525**	0.183	-0.054	0.221	0.042
	Sig. (2-tailed)	0.432	0.778	0.000	0.162	0.681	0.090	0.751
6.4 Probability of occurrence of Law & order	Pearson Correlation	0.243	0.229	0.177	.585**	0.003	0.071	0.182
	Sig. (2-tailed)	0.062	0.078	0.175	0.000	0.982	0.588	0.165
6.5 Probability of occurrence of War and civil disorder	Pearson Correlation	0.087	0.247	.353**	.258*	.282*	0.068	-.416**
	Sig. (2-tailed)	0.507	0.057	0.006	0.046	0.029	0.606	0.001
6.6 Probability of occurrence of Requirement for permits and their approval	Pearson Correlation	0.067	0.124	.376**	0.242	0.121	.637**	0.097
	Sig. (2-tailed)	0.609	0.344	0.003	0.062	0.359	0.000	0.462
6.7 Probability of occurrence of Legal disputes among the parties in the contract	Pearson Correlation	0.204	.382**	0.017	0.032	0.097	-0.045	.314*
	Sig. (2-tailed)	0.117	0.003	0.898	0.810	0.462	0.735	0.015

Table 15: Correlations between occurrence of Socio-Political and Legal risks and their effect on project completion time

4.3.2.7. Logistic Risks

Correlations between occurrence of Logistic risks and their effect on project cost				
		15.1 Impact of Unavailable labor, material and equipment on cost	15.2 Impact of Undefined scope pf working on cost	15.3 Impact of High competition in bids on cost
7.1 Probability of occurrence of Unavailable labor, material, equipment	Pearson Correlation	.533**	.312*	.527**
	Sig. (2-tailed)	0.000	0.015	0.000
7.2 Probability of occurrence of Undefined scope pf working	Pearson Correlation	.330*	.669**	.333**
	Sig. (2-tailed)	0.010	0.000	0.009
7.3 Probability of occurrence of High competition in bids	Pearson Correlation	0.243	0.163	.489**
	Sig. (2-tailed)	0.062	0.213	0.000

Table 16: Correlations between occurrence of Logistic risks and their effect on project cost

Correlations between occurrence of Logistic risks and their effect on project completion time				
		23.1 Impact of Unavailable labor, material and equipment on time	23.2 Impact of Undefined scope pf working on time	23.3 Impact of High competition in bids on time
7.1 Probability of occurrence of Unavailable labor, material and equipment	Pearson Correlation	.620**	.374**	.379**
	Sig. (2-tailed)	0.000	0.003	0.003
7.2 Probability of occurrence of Undefined scope pf working	Pearson Correlation	.412**	.640**	0.243
	Sig. (2-tailed)	0.001	0.000	0.062
7.3 Probability of occurrence of High competition in bids	Pearson Correlation	0.049	.288*	.504**
	Sig. (2-tailed)	0.709	0.025	0.000

Table 17: Correlations between occurrence of Logistic risks and their effect on project completion time

4.3.2.8. Environmental risks

Correlations between occurrence of Environmental risks and their effect on project cost			
		16.1 Impact of Natural disaster on cost	16.2 Impact of Adverse weather condition on cost
8.1 Probability of occurrence of Natural disaster	Pearson Correlation	.265	0.054
	Sig. (2-tailed)	0.040	0.682
8.2 Probability of occurrence of Adverse weather condition	Pearson Correlation	0.021	.276
	Sig. (2-tailed)	0.876	0.033

Table 18: Correlations between occurrence of Environmental risks and their effect on project cost

Correlations between occurrence of Environmental risks and their effect on project completion time			
		24.1 Impact of Natural disaster on time	24.2 Impact of Adverse weather condition on time
8.1 Probability of occurrence of Natural disaster	Pearson Correlation	-.324*	-0.022
	Sig. (2-tailed)	0.012	0.869
8.2 Probability of occurrence of Adverse weather condition	Pearson Correlation	-0.022	.297*
	Sig. (2-tailed)	0.867	0.021

Table 19: Correlations between occurrence of Environmental risks and their effect on project completion time

4.3.2.9. Discussion of the correlation results

The correlation was done between the dependent and independent variables for all eight classification of risks. Based on the above correlational results, all the independent variables (probability of occurrence of risk) are significantly related with the dependent variable (effect of risk on project cost and project completion time) at p value <0.05 except for three pairs. The pairs are, correlation between probability of occurrence of labor injuries and the effect it have on project cost, correlation between probability of occurrence of inflation and the effect it have on project completion time and correlation between probability of occurrence of changes in law and regulation and the effect it have on project cost. The 2-tailed value of these three variables is greater than 0.05 (0.22,0.091 & 0.089 respectively) which indicates that there is no significant correlation between the dependent and independent variables. Construction projects consists of many related operations that are susceptible to several risk factors (independent variable) that affect the project objectives (dependent variable). (Mhetre, Konnur, & Landage, 2016)

4.3.3. Linear Regression

Linear regression is the next step after correlation. It is used when to predict the value of a variable based on the value of another variable. In this paper, we are trying to check the hypothesis that the probability of occurrence of the identified risks (independent variable) can predict the effect of these risks on cost (dependent variable) and completion time of the project (dependent variable). Based on this model we will have 2 models that explain relation between the independent and dependent variables.

4.3.3.1. Assumption for linear regression

The first step in this analysis is to determine which type of regression analysis is suitable for the type of data collected. In this case, as shown in the graph below, the relationship between probability of occurrence of risk and its effect on project cost and the relationship between probability of occurrence of risk and its effect on project completion time is linear. Since, there is one independent variable that explains the dependent variable; the regression technique used in this paper is simple linear regression.

