Managing Risk of Construction Projects to Enhance Project Performance Delivery

by

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DECLARATION

I, Abdarahim Sahal Mohamed Salem, declare that the contents of this dissertation represent my own unaided work, and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology

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ABSTRACT

The construction industry is extremely complex, with dynamic project environments creating an atmosphere of high uncertainty and risk. For that reason, risks in construction projects have become an inevitable feature and the industry is susceptible to numerous business, socio-political and technical risks that negatively influence project delivery. This study therefore investigates the causes of risks in construction project delivery and the effect on project and organisational performance, so that efficient control measures can be designed to minimise their occurrence. The objectives of the study were as follows: (i) to determine the major causes of risks during construction project; (ii) to identify which construction risks are regarded as the most significant in militating the success of construction project; (iii) to determine the detrimental effect of risks on project and organisational performance, and (iv) to establish an effective strategy for reducing risks associated with construction projects.

A quantitative research design was adopted, and the sample comprised of randomly selected contracting firms and construction professionals in the Western Cape Province. Specifically, only contracting firms registered on the CIDB database formed part of the study, whereas in the category of construction professionals, only those registered on the Professions and Projects Register and in good standing were sampled. It is worth noting that 60 respondents, representing 23% of those approached, willingly participated in the survey. The data was statistically analysed using descriptive and inferential analyses.

The salient findings revealed that project management-related risk factors are the major causes of risks during construction project delivery; these factors include inadequate project planning, inadequate project budgeting, incompetence of local project team members and scheduling errors/ill planned schedule. In addition, the study revealed the impact of construction risks on projects and organisational performance, and it was found that cost overrun was ranked the most significant on project performance and disputes between parties to the contract was ranked the most significant on organisational performance. It is also worth mentioning that the opinions of construction professionals do not vary significantly with regard to the detrimental effect of risks on project performance. The research suggested strategies for mitigation of risk: the strategies include design strategy, construction and project management, and financial strategy. Furthermore, it was evident that the perceptions relative to the effective strategies for mitigating risks do not differ among construction participants. In effect, the analytical taxonomy of the major causes of risks and their ripple effect is the most obvious intervention in identifying, assessing and responding to risks. Hence, construction professionals and contractors should consider forming a risk management team within their respective firms, and allocate a budget for the team to attend risk management-related training courses.

Key words: Construction project performance, cost overrun, project delivery, risk management, risk

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DEDICATION

To my parents and my sibling

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LIST OF ABBREVIATIONS

Abbreviation

ANOVA: Analysis of variance

CIDB: Construction Industry Development Board

CPM: Construction project management

CPUT: Cape Peninsula University of Technology

GDP: Gross Domestic Product

IEC: The international standard

OECD: Organisation for Economic Co-operation and Development

PMBOK: Project Management Body of Knowledge

PMI: Project Management Institute

SHR: Strategic human resource

SPSS: Statistical Package for the Social Sciences

STD: Standard Deviation

Glossary

Construction project management *(CPM):* is the overall planning, coordination, and control of a project from beginning to completion (Ilveskoski & Niittymäki, 2015:8).

Cost: is the expense associated with the construction contract, including the cost of materials, the labour, and equipment costs necessary to put the materials in place. Added to this are overhead costs, which include both job site management and the contractor's standard cost of doing business, such as office, staff, and insurance (American Institute of Architects, 2013:163).

Project performance: the overall achievement of project parameters of a given project in respect of time, cost and quality (Mensah, 2007:10).

Quality: is the operations and activities of the performing organisation that determine quality policies, objectives, and responsibilities; thus the project will meet the needs for which it was undertaken (PMBOK, 2004: 220).

Risk identification: is the process of discovering, and documenting the characteristics of, the most significant risks and their impact on the project (PMBOK, 2004:237).

Risk management: is a process of planning, assessment, identification, analysis (quantitative and qualitative), response, monitoring and control on a project. Most of these processes are updated throughout the project (PMBOK, 2004:237).

Risk: is a doubtful case or condition which, if it occurs, has a negative or a positive consequence on at least one project objective, such as cost, time and quality (PMBOK, 2004:238)

Time: is the complete time calculated, such as the number of days, weeks, months or years from the commencement of construction activities on site to practical completion of a construction project (Chan & Chan, 2004:211).

CHAPTER ONE

1.1 Introduction

The construction sector is one of the industries that plays an important role in South Africa's economy, and is one of the biggest contributors to the gross domestic product (GDP) (Chihuri & Pretorius, 2010:64). Construction in South Africa faces many risks. According to Chihuri and Pretorius (2010:65), some of the major risks associated with construction projects in South Africa are: lack of power (electricity crisis), skills shortages, and escalating costs in construction materials.

In a similar vein, Shunmugam and Rwelamila (2014:3) attribute the lack of progress in the South African construction industry to the rapid upsurge in fuel prices, poor performance of the local currency (Rands) compared to other major currencies, including the British pound and the US dollar, combined with a high level of inflation. Shunmugam and Rwelamila (2014:3) add that one of the worst blows to the industry surfaced in 2011, where some of the biggest construction firms were charged with anti-competitive behaviour.

According to Gigaba (2013: online), time overrun, inexperienced management of the site, cost and time fluctuations, inefficiency problems and lack of employee participation are among the difficulties faced during the execution of construction projects. Gitau (2015:1) contends that programming and design may entail risks such as over-design, poor constructability, poor estimating and scope creep. On the other hand, the construction phase is susceptible to risks relating to change orders, delays, and quality concerns. Davis (2015: online) also points out that construction projects and infrastructure development cannot be controlled and exposed to losses, as a result of changes in the nature and frequency of climate-related natural disasters, and if these are not taken into account carefully the whole project may be lost. For instance, due to heavy rains experienced in March 2014, the South African construction industry lost between R50 and R100 million per day in revenue (Davis, 2015: online). The common construction risks prevalent in the South African construction industry and their potential impact are presented in Table 1.1.

Table 1.1: The common construction risks associated with South African construction

Construction risks framework	Potential impact
Lack of human resources	Poor profession and reputational problems
Lack of essential raw materials	Time overrun and fines
Availability and access to key plant	Time overrun and fines
Tendering and contract exposures	Legal exposures
Identification, reporting and action of project non-conformance	Project management issues
Inadequate risk management practices	Guarantee exposures
Inadequate management of construction projects	Contractor/subcontractor exposures
Poor management of data	Operational exposures
Financial variations and cost overrun on long-term projects	Financial/cost exposures
Inadequate government by-laws and regulation	Curtailed options

(Visser & Joubert, 2008:1373)

1.2 Background to the research problem

The construction industry is susceptible to risks because of the unusual characteristic of construction processes, such as long time periods, challenging environment, complex procedures, monetary force and different organisational structures (Zou, Zhang & Wang, 2006:2). Kuang (2011:4) contends that construction projects have a number of features, including specific goals, limited periods of time, financial constraints and economic demands, particular organisational and legal contractual terms, complication and systematic characteristics. Any investment project is a complicated system, but this is even more so for construction projects, as there are several risk aspects and complex relations, which will impact the project. Therefore, if risk factors are not considered, these factors will cause damage because of the inevitable decision-making errors (Kuang, 2011:4). Quality, time, cost, health and safety and environmental sustainability are the main objectives of construction project management. In a construction project, the time objective is closely and inseparably related to the cost objective. Therefore, a key part of the risk management process in construction should be the incorporation of risk management as it pertains to the construction project schedule (Kuang, 2011:4).

According to Mahendra, Pitroda and Bhavsar (2013:139), risk has a serious effect on a construction project in terms of its main objectives, which are cost, time, quality, health and safety and sustainability. Mahendra *et al.* (2013:139) assert that the reputation of the construction industry in respect of managing risks in projects has been abysmal. Risk management is a procedure which contains various steps, such as risk identification, qualitative and quantitative risk assessment, risk response a suitable method for handling, controlling and monitoring the risks. The management of risk in construction projects has been acknowledged as a vital management process in fulfilling the project objectives in terms of cost, time, quality, health and safety and environmental sustainability (Zou *et al.,* 2006:1).

Cerić (2003:2) argues that the construction industry can be positively changed through improved risk management practices. One possible method is to study the reasons behind the risks, their likelihood of occurrence and their influence on project objectives (including cost, time, quality, health and safety, and environmental sustainability) for a specific type and size of project. Therefore, it is imperative to engage an expert to assist in the process of risk identification during the initiation/planning, design, implementation, and handover phases in order to develop an adequate risk response. This can be achieved by relying on previous experiences and data gathered from similar projects (Cerić, 2003:2). Cerić (2003:2) further states that another way of managing risk is to develop quantitative and qualitative risk analysis methods and this approach should be used in specific phases of the project lifecycle. In light of the above, Cerić (2003:2) stresses that the development of a decision support system under conditions of uncertainty would enhance the risk management process by significantly reducing the risk of poor risk management. Cerić (2003:2) adds that risk response should be a continuous process based on previous experience, but bearing in mind that changes are also necessary in the construction industry. Altoryman (2014:8) argues that several construction projects struggle with mismanagement in spite of continuous enhancements in the field of project risk management. Therefore, to establish the basis for designing a standard construction risk management tool to be adopted in future, there is a need for a comprehensive analysis of the construction environment.

According to Berk (2012:200) risk management in the construction project is a thorough and critical task that should be undertaken before the approval of any project. As construction projects become more difficult, the potential risks to owners, contractors, management, and project teams increase the possibility of negative impacts and damages in construction projects. Berk (2012:200) further states that to determine the risks which could affect construction, the management team should implement a risk appraisal on construction projects, thus increasing the feasibility of stopping and alleviating delays to the project schedule and avoiding extensions and abandonments of the project. Risk management should continue throughout the construction process to improve performance. Risks must be identified, quantified, and prioritised; thereafter, an idea must be developed to remove or reduce risk occurrence. Simple methods of identifying risks include using a brainstorming session or checklist (Berk, 2012:200). In general, project risks can be qualitatively assigned based on oral descriptions of their likelihood and repercussions (Adverse Weather, 2012: online). Management of risk in construction projects is presently full of deficiencies, which subsequently impact on project management function and in the end, projects' performance (Serpella *et al.,* 2014:654).

Serpella *et al.* (2014:654) contend that the reductionist approach has been adopted to manage risk in construction projects, but, this approach has not yielded positive results and limits the quality of project management. For instance, most of the time, risk is controlled through the provision of contingencies (money) or floats (time) that are not determined based on a comprehensive analysis of the risks that may negatively influence a particular project, and that in many cases are clearly deficient to cover the consequences of risks that do occur during the project realisation (Serpella *et al*., 2014:654). Then, in most cases, projects finish with cost overruns and delays. To design an effective and efficacious risk management containment strategy, it is necessary to have a proper and systematic method and, more importantly, understanding of, and expertise at, deploying various types of risk management (Serpella *et al*., 2014:654).

1.3 Problem Statement

Construction projects are faced with many risks including changes to design, environment-related, project management-related, finance-related, socio-political-related, and right of way-related which often impact on project delivery adversely in terms of cost, time, quality, safety and environment. The magnitude of these effects as well as the frequency of occurrence have not been adequately assessed.

1.4 Research Hypotheses

The research hypotheses to be tested in this study are as follows:

- H1: There is no statistically significant difference between the mean rankings of construction participant's perceptions with regard to the importance of the major causes of risks during construction;
- H2: There is no statistically significant difference between construction participant's perceptions with regard to the major causes of risks during construction;
- H3: There is no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance;
- H4: There is no statistically significant difference concerning the perceptions of construction professionals and the effective strategy for mitigating risks, and
- H5: There is no statistically significant difference between the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks.

1.5 Objectives and Aim of the Research

The aim of the study is to identify the major causes of risk during construction projects with a view to enhancing effective project delivery.

The research objectives investigated in this study were:

- To determine the major cause of risks in construction projects.
- To identify which construction risk is regarded as the most significant in militating against the success of construction project.
- To determine the detrimental effect of construction risks on the project and organisational performance.
- To establish an effective strategy for reducing risks associated with construction projects.

1.6 Delineation of the Research

The study was limited to construction and consulting companies which were engaged in construction projects in Western Cape, South Africa.

1.7 Significance of the Study

Management of risk assists the organisation to determine the weaknesses, strengths, chances and obstacles encountered during the commission of the project. Advanced planning for unexpected cases helps the organisation to be ready to respond to risk occurrences. An important factor in a project's success is how the organisation deals with expected risks. The findings of this study will benefit the construction industry and help allow them to educate stakeholders about the role risk plays in altering the course of a construction project. This study will help allow contractors, designers, owners and risk management teams to be familiar with risks and their impact.

1.8 Conceptual Framework

The purpose of a risk management system is to detect expected risks, control them, and take corrective actions either before or as risks occur. The conceptual framework depicted in Figure 2 explains how effective risk management systems lead to the success of a project. The conceptual framework starts with identifying the major risks, followed by categorising the risks into client, design team, contractor and owner-related. Understanding the categorisation of risks helps to develop an effective risk management system. Furthermore, the identification of construction risks will help institute effective corrective measures before or as risks occur. This will also inform the development of a suitable risk management system, which in turn will lead to gains for the project in terms of cost, time and quality.

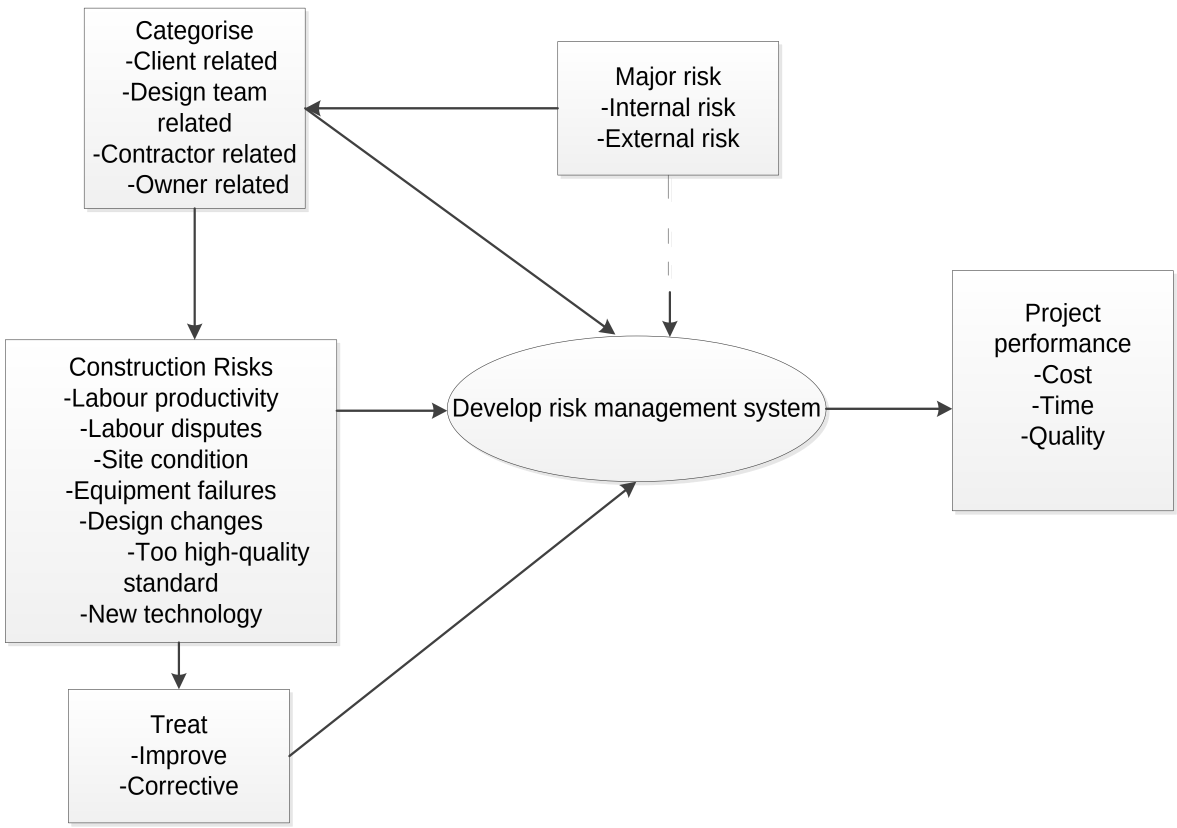

Figure 1.1: Author's conceptual framework

1.9 Dissertation Outline

The following outlines the structure of the dissertation.

Chapter One: This introductory chapter encapsulates a brief introduction to the study, the background to the research problem, the problem statement, the research hypotheses, aims and objectives, the significance of the study, the scope and limitations of the study, conceptual framework, and the outline of the dissertation.

Chapter Two: The review of literature chapter provides an analytical taxonomy of the root causes of risks in construction projects. This section subsequently outlines the detrimental effect of risks on project delivery, as well as the measures adopted to mitigate their occurrence.

Chapter Three: The systematic approach used in achieving the aims and objectives of the study is discussed in this section. It describes the methodological approach, the sample strata, development of the research instrument, and statistical tools used in the data analysis process.

Chapter Four: This chapter presents the data analysis and interpretation of the results.

Chapter Five: This chapter presents a detailed discussion with respect to testing of the hypotheses postulated in this chapter.

Chapter Six: This section is referred to as the conclusions and recommendations chapter. It provides a detailed account of how the research objectives have been achieved and outlines any conclusions relative to the hypotheses. The subsequent sub-headings outline the limitations, as well as the recommendations, of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter will focus on reviewing literature related to the study and will carefully review pertinent authors in an effort to examine and explain the research problem which has been outlined in Chapter One of this study. It will cover descriptions of the construction industry, role or contribution of the construction industry, the concept of risk, sources of risk, classification of risk in construction, and managing risk during projects in order to enhance project performance delivery.