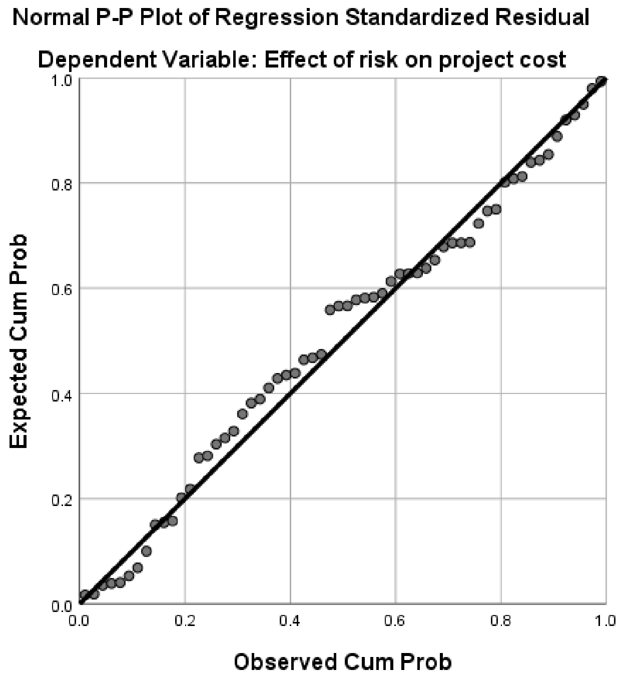

Figure 8: Normal P-P plot of regression Standardized Residual taken form SPSS (Model-1)

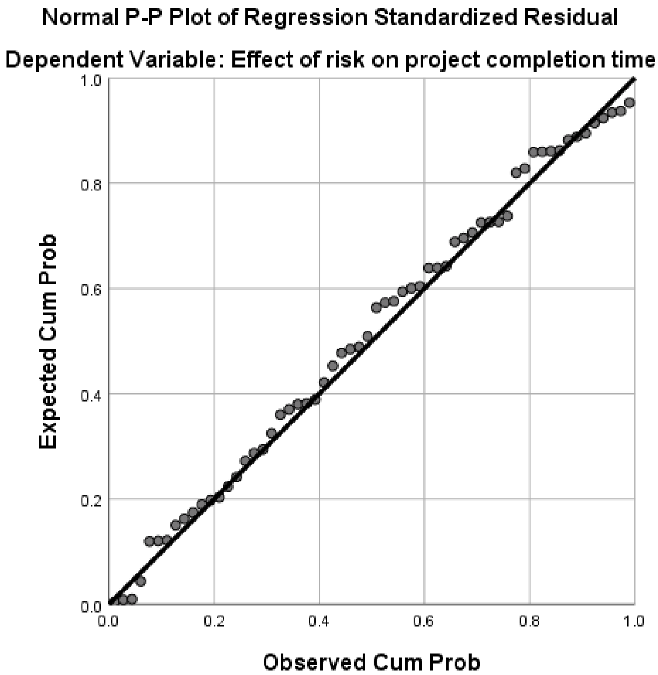

Figure 9: Normal P-P plot of regression Standardized Residual taken form SPSS (Model-2)

Before proceeding with the linear regression, first we need to check other assumptions that are required for a linear regression to give a valid result. The list of assumptions to be considered are listed as follow.

- **Outliner**: is an observed data point that has dependent variable that is very different than that is predicted by the regression model. These values can reduce the fit of the regression equation to predict the value of the dependent variable. Therefore, there should be no significant outliers in the collected data. In SPSS, the existence of outliner in the data are distinguished by checking the value of Standardize residual. If the minimum value is greater than -3.29 and the maximum less than 3.29, that means the data have no outliner. As shown in the table below this assumption is satisfied in both models.

Table 20: Standardized residual value from SPSS

		Mode-1 (Probability of occurrence of risk and Effect of risk on project cost)	Mode-2 (Probability of occurrence of risk and Effect of risk on project completion time)
Standardized residual value	Min.	-2.115	-2.59
	Max.	2.472	1.672

- **independence of observations:** this shows that there is no relation between the observations in each group and the groups themselves. This can be checked using the Durbin-Watson statistic value from SPSS. If the Durbin-Watson value is greater than one and less than 3, then the variables have independence of observation. This requirement is fulfilled for both models in this study.

Table 21: Durbin-Watson value from SPSS

	Mode-1 (Probability of occurrence of risk and Effect of risk on project cost)	Mode-2 (Probability of occurrence of risk and Effect of risk on project completion time)
Independent Observation (Durbin-Watson analysis)	2.072	1.934

- **homoscedasticity:** which is the distance between the scatter of the data points from the model is similar. The following scatter plot graphs can show the homoscedasticity of the data collected for both models.

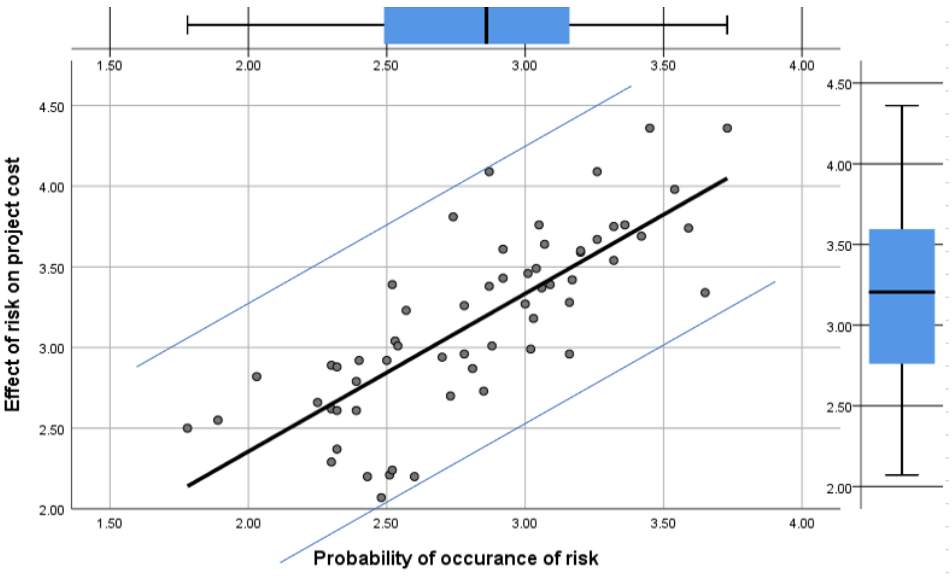

Figure 10: Scatter plot between occurrence of risk and effect on project cost

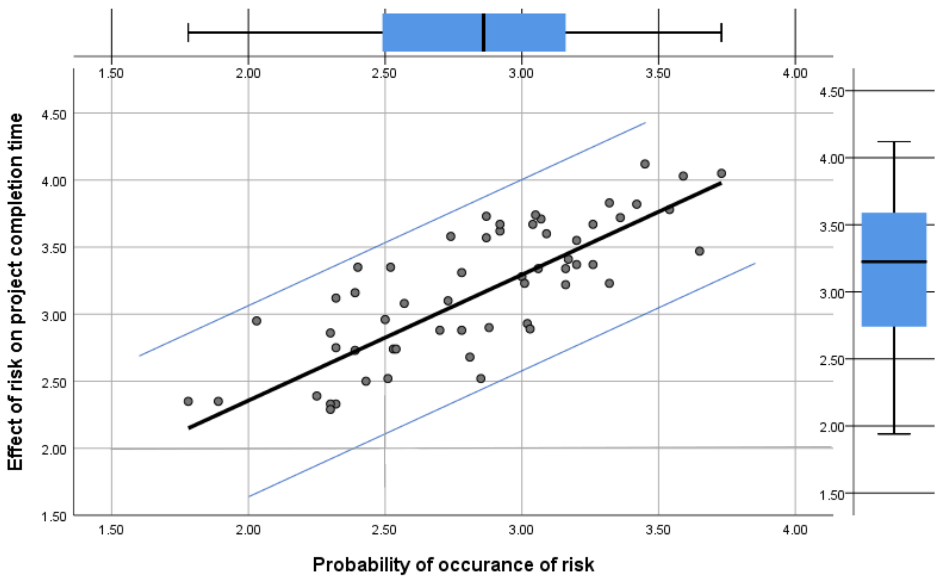

Figure 11: Scatter plot between occurrence of risk and effect on project completion time

- **Normally distribution:** The developed histogram by SPSS shows whether the residuals are normally distributed or not. The normal distribution describes how the values of a variable are distributed. It is a symmetric distribution where most of the observations cluster around the central peak and the probabilities for values further away from the mean taper off equally in both directions. (Al-Hemyari, 2018) Below is the histogram, indicating normal distribution for both of the models for the data collected.

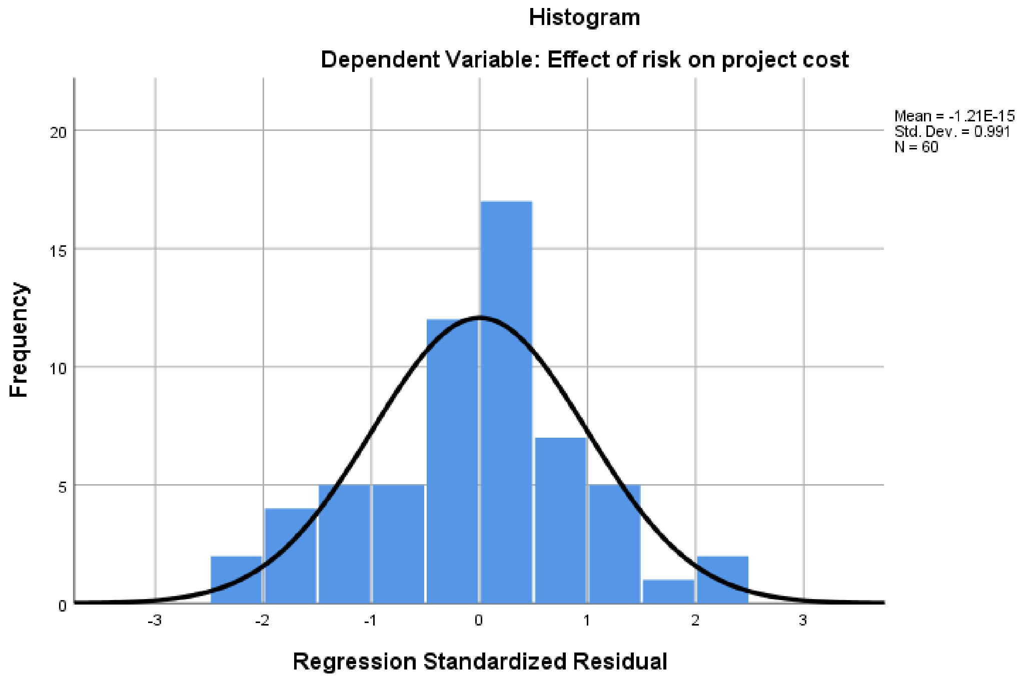

Figure 12: Normal distribution of model 1 from SPSS

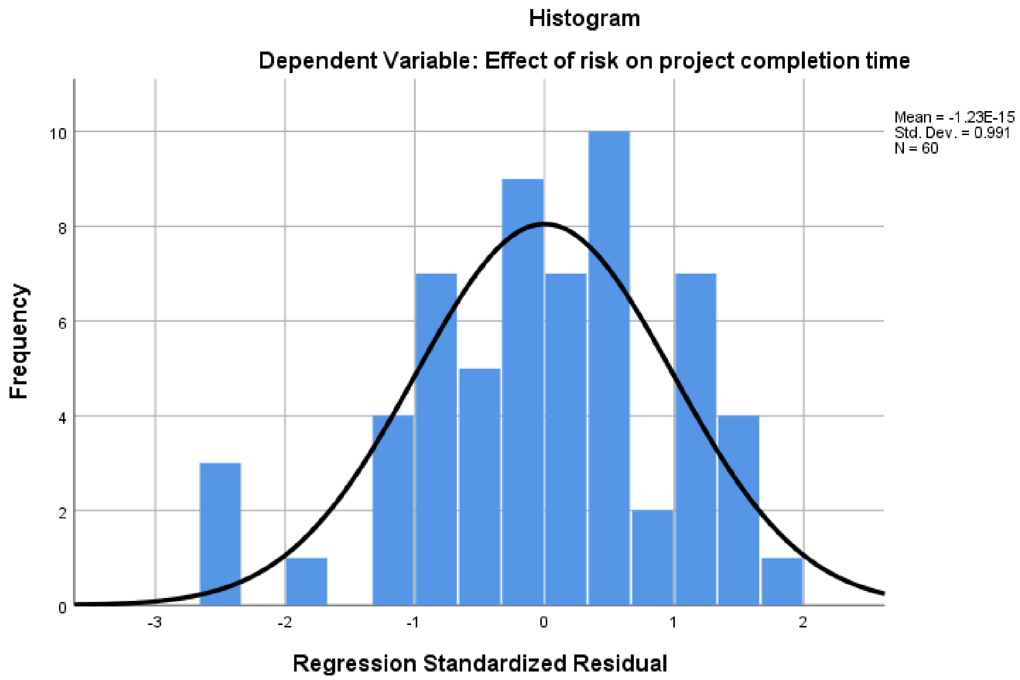

Figure 13: Normal distribution of Model 2 from SPSS

4.3.3.2. Simple linear regression

After checking all the above assumptions, we can proceed with the regression. As mentioned above, in the case of this research, there are 2 models (1 explaining the relationship between probability of occurrence of the risk with its effect on project cost and the other 1 explaining the relation between probability of occurrence of the risk with its effect on project completion time. Running SPSS statistics will generate:

- R and R^2 values: The R value represent the simple correlation while the R^2 indicates how much of the dependent variable can be explained by the independent variable. The higher the value of R^2 the higher the dependent variable is explained by the independent. The R^2 fro both model is shown in the table below.