2.2 The Construction Industry

The construction industry focuses on the development of infrastructure such as roads, houses, apartments, factories, offices, schools, roads and bridges (OECD, 2008:9). According to Koehn and Reddy (1999:39), the construction industry plays a greater role in the economy in the developing world, boosting employment in developing countries more so than it does in developed ones. Various authors (e.g. Hinze & Olbina, 2008: 406; Pillay & Haupt, 2008: 433) are of the opinion that the construction industry operates differently from one project to another and is constantly in flux. For example, the working conditions in the construction industry very often differ due to the complex nature of projects, posing many challenges to the workers. Thus, the industry is considered to be risky and of a highly hazardous nature. For this reason, Hinze (2006:321) contends that, on the global scale, the construction industry has higher injury rates than even the mining sector.

2.3 The Role or Contribution of the Construction Industry

The construction industry has been identified by several studies as an important contributor to national economic development (Olanrewaju & Abdul-Aziz, 2015:9; Rameezdeen, 2007:76). A study by Hillebrandt (1985:10) reveals that, for any country, construction is an important sector that directly influences the economy. Construction encompasses multiple contributors and is linked to several activities, not only in building, but also other area such as manufacturing, utilisation of materials, energy, finance, labour and equipment.

According to Wibowo (2009:279), the significance of the construction industry is engaging in terms of scale and share in the development process, for both developed and developing countries. Furthermore, Wibowo (2009:279) maintains that the construction industry provides meaningful public and private physical structures, as well as infrastructure necessary for activities such as commerce, services, utilities and other activities related to other industries. The construction industry contributes not only by producing finished products, but also creates employment locally and nationally, and has both a direct and indirect effect on the economy (Wibowo, 2009:279). Field and Ofori (1988:41) contend that the contribution of the construction industry to a country's economy can be evident in terms of the production of specific and national basic needs which represent the provision of fixed capital assets and infrastructure of a country. Furthermore, the authors point out that the industry contributes directly to national Gross Domestic Product (GDP) and employment creation.

2.4 The Concept of Risk

The term "risk" is interchangeably used in different connotations to describe different situations, such as hazard or uncertainty (Al-Bahar & Crandall, 1990:533). According to Samson, Reneke and Wiecek (2009:558), risk management studies primarily make use of the concept of risk and uncertainty in their publications. Further, the authors point out that risk and uncertainty are two concepts that are closely related.

Several authors, such as Flanagan and Stevens (1990:121) and Byrne and Cadman (1984:8) disagree that the concepts are related, and instead highlight the differences between the two concepts. There are many definitions of risk and uncertainty, but the consensus is that uncertainty arises when the occurrence of an event cannot reasonably be anticipated or its magnitude cannot readily be determined. Boothroyd and Emmett (1996:63) and Kartam and Kartam (2001:325) define the term risk in construction as "*a consideration in the process of a construction project whose variation results in uncertainty in the final cost*". Cooper and Chapman (1987:94) also describe risk as exposure to the possibility of economic or financial loss or gain, physical damage or injury or delay, as a result of the uncertainty related to pursuing a particular course of action. According to Jannadi and Almishari (2003:492), risk is *"a combination of the probability, the severity, and the exposure of all hazards of an activity"*. Chapman (2001:147) states that risk is the likelihood of occurrence and the extent to which a negative event adversely affects an activity". Risk can also be described as "a threat to project success, where the repercussion upon project success is uncertain (Barber, 2005:584).

2.5 Project Risk

Though different definitions for project risk have been presented in research literature by diverse authors (Baloi & Price, 2003: 261; Barber, 2005:584; Chapman & Ward, 2002; Flanagan & Norman, 1993:56; IEC, 2002:73; Jaafari, 2001:89; PMI,2000:127; Smith, Merna & Jobling, 2006:4), the most unifying thread is the understanding of risk residing in uncertain events and the ripple effect on project parameters (Osipova, 2008:19). The international standard "Project Risk Management Application Guidelines" uses the terms 'probability' and 'consequence' and describes risk as an amalgamation of the probability of an event occurring and its consequential effect on project parameters (IEC 2002:73). As this thesis discusses risks in the construction project context, a formal definition from "A Guide to the Project Management Body of Knowledge" is used (PMI 2000). According to PMI (2000: 133), risk is defined as "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives". In addition, Chapman and Ward (2002:97) argue that the concept of risk and the concept of uncertainty can be used interchangeably. The authors add that the term 'risk' is often related to adversity and focuses on threats, not opportunities. This aligns with Akintoye and MacLeod's (1997:31) findings that quite a significant number of respondents that were surveyed agreed that risks may have a negative impact on project objectives.

Smith, Merna and Jobling (2006:4) posit that project risks may be categorised into three main groups, namely known risks, known unknowns, and unknown unknowns. According to Smith *et al.* (2006: 4), known risks can occur as a result of minor variations in productivity and may inflate material costs. These types of risks are unavoidable feature and prevalent in all construction projects. According to Smith *et al.* (2006: 4), the known unknowns are the risk events whose occurrence is foreseeable or predictable. In other words, either their probability of occurrence or their likely effect is known. The unknown unknowns are the most complicated risk events, whose probabilities of occurrence and effect may not be easily detected by even the most experienced personnel. These types of risk events are typically considered as force-majeure (Smith *et al.,* 2006:4). Thus, considering the likelihood of the occurrence and the consequence for project objectives, risk events that have high probability and high impact are subject to risk management. Hence, Ehsan, Alam, Mirza and Ishaque, (2010:16) argue that construction-related risk may be perceived as the likelihood of the occurrence of uncertain events, or a combination of several factors, that is likely to occur in all the phases of the project lifecycle, which has a detrimental effect on project delivery.

2.6 Sources of Risks

Klemetti (2006:84) states that construction risks may be categorised in several ways, depending on the sources of risk, and the impact of those risks on the project phase. A number of authors have divided project risk into two major groups, namely internal and external (Al-Shibly, Louzi & Hiassat, 2013:22; El-Sayegh, 2008:431; Qammaz, 2007:89; Van Thuyet, Ogunlana & Dey, 2007:175; Carr & Tah, 2000:491). According to Qammaz (2007:89), internal risks are generated within the project, though they do have the capability of being controlled. On the other hand, external risks may originate from outside the project and in most cases, are out of the control of contractors. The internal (controllable) sources may be due to client system, consultants, contractors and subcontractors and suppliers (Qammaz, 2007:89). Examples include financial, design, contractual, construction, personal and operational risks (Van Thuyet *et al.,* 2007:175). External sources may be ascribed to the following factors: economic and globalisation dynamics; environmental constraints; government; unanticipated circumstances; statutory requirements; political controls; health and safety issues outside the control of the project team, and socio-cultural issues (Al-Shibly *et al.,* 2013:22). According to Qammaz (2007:89), the sources of risk include adverse physical conditions, design, managerial complexities, client's financial resources, techniques and technology, extent of subcontractor availability, and availability of resources.

Qammaz (2007:89) posits that the source of risk may be classified as contractually-related; that is when risks stem from contract documents; or it may be construction-related and sourced from project execution. Al-Shibly *et al.* (2013:22) point out that the source of risk cannot always be determined: it can be linked to employees' and managers' limited knowledge, limited experience and information, and changes in the parties involved in the construction process. In addition, risk can stem from financial markets, project failures, legal liabilities, credit risk, accidents, natural occurrences and disasters, and from competitors (Al-Shibly *et al.,* 2013:22).

2.6.1.1 Internal Risks

Wang, Dulaimi and Aguria, (2004:237) opine that internal risks affect all projects, regardless of whether the projects are local or international. According to Renuka, Umarani and Kamal (2014:32), these risks are more manageable and may differ between projects; they cover uncertainties due to labour, plant, material, subcontractors, and the site conditions. Fisk and Reynolds (2009:169) also describe internal risks by citing examples such as resource risk, project member risk, construction site risk, and document and information risk. Furthermore, the authors state that resource risks are those risks related to materials and machinery; hence, the accessibility and efficiency of the resources required to assist in implementing the project are reasonable risk events which must be assumed by the contractor.

2.6.1.2 External Risks

According to Banaitiene and Banaitis (2012:432), external risks include lack of knowledge regarding social conditions, as well as lack of knowledge the local economy and political situations. Unfamiliar and new procedural formalities, regulatory frameworks and governing authorities may also influence construction project performance. Rezakhani (2012:33) classified the external risk factors into the following; unpredictable\uncontrollable and predictable\uncontrollable. According to Tah, Thorpe and McCaffer (1993:281), external risks are those factors that are predominant in the external environment of projects, including risk related to inflation, fluctuations in currency exchange rate, change in technology, client-related changes, politics, inclement weather conditions and major accidents or natural disasters. Furthermore, external risk is relatively uncontrollable and there is the need to continually examine and predict its occurrence in the context of a company's strategy (Zavadskas, Turskis & Tamošaitiene, 2010:34; Tah *et al.,*1993:281).