- Next, we have to check that the regression equation fits the data (i.e., predicts the dependent variable) by checking the ANOVA table created by SPSS after analyzing the data. If the value of significance in this table is less than 0.05, then the model works better than simply using the mean to explain the relation. And on the analysis done on SPSS for both models it was found that, the significance is closer than 0 (less than 0.05) which implies, the model works well.

- Finally, the coefficient table will provide us the coefficients of the independent variable and the constant with the respective significance value.

Table 22: Regression analysis result from SPSS

		Mode-1 (Probability of occurrence of risk and Effect of risk on project cost)	Mode-2 (Probability of occurrence of risk and Effect of risk on project completion time)
R^2		0.601	0.563
Coefficient	Constant	0.398	0.479
	Probability of occurrence of risk	0.979	0.938

The value of R^2 demonstrations that, for the 1st model, 60.1% of effects of risk on project cost (dependent variable) can be predicted by the probability of occurrence of risk (independent variable). While for the 2nd model, the percentage in which the effect of risk on project completion time (dependent variable) is predicted by the probability of occurrence of risk (independent variable) is 56.3%. Thus, the result proves the hypothesis: that there is a relationship between probability of occurrence of risk and the effect it has on project cost and project completion time.

Based on the above result, the regression equation can be present as:

Model-1: Effect of risk on project cost = 0.398 + 0.979 (probability of the occurrence of risk)

Model-2: Effect of risk on project completion time = 0.479 + 0.938 (probability of the occurrence of risk)

4.4. Risk response

As discussed in the literature review, after identifying the risks and identifying which risks affect the project objectives severely, the next step is developing a strategy that helps minimize the negative effects of the risks through the identified risk response methods (Bahamid & Doh, 2017). In this section, the response choice of the participants for the risks were analyzed and summarized in the table below.

Risk Factors		Risk Avoidance	Risk Transfer	Risk Mitigation	Risk acceptance	Risk exploit	Risk Share	Risk Enhance	Contingency plan
1. Design Risks									
Defective design	N	15	41	6	1	1	4		3
	%	21.1%	57.7%	8.5%	1.4%	1.4%	5.6%		4.2%
Not coordinated design (structural, mechanical, electrical, etc.)	N	9	23	25	2	7	6	3	1
	%	11.8%	30.3%	32.9%	2.6%	9.2%	7.9%	3.9%	1.3%
Inaccurate quantities	N	14	15	13	8	4	9	4	2
	%	20.3%	21.7%	18.8%	11.6%	5.8%	13.0%	5.8%	2.9%
Lack of consistency between bill of quantities, drawings and specifications	N	8	20	19	5	3	3	13	3
	%	10.8%	27.0%	25.7%	6.8%	4.1%	4.1%	17.6%	4.1%
unqualified designers	N	23	29	6	1	7	1		
	%	34.3%	43.3%	9.0%	1.5%	10.4%	1.5%		
2. Construction risks									
Rush bidding	N	8	3	12	14	10	6	3	16
	%	11.1%	4.2%	16.7%	19.4%	13.9%	8.3%	4.2%	22.2%
Gabs between implementation and Specification	N	29	4	21	4	12	1	7	2
	%	36.3%	5.0%	26.3%	5.0%	15.0%	1.3%	8.8%	2.5%
Labor productivity	N	9	6	18	11	9	1	10	6
	%	12.9%	8.6%	25.7%	15.7%	12.9%	1.4%	14.3%	8.6%
Design change	N	8	19	10	3	8	16	8	5
	%	10.4%	24.7%	13.0%	3.9%	10.4%	20.8%	10.4%	6.5%
Labor disputes	N	11	1	28	18	3	2	3	4
	%	15.7%	1.4%	40.0%	25.7%	4.3%	2.9%	4.3%	5.7%
Site condition	N	8	4	18	17	5	13	6	6
	%	10.4%	5.2%	23.4%	22.1%	6.5%	16.9%	7.8%	7.8%
Equipment failures	N	11	3	8	28	3	2	1	14
	%	15.7%	4.3%	11.4%	40.0%	4.3%	2.9%	1.4%	20.0%
Lower work quality due to time constraint	N	26	2	10	9	10	6	5	11
	%	32.9%	2.5%	12.7%	11.4%	12.7%	7.6%	6.3%	13.9%

Lower work quality due to workman ship	N	39	1	5	15	7			4
	%	54.9%	1.4%	7.0%	21.1%	9.9%			5.6%
Construction procedures	N	15	2	17	12	3	5	17	2
	%	20.5%	2.7%	23.3%	16.4%	4.1%	6.8%	23.3%	2.7%
Actual quantity differs from the contract	N	5	17	11	5	24	6	14	2
	%	6.0%	20.2%	13.1%	6.0%	28.6%	7.1%	16.7%	2.4%
3. Physical risks									
Damage to structure	N	39	6	5	11	5	6		3
	%	52.0%	8.0%	6.7%	14.7%	6.7%	8.0%		4.0%
Damage to equipment	N	20	7	16	11	1	7	2	12
	%	26.3%	9.2%	21.1%	14.5%	1.3%	9.2%	2.6%	15.8%
Labor injuries	N	33	6	16	11	4	2	2	7
	%	40.7%	7.4%	19.8%	13.6%	4.9%	2.5%	2.5%	8.6%
Supplies of defective material	N	29	7	12	8	8	6	4	5
	%	36.7%	8.9%	15.2%	10.1%	10.1%	7.6%	5.1%	6.3%
Theft	N	31	7	20	10			4	5
	%	40.3%	9.1%	26.0%	13.0%			5.2%	6.5%
4. Organizational & Managerial risk									
Contractual relations	N	11	3	22	13	11	14		7
	%	13.6%	3.7%	27.2%	16.0%	13.6%	17.3%		8.6%
Contractor's experience	N	16	4	16	12	9	3	3	8
	%	22.5%	5.6%	22.5%	16.9%	12.7%	4.2%	4.2%	11.3%
Attitudes of participants	N	19	1	18	7	8	12	4	3
	%	26.4%	1.4%	25.0%	9.7%	11.1%	16.7%	5.6%	4.2%
Inexperience work force	N	43	1	10	5	1			11
	%	60.6%	1.4%	14.1%	7.0%	1.4%			15.5%
Ambiguous Planning due to project complexity	N	8	3	28	6	8	11	5	3
	%	11.1%	4.2%	38.9%	8.3%	11.1%	15.3%	6.9%	4.2%
Resource management	N	18	1	20	21	4	12		3
	%	22.8%	1.3%	25.3%	26.6%	5.1%	15.2%		3.8%
Poor communication between involved parties	N	22	1	27	17	8	5		
	%	27.5%	1.3%	33.8%	21.3%	10.0%	6.3%		
5. Financial Risk									
Inflation	N	2	6	16	16	2	25	2	12
	%	2.5%	7.4%	19.8%	19.8%	2.5%	30.9%	2.5%	14.8%
Payment delays	N	2	13	30	13	2	3		11
	%	2.7%	17.6%	40.5%	17.6%	2.7%	4.1%		14.9%