Li and Liao (2007:2043) argue that political risks are related to amendments to government laws or legislative systems, regulations and policies, as well as inadequate administration systems. Economic risks are related to inconstancy of economy in the country, repayments and defaults in the manufacturing industry, inflation and funding issues. Zavadskas, Turskis and Tamošaitiene (2010:34) cited in Tvaronavičienė and Grybaitė (2007) analysed Lithuanian economic activities related to construction. The economic disasters in the Lithuanian construction industry were attributed to contractors' inability to assess the probability of the risk events and their cost impact. According to Ginevičius and Podvezko (2009:418), social risks are increasingly significant to any effort at risk allocation and describe a situation whereby the project outcome can be significantly influenced due to political interference and social pressures from role-players having vested interests in a project.

2.7 Classification of Risks in Construction

There are many different types of risks identified by various authors (Schieg, 2015:79; Mahendra, Pitroda, & Bhavsar, 2013:139; Abdkarim *et al*., 2012:4). Zhang and Xing

(2010:1067) contend that, depending on the project scope, types of risks may differ among investments. These risks may occur in each construction project, regardless of its size and scope. Gajewska and Ropel (2011:23) contend that the most common types of risks for the construction industry include changes in design and scope, coupled with time frames for project completion. Gajewska and Ropel (2011:23) further argue that when scope or design changes are implemented, the more additional resources, time, and cost are required.

Mahendra *et al.* (2013:139) opine that construction-related risk can be broadly categorised into seven groups, namely: construction risks, environmental risks, financial risks, organisational risks, physical risks, technical risks, and socio-political risks. Similarly, Schieg (2015:79) maintains that the occurrence of risks in construction projects may be classified according to the following risk types: personnel risks; quality risks; set date; deadline risks; external risks; cost risks, and risks of strategic decisions. This is corroborated by Renuka, Umarani, Kamal (2014:31) who reveal that the most significant risks associated with construction projects include:

- Country risk; such as inflation, country economic condition;
- Environmental and geological risk, such as weather and climatic conditions;
- Statutory compliance risk, for example statutory clearance before planning a project;
- Design-related risk: e.g. design and scope changes;
- Project execution risk: implementation of new technology, inadequate safety procedures, delays in construction, poor managerial skills, lack of coordination between teams, and
- Resource-related risk: e.g. lack of or unavailability of resources.

A study by Abdkarim *et al.* (2012:4) reveals that the most significant risk-contributing factors include shortage of materials, late delivery of materials, shortage of equipment, poor quality of workmanship, and cash flow difficulties. It is important to note that these significant factors may be classified into two major groups, namely construction and finance. Abdkarim *et al.* (2012:4) point out that, to minimise the chances of failure during construction projects, the significant risk factors should be properly managed in order to achieve project success.

2.7.1 Client and Owner-Related Risk

Zou, Zhang and Wang (2006:8) identify four key risks related to clients, namely tight project schedule, changes by the client, high performance or quality expectations, and incomplete approval. Relative to tight project schedules, Zou *et al.* (2006:8) contend that the clients must prepare a practical schedule allowing sufficient but not excessive time to accommodate all design and construction activities. As time and cost are always closely connected, an excessively-long schedule will certainly crash the project cost benefit and delivery. With regard to changes emanating from the client, Zou *et al.* (2006:8) opine that scope changes may lead to changes in the planning, design and construction. The root source of scope changes is twofold: either changes emanating from the client or the misconception of the client's need in the project transitory. Furthermore, high performance or quality expectations is what most clients have in mind, which might entail the sacrifice of project cost, time, delivery, performance and even safety (Zou *et al.,* 2006:8). According to Zou *et al.* (2006:8) incomplete approval of plans and other documents is a client-related risk which usually occurs because of management weakness in the project routines or the bureaucracy of government. Therefore, clients need to appoint a competent team who are capable of preparing project documentation effectively and efficiently in order to obtain the approval from government agencies.

2.7.2 Design Team-Related Risk

The extension of construction places great weight upon the design professions. Keeping performance standards of design teams high during a project is often difficult, and occasionally, design or specification deviations occur that create construction problems. Design errors/failures or constructability errors are becoming more and common, and the architect must be aware of the true cost of design failures. Design variations occur in the design phase of a construction project and are the result of issues such as variations by the client and defective designs. Inadequate programme scheduling also often arises in projects when the schedule is tight] and when other programmes need to be reduced to meet the project timeline (Zou, Zhang & Wang, 2006:9). Gajewska and Ropel (2011:23) add that project completion ahead of time may be as troublesome as delays in a schedule. Gajewska and Ropel (2011:23) further state that fast-tracking a project on the one hand may be attributed to insufficient planning or design problems which in fact shorten the completion time, but on the other hand, this may lead to a low quality of final product and increased overall cost. This is in line with Gould and Joyce's (2009:119) assertion that schedule overrun leads to an upsurge in project costs that must be incurred by either the clients or contractors as a result of deviation from the specification. For that reason, keeping a balance between cost, time and quality is of utmost importance, since these parameters are considered as the most important for the construction industry (Zhang & Xing, 2010:1067).

Nkhabu (2010:9) opines that any changes in the design lead to increase in project cost; for instance, changes will affect the project cost where the contract clauses allow for changes to be made and the contractor is allowed compensation for making the changes. Some procurement strategies do not make provision for design changes, nonetheless, when the construction commences, the changes allowed are changes inherited by the project. Hence, design changes in construction projects should be avoided as much as possible.

2.7.3 Contractor-Related Risk

In most cases, the onus rests on the main contractors to evaluate the capabilities of their subcontractors and therefore to know the dangers of not assessing the risk properly (Fisk & Reynolds, 2009:168). Fisk and Reynolds (2009:168) state that subcontractor risks are those risks properly assumed by the contractor, except where they arise from one of the other listed risks attributable to stakeholder or architect. Zou, Zhang and Wang (2006:10) reveal that contractor-related risk includes factors such as unsuitable construction programme planning, lack of coordination between project participants, occurrence of dispute, and general safety accident occurrence. Zou *et al.* (2006:10) posit that unsuitable construction programme planning is a risk which may stem from insufficient programme scheduling, overly-innovative design or the contractor's lack of knowledge in planning construction programmes.

Zou *et al.* (2006:10) add that the lack of proper coordination amongst project participants may be due to inadequate management of construction team and programmes. Lack of sufficient professionals and managers is often related directly to delays in the construction phase. The contractors must map the construction progress all the time and organise different project stakeholders in order to secure sufficient professionals, managers and skilled labourers that are ready commit to the project. Furthermore, risks due to occurrence of dispute within the construction project occur primarily as a result of inconsistency and variations in design and construction (Zou *et al.* 2006:10). According to Zou *et al.* (2006:10), general safety accident occurrence is usually associated with lack of project management, negligence regarding construction safety, and conflict arising from incompatible construction programmes by the contractor(s), and can directly bring about personnel changes or delay the construction progress.

2.8 Construction Risk

The construction industry is extremely predisposed to risk, with multifaceted and vigorous project environments creating an atmosphere of high uncertainty and risk; the industry is susceptible to numerous business, socio-political and technical risks. In recent years, the track record of the construction sector in terms of coping with these risks has not been encouraging; therefore, the people working in the industry suffer countless failures, including failure to abide by quality and operational requirements, cost overruns and delays in project completion (Mhetre, Konnur & Landage, 2016:153). According to Akintoye and MacLeod (1997:31), construction risk is commonly perceived as events that influence project performance in terms of delivery, cost, time and quality. Furthermore, Akintoye and MacLeod (1997:31) add that construction risks include such factors as availability and efficiency of labour, soil and site conditions, shortage of material and quality as well as safety issues on site. The relevant weight attached to risk factors by project management practitioners is expected to change in view of the current performance of the construction industry on health and safety, requiring employers and their agents to provide information on details of risks and avoid foreseeable risks to the health and safety of any person at work.

2.8.1 Labour Productivity

According to Sanvido (1988:294), despite the common perception that labour is the major factor behind good or poor project performance, unsuccessful management has been identified as the main cause of poor productivity. Liberda, Jergeas and Ruwanpura (2003) illustrate how management can affect resources and change the plan; Canadian construction industry professionals with a minimum experience of 27 years identified management as the primary determinant of productivity among, and ranked it higher than external and human factors. According to Rojas and Aramvareekul (2003:78), management teams have to properly investigate owners, general contractors, electrical contractors, mechanical contractors, and consultants in order to determine an absolute level of construction labour productivity drivers and opportunities. The authors further stated that management skills and manpower issues are the two areas in a project with the highest possibility of affecting productivity.

2.8.2 Labour Disputes

Labour relations are characterised as one of the most important facets, if not the greatest, faced by construction project owners. Labour relations are often worsened by a careless approach to the management of industrial relations based on the establishment of “the Agreement, which is more often than not set up without recourse to experts in labour relations (SHR, 2014:1). Labour-related risks on a construction project can take many forms. The most noticeable, and the one receiving the most attention, is labour disputes, which can take the form of strikes, work stoppages or go-slows and construction disputes. Besides pointing out significance labour-related risk, the author enumerates a number of other factors that contribute to the make-up of labour-related risk, all of which may lead to decreases in labour productivity, scheduled delays, or increased labour costs. They include: a general lack of awareness of the past, present and future labour relations environment; erroneous payroll processes; lack of appreciation of reasonable and competitive labour costs; inadequate skill levels and shortage of appropriately skilled labour; ineffective attendance management; poor selection of employees; restrictive work practices; poor work organisation; low standards of site accommodation and facilities, and restrictive employment agreements (SHR, 2014:2).

In order to minimise or avoid labour disputes as much as possible, it is imperative to adopt the conventional approach to labour relations project management. This approach includes taking cues from the last comparable project in terms of costs and arrangements, developing a list of inflexible parameters for contractors and managing disputes by past practice and reaction (SHR, 2014:2).

2.8.3 Site Conditions

Venzie and Esquire (2008:1) point out that different site conditions prerogatives concentrate primarily on physical conditions at the project site, which are certainly absent or imaginable and therefore were unexpected at the time of the contract; site conditions that are behind the evolution of “different site conditions” prerogatives refuge a number of surface and subsurface conditions which impact the time delivery and cost of construction and are generally not provided for in the contract documents. Venzie and Esquire also point out that “as an unauthorised cost event, the unexpected (unforeseen, concealed, unknown) site conditions create a substantial contract performance risk which can impact the cost of construction for one or both of the parties; for construction lawyers, the subject of different site conditions becomes an evaluation of the allocation of such risks under the contract documents and entitlement to recover the additional costs and damages associated with the unforeseen site conditions including delay and any other schedule impacts”.

2.8.4 Equipment Failures

A study by Fan and Fan (2015:203) reveals that, in order to minimise or prevent construction losses, it essential to assess the consistency of construction equipment and predict the failures or repair needs with a reasonable degree of accuracy. According to the authors, consistency and obtainability of the equipment that is used in construction plant and civil engineering fields are an important issue for all stakeholders; the unanticipated failure and repair of any equipment could have a considerable effect on construction project performance in terms of cost and time required for the completion of the project.

In construction projects, equipment will always play a significant role, particularly in the heavy and highway sectors of the construction industry (Day & Benjamin,1991: 52). Further, Day and Benjamin point out that contractors possessing a significant equipment taskforce must take required measures to maximise equipment utilisation and minimise equipment failures. Guarantee costs are tremendously problematic to measure, because they do not appear in cost reports and are easily ignored; guarantee cost of equipment failures in the field cannot be afforded if completing construction on time and on budget is required. The impact that failures have on operations and the incidence with which they occur are key factors in managing construction equipment (Fan & Fan, 2015:203).

According to Nepal and Park (2004:199), the ability to predict equipment failures is essential, since it will assist in terms of reducing repair cost and manage project delivery and equipment costs. It is important to note that maintenance actions taken before failure are more cost-effective, less disruptive to project delivery, and easier to manage than repair actions taken after the machine has broken down.

2.8.5 New Technology

Zhao and Li (2014:2890) argue that a weak technology environment might produce various risks and that technology risks in the construction process may significantly affect the completion of a project and subsequently lead to financial and reputational loss. This risk factor includes problems or concerns connected with the technologies involved in the implementation methods and operational technology of the project (Jayasudha & Vidivelli, 2016: 6933). Gharabagh *et al*. (2009:533) postulate that in order to have access to sufficient integrated information concerning the risks in different phases of the project, such as planning and operation, and in order monitor them concurrently, risk management staff are advised to use information technology tools when managing these processes. According to Bahli and Rivard (2005:175), using information technology can be a source of unpredicted risks which are not in line with an organisation's objectives. Further, they categorise the various types of construction technology risk as follows:

- The adoption of obsolete construction technology;
- Irrational construction technology and scheme;
- Unsuitable health and safety measures during construction;
- Incorrect application of new methods and technology;
- Half-baked consideration on the actual condition of the construction site;
- Unacquainted with the design intention and design drawings;
- Deviation from the drawing and specification;
- Lack of adherence to construction standard;
- Inadequate information relative to site and the nature of the ground;
- Unreasonable personnel organisation and arrangement;
- Unreasonable allocation of materials and
- Unreasonable equipment allocation to tasks or activities (Bahli & Rivard, 2005:175).

2.9 Effect of Risks on Construction Projects

The effect of risk on project delivery can be detrimental in a number of ways. The most serious consequences of risk identified by Radujkovic and Car-Pusic (2004:1) are cost and time overruns. Similarly, risk in the construction industry is commonly viewed as having their origin in any events that impact project objectives related to cost, time and quality (Akintoye & MacLeod,1997:31). This is corroborated by Wang and Chou (2003:60) who assert that risks and uncertainties associated with construction projects, cause cost overrun, schedule delay and lack of quality both during the progression of the projects and at their end. Baloi and Price (2001: 261) argue that poor cost performance seems to be the norm rather than the exception in most construction projects, and both clients and contractors suffer significant financial losses due to cost overruns. These events are among the most common outcomes which contribute to project failure scenarios. Cerić (2003:12) also adds that risk may have a detrimental impact on budgeted costs, the duration of the project and the project quality. In the long run, both lengthier duration and quality loss may be expressed in terms of increased expenses. Cerić (2003:12) further highlights that risk impact can be calculated if there is enough information. In practice, however, it is often a daunting task to calculate risk impact quantitatively, so a qualitative appraisal is made estimating the impact as low, medium or high. Risk has an adverse impact on the project, it might change the scope of the project, or even lead to the project being abandoned (Cerić, 2003:12).

2.9.1 Project Performance

Regarding project performance, many contracting firms have adopted better project management tools such as Primavera3 and Six-Sigma, which improve control mechanisms and increases the predictability of project outcomes (Dunna & Burela, 2007:14). In spite of all the best practices, predictability of project outcomes is still an issue of concern. According to Sambasivan and Soon (2007:517), the inability of project participants to achieve targeted times, budgeted project costs and specified quality may lead to various unanticipated ripple effects on a project's performance. Lewis (1998:43) maintains that the overall success of a project is measured based on the project meeting technical performance and achieving high levels of satisfaction amongst key players and various stakeholders involved in the project. Lewis (1998: 43) further highlights that an important aspect of success is perception and states that "If the right people perceive that the project was a success, then it was, for all practical purposes". Hence, the reasons for success and delays in most cases are attributable to differing and vested interests of participants and stakeholders.

2.9.2 Project Performance Measures

Chan and Chan (2004) state that the measurement of project performance is ultimately defined by the overall outcome achieved at the completion of the project. Konchar and Sanvido (1998) add that measuring construction project performance is an important piece of the project management / project controls process and must be taken very seriously. According to Gransberg and Buitrago (2002), there are three types of project performance measurement, namely relative, static, and dynamic. Relative measurements are expressed as a percentage and as a result are independent of the size of a project. The second type is static measurements. These measurements are discreet numerical measures that do not change with time. Lastly, dynamic measurements are those that vary with time. Dynamic measurements are also project size dependent.

2.9.3 Effect of Risk on the Cost of Project

Cost overruns are very common in the construction industry. Few projects are accomplished within approved costs (Subramani, Sruthi, & Kavitha 2014: 2). A study conducted by Shen, Wu and Ng (2001: 78) reveals that increase in the cost of a project as a result of policy change was ranked as the most common cause. Baloyi and Bekker (2011:55) contend that the common causes of construction cost overruns are fluctuations in the price of construction materials, additional work or changes to work emanating from clients, time overruns caused by contractors, poor estimates and material take-off and delay in payments. Charles and Andrew (1990:548) also opine that cost overruns, as well as project delays, are commonly acknowledged as the main factors leading to the high cost of construction. Bowen, Hall, Edwards, Pearl, & Cattell, (2012: 48) point out that customers are increasingly concerned with the general productivity of projects and the accountability of projects. Further, the authors mention that research to date has inclined to focus on the technical facets of handling costs on construction projects in the achievement of customer objectives. Nevertheless, there is still some indication in the published literature of a concern for the organisational, social and political problems that are essential in the management of construction costs and the ability of the project team to meet the customer's needs in terms of cost.

2.9.4 Effect of Risks on Project Time

Timely accomplishment of a construction project is regularly perceived as a major determinant of project success by clients, contractors and consultants (Bowen *et al.* 2012:48). However, if a project is delayed, the timeframe is either extended or accelerated, which consequently results in additional project cost. Gajewska and Ropel (2011:23) point out that schedule overrun leads to an upsurge in project costs that must be incurred by either the clients or contractors as a result of deviation from the works. For example, unexpected ground conditions are seen as the second most serious risk to project delays (Shen, 1997:102). In addition, the fluctuation in labour force on the site does typically affect project progress (Shen, 1997:102). The norm in the industry is to make an allowance based on the project cost; notably, this allowance is usually discretional, based on previous experience (Rosazuwad, 2010:13).

Ameh and Osegbo (2011:65) claim that the relationship between time overrun and construction labour productivity is inversely proportional. Furthermore, the authors cite the study by Newcombe, Langford and Fellows, (1990) which reveals that there has been widespread disapproval of the failure of the construction industry in general to deliver projects in a timely way. Hence, well-organised management effort is essential to achieve a construction project on time. Determined management effort will assist to control both costs and quality, and the client's objectives can be accomplished through a management effort that recognises the interdependence of time, cost and quality

(NEDO, 1983:1). Vaardini, (2015:14260) lists the impacts of risks on time as follows: overruns in project costs, increased market risk, decrease in customer's faith and trust, increased stress to overall team, disputes among parties, negative social impact, poor quality of work.