Material cost	N	1	5	24	19	1	18	2	12
	%	1.2%	6.1%	29.3%	23.2%	1.2%	22.0%	2.4%	14.6%
Exchange rate fluctuation	N	1	9	30	13	3	15	2	3
	%	1.3%	11.8%	39.5%	17.1%	3.9%	19.7%	2.6%	3.9%
Low market demand	N	4	5	6	32	10	2	6	10
	%	5.3%	6.7%	8.0%	42.7%	13.3%	2.7%	8.0%	13.3%
Financial failure of the contractor	N	11	4	10	15	4	3		31
	%	14.1%	5.1%	12.8%	19.2%	5.1%	3.8%		39.7%
6. Socio- political and legal risks									
Changes in laws and regulations	N	4	13	8	36	4	13	1	
	%	5.1%	16.5%	10.1%	45.6%	5.1%	16.5%	1.3%	
Pollution and safety rules	N	16	4	11	27	2	9		2
	%	22.5%	5.6%	15.5%	38.0%	2.8%	12.7%		2.8%
Bribery/Corruption, Language/Cultural barrier	N	25	3	24	14	3		2	2
	%	34.2%	4.1%	32.9%	19.2%	4.1%		2.7%	2.7%
Law & order	N	11	4	11	30	1	10	2	2
	%	15.5%	5.6%	15.5%	42.3%	1.4%	14.1%	2.8%	2.8%
War and civil disorder	N	4	15	7	19		20		13
	%	5.1%	19.2%	9.0%	24.4%		25.6%		16.7%
Requirement for permits and their approval	N	6	6	18	29	3	13		
	%	8.0%	8.0%	24.0%	38.7%	4.0%	17.3%		
Legal disputes among the parties in the contract	N	18	3	28	5	7	10	1	1
	%	24.7%	4.1%	38.4%	6.8%	9.6%	13.7%	1.4%	1.4%
7. Logistics Risks									
Unavailable labor, material and equipment	N	10	3	22	13	4	4	2	10
	%	14.7%	4.4%	32.4%	19.1%	5.9%	5.9%	2.9%	14.7%
Undefined scope pf working	N	8	11	16	11	7	5	15	
	%	11.0%	15.1%	21.9%	15.1%	9.6%	6.8%	20.5%	
High competition in bids	N	4	7	27	23	3			10
	%	5.4%	9.5%	36.5%	31.1%	4.1%			13.5%
8. Environmental risks									
Natural disaster	N	3	15	5	8	6	16	3	12
	%	4.4%	22.1%	7.4%	11.8%	8.8%	23.5%	4.4%	17.6%
Adverse weather condition	N	4	12	9	10	8	18		14
	%	5.3%	16.0%	12.0%	13.3%	10.7%	24.0%		18.7%

Table 23: Risk response

In the above table the percentage of the responses of the participants for risk response is shown. The highlighted ones are responses with the highest percentage of rating for the risk factor.

In the previous section, the risks that have a high probability of affecting the project objectives are identified. The graph below, will summarize the recommended response methods by project managers for the risks that have high effect on construction project objectives.