2.9.5 Effect of Risks on Project Quality

Flanagan and Tate (1997) state that, from the client perspective, quality may be defined as one of the project parameters that contributes to value for money. According to Schiffauerova and Thomson (2006:542), the effective way to enhance customer satisfaction is by improving quality. However, any serious attempt to improve quality must be considered with the costs associated with achieving quality. Rezaian (2011: 218) recommends that project managers and management accountants endeavour to reduce the total cost, time and risk while maximising the overall quality. It is obvious that the relationship between cost and quality is inversely proportional. Therefore, the impact of risk on the cost will influence the quality. Al-Bahar (1990), as cited by Bodicha (2015:110), states that risk events such as acts of God, financial and economic risks, physical risks, political and environmental risks, risk due to design changes and construction-related risks associated with the construction industry will have a detrimental effect on the quality of project outcome. In addition, the PMI (2008:218) reported that the occurrence of risks may positively or negatively influence at least one of the project’s objectives, including quality.

2.10 Risk Management

Van Zyl (2009) posits that risk is inevitable and constitutes part of the spectrum of individuals’ activities over generations, and risks are present in everything people come into contact with. According to Flanagan and Norman (1993:45) and Zou *et al.* (2007:602), risk management is a system that aims to classify and measure the extent of all risks to which a business or project is exposed, in order to suggest conscious decisions to manage those risks. Risk management is an important concept, and one of the nine foci in project management. It is viewed as “the procedures concerned with conducting risk management planning, identification, analysis, responses, and monitoring and controlling on a project” (PMI, 2004 & Zou *et al.*, 2007:602). Smith *et al.* (2006:26) provide a comprehensive exposition of the concept of risk management and illustrate the way the concept might be used in practice. The authors state that risk management cannot be viewed as an instrument to forecast the future, as an accurate prediction might be impossible. However, the authors view risk management as an instrument that facilitates the project, so that better decisions can be made based on the information concerning the investment. Australian/New Zealand Standard AS/NZS (2004:4) describe the term risk management as “the culture, processes and structures that are directed towards realising potential opportunities whilst managing adverse effects”. The term is defined by Cooper *et al.* (2005:3), as the “process involving the systematic application of management policies, processes and procedures to the tasks of establishing the context, identifying, analysing, assessing, treating, monitoring and communicating risks”.

The lack of a formalised approach to risk management has, predictably, produced inconsistent results. According to Carr and Tah (2001:170), a formalised approach to risk management has to be implemented in order to address the risk factors consistently to avoid potentially devastating consequences. Risk management is indispensable to construction industry activities in order to minimise losses and enhance profitability (Baker & Reid, 2005; Zou *et al.,* 2007:602). Further, Akintoye and MacLeod (1997:31) state that, risk management in construction depends primarily on intuition, judgment and experience; and that risk management procedures are often neglected due to a lack of knowledge and uncertainties concerning the suitability of risk management methods for construction industry activities. A study by Chapman and Ward (2002:4) reveals that, risk management has been recognised as an important need in the construction industry in the 21st century. A certain set methods and approaches to risk management have been developed in order to control the effects of potential risks. Smith *et al.* (2006:45) and Flanagan and Norman (1993:51) point out that methodical processes of risk management are classified into different method such as risk identification, classification, risk analysis, and risk response. Gajewska and Ropel (2011:32), as well as Potts (2008:141), classify risk response into: retention, reduction, transfer and avoidance and further illustrate that risk identification is classified as the first step of the risk management process. As an integral part of risk identification, risk classification results from the effort to structure and categorise the various risks affecting a construction project.

2.10.1 Risk Identification

In the construction industry, the management of risk associated projects is becoming a area of growing interest. The identification and analysis phases of the risk management process are considered the most significant, as they have a significant influence on the accuracy of the risk assessment exercise (Maytorena *et al*., 2007:315). According to Zou *et al*. (2007:601), as well as Akinci and Fischer (1998:67), identification of risk is considered to be the opening point of the risk management process.

Many researches identify the analysis process and its tools and techniques as a well-developed process in risk management and state that such analysis is reliant on risk being correctly identified in the first occurrence. Nevertheless, the identification process causes certain problems as the process of risk identification is usually not well understood, and the tools and techniques related are less developed (Edwards & Bowen, 1998:339). According to Karimiazari *et al.* (2011: 9106), in order to enact risk management, risk must be identified first: identification targets risks before they develop into problems and negatively affect a project. Identification is heavily reliant on previous experience or comparable situations which would apply to the current project, with the aim being to avoid compromising the project's success.

2.10.2 Risk Analysis

Risk analysis is considered as the second phase in the risk management process, as it focuses on collecting data regarding the possible risk. Many organisations are more conscientious about using risk analysis as a part of project development and refer to the process as a combination of risk identification and assessment (Gajewska & Ropel, 2011:26). Cooper *et al*. (2005:3) define it as: *"risk analysis as the systematic use of available information to determine how often specified events may occur and the magnitude of their consequences"*. Cooper *et al.* (2005:3) maintain that a wide variety of mathematical approaches and other models and techniques may be adopted for risk analysis. Risk analysis can provide insight into the specific sources of project risk and enable management to devise targeted remedial action. According to Hertz and Thomas (1983:1), risk analysis is an application of different methods that aim to develop insight into, and understanding of, the influences implicated with each risk in a building development, or each variable in the forecasting of the building cost budget. Risk analysis in the construction industry is used to determine the probability and impact of the risks on the project in order to reduce the effects of risk on the main objectives of the project. Risk analysis is common to all projects, regardless of their size, location, client, and other compelling factors (Ogunbayo, 2014:36). Laryea and Hughes (2008:911) note that the construction industry in the past years has performed poorly with regard to risk analysis when compared with other industries.

Al-Bahar (1988) points out that the risk analysis and evaluation process is an important connection between the methodical identification of risks and the rational management of the more significant ones. Al-Bahar further explains that risk analysis forms the basis for decision-making amid different management practices: as the significance and influence of any risk is continually changing, it must be analysed and evaluated regularly as information changes. As a transitional process between risk identification and risk response, risk analysis integrates uncertainty in a qualitative and quantitative way to evaluate the possible impact of risks (Wang *et al.* 2004:237). Slovic and Weber (2002:3) also propose that when assessing risk in any project practice, it is important to use both qualitative and quantitative methods for risk analysis in construction projects. According to Winch (2002) qualitative methods are most appropriate when risks can be positioned somewhere on a descriptive scale from high to low level. This implies that the qualitative assessment prioritises risks according to their probability of occurrence and severity of impact (PMI, 2008). On the other hand, quantitative methods are used to determine the likelihood and influence of the risks identified, and are usually based on numeric analysis. Construction firms prefer to adopt a qualitative approach, as it is more appropriate to designate the risks than to quantify them (Lichtenstein, 1996).

2.10.2.1 Qualitative Risk Analysis

According to Cooper *et al.* (2005, 139:47), qualitative risk analysis is based on descriptive scales, and is used to define the probability and impact of a risk. Further, the authors point out that these relatively moderate techniques are applied when quick assessment is required. Heldman (2005:125) states that these techniques are mostly required in small and medium-size projects. In qualitative risk analysis, risk management methods are applied to define the characteristics of each risk (Kuismanen *et al.,* 2002). Baloi and Price (2003) opine that the analysis of perilous conditions in construction projects is an important challenge that may assist in determining the most suitable technique to be selected by the construction project manager to promote project risk analysis. According to Dikmen *et al.* (2008) there is no collectively recognised technique to evaluate risks in all projects; there are a number of techniques from an engineering perspective that are arithmetical in nature, but are considered to be extremely competitive and effective.

PMI (2004) stated that mental propositions to organising and prioritising risks are the foundation of qualitative risk analysis. According to Lowe (2002) qualitative analysis encompasses the identification of the following: a risk hierarchy, based on the likelihood of incidence and its impact on the project and employees; risk scope, and risk incidence factors (Lowe, 2002). Qualitative risk analysis evaluates the risk's likelihood of occurrence and its impact in order to allow the decision-makers to prioritise the risks that have a high likelihood of incidence and major impact on the project and respond to them accordingly.

PMI (2013) illustrated that qualitative risk analysis is a popular method to rank risks by priority, and then lead the risk response process. Qualitative analysis approaches generate a list of risks, which are ranked in order to prioritise risks for further analysis by assessing and searching methodically for the risks likelihood of occurrence and projected impact (De Marco and Thaheem, 2014). According to Kindinger and Darby (2000), the steps required to analyse risks include: identifying activities that make up the project, identifying applicable risk factors, developing a risk-ranking scale for each and every risk factor, ranking risk for each activity in a hierarchical order, documenting the results and identifying possible actions in order to minimise risks. Radu (2009:644) points out that these methods are often utilised in circumstances of insufficient, limited or unavailable numerical data, in addition to inadequate resources such as time and money.

De Marco and Thaheem (2014) suggested qualitative techniques as follows: “brainstorming, causes and effect diagram or Ishikawa diagram and checklists”; also “Delphi; Event and tree Analysis, risk Breakdown Matrix and risk quality assessment”. In qualitative analysis, PMI (2009) also identified the following processes: analysing the probability of risks; determining the effect of risks on the project objectives; identifying the root causes of the risks; confirming the importance of the risks by ranking, and prioritising how to address the risks.

2.10.2.2 Quantitative Risk Analysis

Quantitative risk analysis consists of statistical techniques that are most easily used with specialised software (Office of Project Management Process Improvement, 2003). Similarly, the quantitative technique is considered as a numerical process of evaluating the likelihood and influence of identified risks on the project (Ogunbayo, 2014:37). De Marco and Thaheem (2014) explain that quantitative risk analysis simply calculates the likelihood of occurrence and quantifies the extent of impact on the project cost, schedule, quality, as well as other objectives. In light of the above, Mahmood, Azhar and Ahmad (2011) and Roberds and McGrath (2006) stress that quantitative risk analysis techniques involve the process of evaluating the effect of all identified and quantified risks. The authors opine that the processes can be carried out by creating numerical models, achieving a combined result, determining the confidence level on the project, carrying out a sensitivity analysis, and updating the prioritised risk lists.

Mahmood *et al.* (2011) adds that the results of quantitative risk analysis processes may be more objective than qualitative risk analysis methods, provided enough data are available for the decision-maker. In addition, personal judgment and previous experience are factors that affect this process.

However, it has been argued that quantitative analytical methods require a lot of work to perform. Therefore, Gajewska and Ropel (2011:67) stress that the effort and time invested in this process should be weighed against the benefits and outcomes from the chosen method. For instance, larger or more complex projects require more in-depth analysis, whereas smaller or simpler projects may sometimes require only identification and taking action on the identified risks. For large construction projects, quantitative risk analysis is becoming more commonly used throughout the Western world (McGoey-Smith, Poschmann & Campbell, 2007:3). This aligns with PMI's (2009) report, as well as Heldman's (2005) assertion that quantitative methods estimate the impact of a risk in a project and are more suitable for medium and large projects, due to the number of required resources, including complex software and skilled personnel (PMI, 2009; Heldman, 2005). According to Maher (2005:26), a quantitative approach to cost and schedule estimation in relation to large or more complex projects is optimal for the reason that uncertainties are usually large at the time of estimation. This implies that in quantitative risk assessment, probability distributions of cost and schedule replace the usual point-estimated values (McGoey-Smith *et al.,* 2007:3).

2.10.3 Risk Assessment

Cooper, Grey, Raymond and Walker (2005:17) describe risk assessment as the overall process of analysing and evaluating risk with the purpose of developing an effective system for prioritising the identified risks. Olamiwale (2014) also states that risk assessment is a method of utilising accessible information to determine the frequency of incidence and the extent of consequences in risk management. Furthermore, risk assessment is a risk management process aimed at measuring, conducting quantitative and qualitative assessment in order to evaluate the extent of the industrial risk factors to the project, as well as to evaluate risk of the potential factors to project success (Karimiazari *et al.* 2011:9105).

The construction industry is confronted with a number of inherent uncertainties and issues, because the industry is plagued by risk. For this reason, risk management is an important part of the decision-making process of this industry and risk assessment is an important part of the risk management process (Karimiazari *et al.,* 2011:9105). Several techniques and tools have been proposed for methodical assessment of risk, though the actual use of these tools and techniques in practice e is limited (Yildiz *et al.* 2014:144). The result of risk assessment determines the input required to make the optimum decision: after the risks have been identified, they can be evaluated in terms of their influence on the project and the probability of their occurrence.

Various methods of risk assessment have been adopted to evaluate the occurrence of risks at different stages of projects. For instance, Choi, Cho and Seo (2004) adopted the fuzzy risk assessment approach for assessing risks associated with underground construction projects. A formalised procedure and associated tools were developed to assess and manage the risks involved in underground construction. According to Karimiazari *et al. (*2011:9107), the risk assessment procedure adopted for underground construction is composed of four steps of identifying, analysing, evaluating, and managing the risks inherent in the projects.

2.11 Risk Response During Project

According to Winch (2002:365), risk response is the action that is required to be taken with regard to the identified risks and threats in construction, and is the third and final stage of the risk management process. In addition, Winch (2002:365) contends that the response approach and strategy to be selected is dependent on the nature and type or risks concerned. Additional requirements are that competent personnel must be engaged to monitor the risks in order to develop an appropriate risk response that will be acceptable to all role-players involved in the risk management process (PMI, 2004). The most common approaches for risk response, according to Potts and Ankrah (2014:129), include avoiding risks, reducing its occurrence, transferring to other parties and retaining to manage. Apart from these types of responses, it is obviously problematic to take a decision based on scanty information, so this situation may be avoided by waiting until the appropriate information is available to deal with the risk (Winch, 2002:356). This process of is referred to as “delay the decision”, and it is important to note that this approach has been adjudged to be inappropriate in some situations, particularly when managing critical risks (Winch, 2002:356).

Avoidance and prevention is of utmost importance if the risk may have a detrimental effect on the whole project. In this case, it may be important to review the objectives of the project. In other words, if the risks have significant impact(s) on the project, the best solution is to avoid it by changing the scope of the project or, in a worst-case scenario, cancel it.

Construction projects are complex and are prone to many potential risks, and these risks may exert a negative influence on a project's success (Potts & Ankrah 2014:121). It is thus important to initiate the risk management process in the early stages of a project, rather than dealing with the damage after the risk has been realised (PMI, 2004:260). Winch (2002:364) states that risk can be managed satisfactorily if the impact of the risk is lower. Many risks can be eliminated in construction projects by placing more emphasis on avoidance, for instance, if major changes are warranted in order to avoid risks in the project, then so be it. Darnall and Preston (2010:165) suggest that it is best practice to apply known and well-developed strategies to manage and control risks instead of new ones, although the new ones may appear to be more economical. This implies that the risks may possibly be avoided, and work can proceed smoothly because the strategy adopted is less stressful to the stakeholders. According to Cooper *et al*. (2005:75), the following activities, when competently executed, assist in avoiding potential risks in construction projects:

- More detailed planning during the initiation and planning phase of the project;
- The adoption of different approaches;
- Adequate health and safety systems;
- Regular reviews of process approach;
- Regular monitoring and inspections;
- Training and skills improvement;
- Permits to work;
- Following the right procedure in order to effect changes, and
- Preventive maintenance.

According to Darnall and Preston (2010:164), one possible way of reducing risks is to add some additional expenses to the project cost to provide a form of insurance in the long term. In some cases, the project managers may appoint experts to manage high-risk activities. Those experts are better suited to find solutions that are beyond the jurisdiction of the project team. Cooper *et al.* (2005: 76) identify the following mitigation strategies that could assist in responding to risk: contingency planning; efficient approach to quality assurance; efficient crisis management and disaster recovery plans; separation or relocation of activities and resources, and unambiguous contract terms and conditions.

Darnall and Preston (2010:165) report that risk transfer, also known as sharing, is another method of responding to risk. In light of this, Gajewska and Ropel (2011:33) as well as Thomas (2009) indicate that the risks could be minimised by sharing with parties that are more resourceful and knowledgeable in terms of the consequences of risk. Darnall and Preston (2010:165) add that in this way, one project team can take advantage of another's resources and experience, since this process entails shifting part or full ownership and management of a risk to another party (PMI, 2008).

When a risk cannot be transferred or avoided, the best solution is to retain the risk. In this case the risk must be controlled, in order to minimise the impact of its occurrence (Potts & Ankrah 2014:106). Retention can also be an option when other solutions are uneconomical (Potts & Ankrah 2014:116). Monitoring is important, because all information with regard to the identified risk is collected and monitored (Winch, 2002:346; PMI, 2004:262). Hence, an efficient method of monitoring and controlling should encapsulate the analysis of the causal nature of the risk and the institution of corrective actions if necessary (PMI, 2004: 264). Monitoring and controlling risk can be successfully carried out by adopting the tools and methods outlined below:

- Risk reassessment: this process assists in identifying new potential risks and should be continually repeated throughout the whole project (PMI, 2004:82).
- Monitoring of the overall project status: this process is conducted to check if there are any variations associated with the project that may lead to new risks and accompanying ripple effects (PMI, 2004:82).
- Status meetings: this process entails discussions with the risk's owner, sharing experience and assisting to manage the risk (PMI, 2004:82).