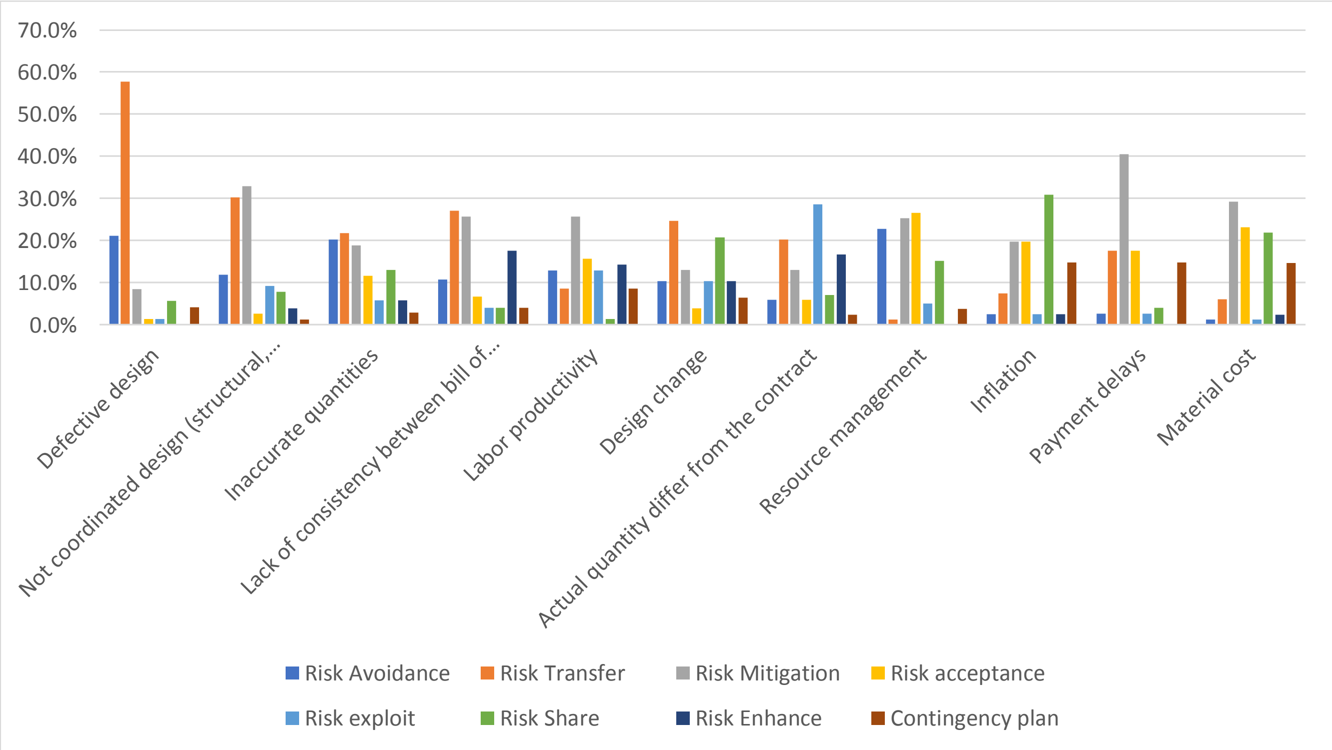

Figure 14: Risk response for risks with high impact

5. Summary, Conclusion and recommendation

5.1. Summary

The main research question of this paper is to determine how to manage risks that affect project cost and completion time in building construction. To answer this question, first 8 main risks, containing a total of 46 sub-criteria, were identified from the literature. In risk management, since we can't avoid all risks and control risks, we need to prioritize risks based on their effect. To determine which risk factors, affect the objectives of the construction project severely, a questioner was distributed to project managers working for ISO certified companies. The participants then rate the probability of occurrence of each factor and their effect on project cost and completion time. Based on the rating, it was determined, 11 of these risk factors have the highest probability of occurrence and high impact on the cost and completion time of the project. Another finding from this paper is the type of response methods to be used for the identified risk factors in construction projects. Accordingly, from the eight risk response methods, the participants selected the response methods they deemed appropriate for each risk factor.

5.2. Conclusion

Risk management is an essential part of construction management. It is a process composed of risk identification, risk analysis, risk response, and monitoring of risk. This process increases the success of the project by helping project managers minimize the deviation from the project objective. Even though the view of project success differs from one stakeholder to another, generally the main criteria for project success assessment are the degree of achievement of objectives. There are several criteria to assess the success of a building construction process; but the main objectives are quality, cost, and time (Atikinson, 1999). In this paper, we consider quality as an objective that cannot be compromised, thus the reason for the selection of the target population (project managers working under ISO certified construction companies). Therefore, the focus of this study is on analyzing the risks that affect project cost and project completion time while assuring the quality of the project satisfies the requirement.

Based on the descriptive analysis, a total of 11 risk factors that have a high probability of occurrence and impact on project objectives were identified. From these risks, 8 affects both the project cost and completion time. The common risk factors are Defective design, non-coordinated design (structural, mechanical, electrical, etc.), consistency between bill of quantities, drawings and specifications, labor productivity, design change, resource management, inflation and material cost. Inaccurate quantities and actual quantities differ from the contract which affects the project cost vastly while their effect on project completion time is average. The remaining factor, payment delay, affects the project completion time highly but its effect on project cost is medium.

Besides, not only the correlation between the selected dependent and independent variables is significant (the 2-tailed value that is closer to zero (<0.05)) but there is also a correlation (a 2 tailed value that is closer to zero and a high person correlation) between the range of effect the risk factors have on the project cost and completion time. Additionally, the regression analysis shows that there the probability of occurrence of risk can determine the impact of risk on project cost and completion time Hence, the result from the correlating and regression analysis can further justify the result acquired with descriptive analysis.

The paper also identified the risk response methods to be applied to minimize the effect of the risks. Accordingly, risk transfer was the first choice for risks resulting from defective design, inaccurate quantities, lack of consistency between bill of quantities, drawings, and specification and design change. The response method that was highly recommended for non-coordinated design (structural, mechanical, electrical, etc.), labor productivity, payment delays, and material cost is risk mitigation. Risk acceptance, exploit, and share was chosen for risks due to resource management; actual quantity differs from the contract and inflation respectively.

5.3. Recommendation

Based on the results of the research, risks that affect construction projects can occur starting from the begging of the project. Most of the risks deemed to impact the construction cost and completion time are related to the design and planning phase. In addition to the response methods suggested by the participants of the survey, i.e. risk transfer and mitigation methods, it is recommended for the consultant to make sure the design, specification, and quantification of detailed works and consistency between documents are done properly and for the contractor to recheck each aspect before proceeding with the construction phase. The other risks that have a high effect on project objectives are labor productivity and resource management and financial risks (inflation payment delays and material cost); these risks occur during the construction phase. To minimize the effect of the first two problems, contractors should focus on developing a management system that focuses on human and resource management. The financial risks, especially inflation and material cost are out of the control of the contractor therefore there should be a contingency plan, that is flexible enough to accommodate those risks without affecting the project budget and schedule severely. This risk should also be handled together with the other stakeholders by sharing the risk or by mitigation.

In conclusion, risks in construction projects are vast and differ from one project to another. Companies need to develop a system that will track the types of risk, cause, and effects and the response method used and its effects that occur in every project so that they can use it as a knowledge base for other projects to minimize the chance of those risks affecting another project. That is every construction company should have an applicable risk management framework.

Bibliography

Al-Hemyari, Z. A. (2018, December). Statistics. In P. D. Al-Hemyari, *Introduction of Statistics.* Researchgate.

Ali, A. S., & Rahmat, I. (2010). The performance measurement of construction projects managed by ISO-certified contractors in Malaysia. *Journal of Retail & Leisure Property, 9*, 25-35.

Assefa, A. (n.d.). Construction Industry. *AAU, FoT, Department of Civil Engineering*, 25-24.

Atikinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management, 17*(6), 337-342.

Aven, T., & Renn, O. (2009). On risk defined as an event where the outcome is uncertain. *Journal of Risk Research, 12*(1), 1-11. doi:10.1080/13669870802488883

Ayalew, T., Dakhli, Z., & Lafhaj, Z. (2016). Assessment on performance and challenges of Ethiopian construction Industry. *Quest Journals, 2*, 01-11.

Bahamid, R. A., & Doh, S. I. (2017). A review of risk management process in construction projects. *IOP Conference Series: Materials Science and Engineering, 271*(012042). doi:10.1088/1757-899X/271/1/012042

Banaitis, A., & Banaitiene, N. (2012). *Risk Management in Construction Projects.* doi:10.5772/51460

Bennett, F. L. (2003). *The management of construction: A Project Life Cycle Approach* (Vol. 1). Butterworth-Heinemann.

Bolarinwa, O. A. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Nigerian Postgrad Journal, 22*(4), 195-201.

COSO. (2018). *Enterprise Risk Management: Applying enterprise risk management toenvironmental, social and governance-related risks.*

Crnković, D., & Vukomanović, M. (2016, November 13). Comparison of trends in the risk management theory and practices within the construction industry. *Electronic Journal of Civil engineering osijek-e-GFOS, 7*, 1-11.

Dionne, G. (2013). Risk Management : History, Definition and Critique. *American Risk and Insurance Association, 16*(2), 147-166.

Eby, K. (2019, May 29). Demystifying the 5 Phases of Project Management. *Smartsheet*. Retrieved from https://www.smartsheet.com/blog/demystifying-5-phases-project-management

Eiser, J. R. (2004). *PUBLIC PERCEPTION OF RISK.* University of Sheffield, Department of Psychology. UK: Foresight programme of the Office of Science and Technology.

El-Karim, M. S., Nawawy, O. A., & Abdel-Alim, A. M. (2016). Identification and assessment of risk factors. *HBRC Journal, 13*, 202-216.

Erstu, L. (2017). *An Assessment On The Risk Management Practice Of construction Projects; Case Study Of Addis Ababa Saving Houses Development Enterprise.* Retrieved from Addis Ababa University: http://etd.aau.edu.et/handle/123456789/13929

Flanagan, R., & Norman, G. (1993). *Risk management and Construction.* Blackwell Science Ltd.

Guo, H. L., Li, H., & Skitmore, M. (2010). Life cycle management of construction projects based on Virtual Prototyping technology. *Journal of Management in Engineering, 26*.

Hancher, D. E. (2003). The Civil Engineering Handbook. In D. E. Hancher, W. Chen, & J. R. Liew (Eds.), *Construction* (second ed., pp. 1-4).

Hendrickson, C. (1998). *Project Management for Construction.* Pittsburgh: Department of Civil and Environmental Engineering, Carnegie Mellon University.

Hillson, D. (2014). How to manage the risk you dont know you were taking. *Paper presented at PMI® Global Congress.* North America, Phoenix,AZ. Newtown Square: Project Management Institute.

Hintsay, H. (2016). *Integrated Risk Management Practice in the Construction Industry.* Addis Ababa University College of Business and Economics, Addis Ababa.

ISO 31000. (2009). *Risk management — Principles and guidelines.*

ISO/Guide 73. (2009). *Risk Management—Vocabulary.* Geneva, Switzerland: International Organization for Standardization.

Jayasudha, K., & Vidivelli, B. (2015). An Assessment and Analysis of Major Risks in Construction Projects. *Asian Journal of Applied Sciences, 3*(05), 846-857.

Jayasudha, K., Vidivelli, D. B., & Surjith, E. G. (2014, August). Risk Assessment and Management in Construction Projects. *International Journal of Scientific & Engineering Research,, 5*(8), 387-396.

KarimiAzari , A., Mousavi, N., Mousavi, S. F., & Hosseini , S. (2011). Risk assessment model selection in construction industry. *Elsevier, 38*, 9105-9111.

Kates, R. W., & Kasperson, J. X. (1983). Comparative risk analysis of technological hazards. *Proceedings of the National Acadamy of Science, 80*, 7027-7038.

Kenton, W. (2019, July 2). *Business Essentials*. Retrieved from Investopia: https://www.investopedia.com/terms/e/enterprise-risk-management.asp

Khattak, A. A., Akhtar, R., Abas, M., Khalid, Q. S., Noor, S., Babar, A., & Azim, S. (2019). Risk management in construction projects: Perspective of contractors and owners. *WALIA journal, 35*(1), 77-89.

Marco, A. D., & Thaheem, M. J. (2014). Risk analysis in construction projects: A practical selection methodology. *American Journal of Applied Sciences*, *11*(1), 74-84.

Mhetre, K., Konnur, B. A., & Landage, A. (2016). Risk Management in Construction Industry. *International Journal of Engineering Research, 5*, 153-155. doi:10.17950/ijer/v5i1/035

Mukaka, M. M. (2012). Statistics Corner: A guide to appropriate use of Correlation coefficient. *Malawi Journal, 24*(3), 69-71.

Munns, A. K., & Bjeirmi, B. F. (1996). The role of project management in acheving project success. *International Journal of Project Management, 14*(2), 81-87.

National Bank of Ethiopia. (2018). *2017/18 Annual Report.* Addis Ababa: National Bank of Ethiopia. Retrieved from http://www.nbe.gov.et/pdf/annualbulletin/Annual%20Report%202017-2018/2017-18%20annual%20report.pdf

Odimabo, O. O., & Oduoza, C. F. (2013). Risk Assessment Framework for Building Construction Projects' in Developing Countries. *International Journal of Construction Engineering and Management, 2*(5), 143-154. doi:10.5923/j.ijcem.20130205.02

Organizational Risk Management Framework. (2018).

Pidgeon, N., Kasperson, R. E., & Slovic, P. (2003). *The Social Amplification of Risk.* Cambrige: Cambridge University Press.

PMBOK Guide. (2017). *A Guide to the Project Management Body of Knowledge* (Sixth ed.). Project Management Institute, Inc.

REZAKHANI, P. (2012, March 30). CLASSIFYING KEY RISK FACTORS IN CONSTRUCTION. *BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI*. Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwjK

2ZbzvpjmAhWBoFwKHSKWC2YQFjAAegQIARAC&url=http%3A%2F%2Fwww.bipcons.ce.tuiasi.ro%2FArchive%2F292.pdf&usg=AOvVaw3eSasI9jBEagZcyOH-cN4F

Saunders, M., Lewis, P., & Thornhill, A. (2007). *Research Methods for Business Students* (Vol. 4). Harlow: Pearson Education Limited.

Schieg, M. (2006). Risk management in construction project. *Journal of Business Economics and Management, 7*(2), 77-83.

Sommer, H. (2010). *Project Management for Building Construction.* doi:10.1007/978-3-642-10874-7

Spikin, C. C. (2013). Risk Management theory: the integrated. *Estado, Gobierno, Gestión Pública*, 89-126.

Stukhart, G. (2016). Inflation and the Construction Industry. *Journal of the Construction Division, 108*(4), 546-562.

Taber, K. S. (2018). The Use of Cronbach's AlphaWhen Developing and Reporting Research Instruments in Science Education. *Res Sci Educ, 48*, 1273–1296.

Thomas, D. R. (2006, June 1). A general inductive approach for analyzing qualitative evaluation data. *American Jornal of Evaluation, 27*(2), 237-246.

United Nation, Department of Economic and Social Affairs, Population Division. (2019). World Urbanization Prospects: the 2018 Revision. (ST/ESA/SER.A/420), 53. New York: United Nations.

Wang, S. Q., Dulaimi, M. F., & Aguria, M. Y. (2004, 02). Risk management framework for construction project in developing countries. *Construction Management & Economics, 22*, 237-252. doi:10.1080/0144619032000124689

Watt, A. (2014). *Project Management.* Victoria: B.C: BC Ccampus. Retrieved from https://opentextbc.ca/projectmanagement/

Wilson, R., & Crouch, E. (1987). Risk assessment and comparisons: an introduction. *Science, 236*(4799), 267-270.

Wissem, E. (2013). RISKS MANAGEMENT: NEW LITERATURE REVIEW. *POLISH JOURNAL OF MANAGEMENT STUDIES, 8*.

World Bank Group. (2015). Ethiopia Urbanization Review: Urban institutions for a Middle - Income Ethiopia. © *World Bank. https://openknowledge.worldbank.org/handle/10986/22979 License:*

CC BY 3.0 IGO. Washington,DC.: World Bank. Retrieved from http://hdl.handle.net/10986/22979

Yazar, Z. (2002). A qualitative risk analysis and management tool-CRAMM. *SANS InfoSec Reading Room White Paper, 11*, 12-32.

Yirga, G. (2017). *Analysis of risk management practices in construction companies.* Retrieved from Addis Ababa University: http://etd.aau.edu.et/handle/123456789/13895

Zegeye, A., Worku, A., Tefera, D., Getu, M., & Sileshi, Y. (2009). *Introduction to Research Methods.* Addis Ababa: Addis Ababa University.

Zou, P. X., Wang, J., & Zhang, G. (2014). Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder perspectives. *International journal of construction management, 8*. doi:10.1080/15623599.2009.10773122

Zou, P. X., Zhang, G., & Wang, J. (2007). Understanding the key risks in construction projects in China. *International Journal of Project Management*, 601-614.

Appendix

Questionnaire

Part 1: General Question

1	Name of the company	______							
2	Grade of the company	______							
3	Year of establishment	______							
4	Experience of the project Manager	under 2 years	☐	2-5 years	☐	5-10 years	☐	above 10 years	☐
5	Educational level	Diploma	☐	Degree	☐	Masters	☐	Other	______
6	Project management trainings	Yes	☐	NO	☐				
7	Type of projects involved in	Building	☐	Road	☐	Other	______		
8	Number of total projects involved in	______							

Part 2: Risk identification

Rate the occurrence of the listed factors and their effect on cost and duration of a project

The rating is from 1-5, 1 being low probability and 5 being Hight probability

Risk Factors	Probability of occurrence					Impact on cost of the project (budget)					Impact on completion time of the project				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Design Risks															
Defective design															
Not coordinated design (structural, mechanical, electrical, etc.)															
Inaccurate quantities															
Lack of consistency between bill of quantities, drawings and specifications															
unqualified designers															
2. Construction risks															
Rush bidding															
Gabs between implementation and Specification															
Labor productivity															
Design change															
Labor disputes															
Site condition															
Equipment failures															
Lower work quality due to time constraint															
Lower work quality due to workman ship															
Construction procedures															
Actual quantity differs from the contract															
3. Physical risks															
Damage to structure															
Damage to equipment															
Labor injuries															
Supplies of defective material															
Theft															

Risk Factors	Probability of occurrence					Impact on cost of the project (budget)					Impact on completion time of the project				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
4. Organizational & Managerial risk															
Contractual relations															
Contractor's experience															
Attitudes of participants															
Inexperience work force															
Ambiguous Planning due to project complexity															
Resource management															
Poor communication between involved parties															
5. Financial Risk															
Inflation															
Payment delays															
Material cost															
Exchange rate fluctuation															
Low market demand															
Financial failure of the contractor															
6. Socio- political and legal risks															
Changes in laws and regulations															
Pollution and safety rules															
Bribery/Corruption, Language/Cultural barrier															
Law & order															
War and civil disorder															
Requirement for permits and their approval															
Legal disputes among the parties in the contract															
7. Logistics Risks															
Unavailable labor, material and equipment															
Undefined scope pf working															
High competition in bids															
8. Environmental risks															
Natural disaster															
Adverse weather condition															

Part 3: Risk response

a) Risk avoidance: is when the project team acts to eliminate the threat or protect the project from its impact by removing the cause of the risk of executing the project in a different direction while still aiming to accomplish project objectives.

b) Risk transfer: involves shifting ownership of a threat to a third party to manage the risk and to bear the impact if the threat occurs.

c) Risk mitigation: action is taken to reduce the probability and/or impact of an adverse risk event to an acceptable threshold.

d) Risk acceptance: acknowledges the existence of a threat, but no proactive action is taken.

e) Risk exploit: The exploit strategy may be selected to capture the benefit associated with a particular opportunity by ensuring that it definitely happens, increasing the probability of occurrence to 100%.

f) Risk share: allocate risk ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does happen.

g) Risk enhance: aims to alter the "size" of the positive risk. The opportunity is enhanced by increasing its probability and/or impact, thereby maximizing the benefits gained from the project.

h) Contingency Plan: This involves the use of a fallback plan if a risk occurs.

Choose which method/ methods of risk response can be use if the listed risks occur or might occur

Risk Factors	Risk avoidance	Risk transfer	Risk mitigation	Risk acceptance	Risk exploit	Risk share	Risk enhance	Contingency Plan
1. Design Risks								
Defective design								
Not coordinated design (structural, mechanical, electrical, etc.)								
Inaccurate quantities								
Lack of consistency between bill of quantities, drawings and specifications								
unqualified designers								
2. Construction risks								
Rush bidding								
Gabs between implementation and Specification								
Labor productivity								
Design change								
Labor disputes								
Site condition								
Equipment failures								
Low quality due to time constraint								
Low quality due to workman ship								
Construction procedures								
Actual quantity differs from the contract								
3. Physical risks								
Damage to structure								
Damage to equipment								
Labor injuries								
Supplies of defective material								
Theft								

Risk Factors	Risk avoidance	Risk transfer	Risk mitigation	Risk acceptance	Risk exploit	Risk share	Risk enhance	Contingency Plan
4. Organizational & Managerial risk								
Contractual relations								
Contractor's experience								
Attitudes of participants								
Inexperience work force								
Ambiguous Planning due to project complexity								
Resource management								
Poor communication between involved parties								
5. Financial Risk								
Inflation								
Payment delays								
Material cost								
Exchange rate fluctuation								
Low market demand								
Financial failure of the contractor								
6. Socio- political and legal risks								
Changes in laws and regulations								
Pollution and safety rules								
Bribery/Corruption, Language/Cultural barrier								
Law & order								
War and civil disorder								
Requirement for permits and their approval								
Legal disputes among the parties in the contract								
7. Logistics Risks								
Unavailable labor, material and equipment								
Undefined scope of working								
High competition in bids								
8. Environmental risks								
Natural disaster								
Adverse weather condition								