2.12 Effective Strategy for Mitigating Risks

Mitigation strategy is a process of responding to the risk after it has affected the project. Mitigation encapsulates all remedial actions that can be taken by the project team to overcome risks from the project environment (Ehsan *et al*., 2010:19). Rastogi and Trivedi (2016:930) emphasise that to mitigate risks in construction projects, there is a need for effective contractual agreements and norms which govern different construction-related practices. Rastogi and Trivedi (2016:953) suggest the following risk mitigation strategies:

- Risks should be allocated to the party that is best suited to control that risk;
- Risk should be allocated through indemnity provisions;

- Indemnity provisions should be backed up with insurance;
- Having insurance in place as a fundamental way to manage risk;
- Ensuring that waivers of subrogation are in place;
- Avoiding reliance on certificates of insurance, and
- Ensuring that contracts are reviewed by a knowledgeable attorney and perusing contracts for consistency before signing.

2.12.1 Design Strategy

Wang, Dulaimi and Aguria (2004: 244) in their study suggest some strategies for mitigation of risks during the design stage. These include arranging and undertaking a comprehensive site investigation before the construction phase, specifying a construction extension clause in the contract and organising for the appraisal/vetting of drawings and design criteria by at least one independent engineering/architect consultant.

2.12.2 Construction and Project Management

A study by Chan, Chan and Lord (2011: 1) reveals a basket of measures that could be adopted to mitigate risk when managing construction projects. Examples include: development of a proper risk management process, site quality management systems, and quality control.

2.12.3 Financial Strategy

Construction Executive (2150: online) reports six ways to mitigate financial risk, including: avoid assumption of design liability, observe corporate formalities, and obtain assurances of ability to pay.

2.13 Chapter Summary

This chapter reviews the literature relating to the causes and effects of risks during construction projects. The literature pertaining to factors contributing to causes of risks during construction projects, effect of construction risks on project performance and effective strategies for mitigating risks has been systematically reviewed. In this chapter, sources of risks were categorised into internal risk and external risks, the classification of risks in construction were categorised as client and owner-related risk, design team-related risk and contractor-related risk. The impact of risks on construction projects was discussed and subsequently considered as effects of risk on the cost of projects, effect of risk on project schedules, and effect of risk on the quality of projects.

The process of risk management was categorised into: risk identification, risk analysis, and risk assessment. In this chapter, effective strategies for mitigating risks were reviewed and subsequently discussed under the following sub-headings: design strategy; construction and project management, and financial strategy.

CHAPTER THREE: RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

The methodology chapter describes the methodological approach that was applied to achieve the study objectives and understand the scope of the study with regard to the research population and sample strata, data collection techniques, data analysis, and ethical considerations. Phoofolo (2006:36) postulates that the importance of research design is twofold. Firstly, it assists in the achievement of the research aim and objectives, and secondly, it is the method that guides the rational preparations for data collection and analysis in order to draw conclusions. According to Burns and Grove (2003:195), research design is a strategy to conduct research with supreme control over any factor that may delay or affect the validity of the findings. Research methodology is a theory concerning how an investigation should be carried out and involves analysis of expectations, principles and procedures in a particular approach of investigation (Schwardt, 2007:195).

3.2 Methodological Approach

Creswell (2014:33) posits that there are three research approaches that can be adopted in any research investigation; they include qualitative, quantitative, and mixed methods. According to Creswell (2014:33), the three research approaches are not as discrete as they first appear. It is important to note that a quantitative approach, as depicted in Figure 3.1, was adjudged appropriate for this study, as it determines the need and captures the views of respondents with regard to the major causes of risks in construction projects and the negative effect on project performance or delivery. The subsequent subsections explain the mixed, qualitative and quantitative research methods.

3.2.1 Qualitative Research Methods

According to Holloway and Wheeler (2002:30), qualitative research is a “technique of social question that focuses on the way people understand and make logic of their experience and the world in which they live”. The drive of the qualitative approach is to emphasise experiences from the participants’ perspective (Holloway & Wheeler, 2002:30). This is in line with Creswell (2013:32), who postulates that qualitative research methods use an approach to explore and understand the meaning that individuals or groups ascribe to a social or human problem. Flick (2011:14), as well as Kumar and Phrommathed (2005:156) list the advantages of qualitative research as follows:

- Qualitative research methods allow for detailed and exact analysis of a few cases, hence, participants have more freedom to determine issues that are relevant in the context.
- The strength of qualitative research is the ability to study phenomena in-depth.

Flick (2011:14), as well as Kumar and Phrommathed (2005:156) also identify the disadvantages of qualitative research as follows:

- The design of qualitative research projects is less specific, lacking in consistent structural depth.
- The analysis of qualitative data consumes more time with generated results not broadly generalisable.

3.2.2 Quantitative Research Methods

According to Babbie (2010:24-25), a quantitative research method is an approach that highlights objective measurements and numerical analysis of data collected through polls, questionnaires or surveys. Further, Babbie (2010:24-25) postulates that quantitative research essentially focuses on gathering numerical information and simplifying it across groups of people. In a similar vein, Sibanda (2009:2) posits that the quantitative approach focuses on gathering numerical data and generalising it across groups of people. Creswell (2013:17) opines that quantitative research methods resort to the use of post-positivism for development of knowledge, employ strategies such as experiments and surveys, and collect data on predetermined instruments that yield statistical data. Burns and Grove (2003:201) argue that quantitative research is useful to measure the incidence of different opinions in a chosen sample. Quantitative research is considered to be the classic scientific approach. It involves the generation of data in quantitative form, which is subjected to quantitative analysis (Kothari, 2002:5). This project adopts a quantitative approach in order to gain an understanding of managing risk in construction projects to enhance project performance delivery.

3.2.3 Mixed Research Methods

Ivankova and Greer (2015:65) opine that a mixed method is a combination of qualitative and quantitative approaches within a study that generates more credible and persuasive conclusions about the research problem. Easterby-Smith *et al*. (2012:63) summarise some strengths and challenges of using mixed methods, as detailed in Table 3.1

Table 3.1: Advantages and disadvantages of mixed methods

Advantage	Disadvantage
Increase confidence and credibility of results.	Replication is difficult to achieve.
It enhances validity of the study.	There must be an important link between the research design and the research question.
Stimulates creative and inventive methods.	They provide no help if the researcher asks the wrong questions.
Divergent dimensions can be uncovered.	More resources are required compared to single method studies.
Can easily assist in term of synthesising and integrating theories.	The overall design should be accurate to overcome any unforeseen lapses.
May serve as an important test for opposing theories.	The researcher should be skilful and knowledgeable in the use of both techniques.
Confirmatory and exploratory research may be combined and carried out simultaneously.	It is not helpful if one method simply overshadows the other.
Present greater diversity of opinions.	
Provide better inferences.	

(Source: Easterby-Smith *et al.,* 2012:63)

3.3 Data Collection

Data collection techniques entail the process of exploring a range of data sources to gather information for a research study (Struwig, Struwig and Stead, 2001:116). Leedy and Ormrod (2010:210) contend that the choice of data collection technique adopted for a study is directly dependent on the sample frame, nature of the sample, research topic and the facilities available for data collection. The data types that are collected in a research study are both secondary and primary data (Struwig *et al.,* 2001:116). Questionnaires and literature reviews were used to obtain data for this study, as subsets of primary and secondary data collection.

3.3.1 Primary Data

Struwig and Stead (2007:80) describe primary data as new data generated for a particular research study. According to Kumar (2011:140), this method of data collection requires researchers to ensure respondents properly understand the purpose and relevance of the study, especially when using a quantitative approach. Leedy and Ormrod (2010:89) add that the most valid, informative, and most truth-manifesting information is the primary data. The collection of the primary data was conducted via a questionnaire survey comprised of closed-ended and open-ended questions administered to participants, including contractors, engineers, designers, owners, and risk management teams in the construction industry.

3.3.2 Secondary Data

According to Kothari (2004:95), secondary data are data which have already been collected and systematically reviewed by someone else and have already passed through the statistical process. According to Naoum (2007:18), the nature of the data can either be descriptive or analytical. Descriptive data describes previous research work conducted by previous authors. On the other hand, it is analytical as it critically analyses the contribution of others with a view to identifying similarities and contradictions made by previous authors/researchers (Naoum, 2007:18). The secondary data was gathered from textbooks, journals, conference proceedings, dissertations and theses. Specifically, the search for information was carried out principally at the Postgraduate Computer Laboratory situated within the Department of Construction Management and Quantity Surveying at the Cape Peninsula University of Technology. The following databases were accessed during the literature search: EBSCO; Emerald Insight online; Business Periodicals Index; Social Sciences Index, Wiley InterScience, and CPUT's own database. Specifically, the review of literature with regards to managing risk of construction projects in the South African context was compared to other developing and developed countries that were relevant to the study.

3.4 Questionnaire Design

The design goal of the questionnaire was to achieve the researcher's objectives by obtaining valid data from respondents (Azzara, 2010:18). Bhattacharyya (2002:62) maintains that questionnaires can be deployed by personal interview, mail, or telephone, depending on the type of information to be collected and the type of respondents. Azzara (2010:172) adds that sometimes, there is a need for open-ended questions; the need to ask specific questions which are too varied and not easily structured, which are particularly useful when the researcher is unsure about the answers given.

3.4.1 Questionnaire Development

A questionnaire is defined as a multiple-stage process that requires attention to many details at once. Various questions can be asked in detail and in different ways (Burns & Grove, 2003:234). However, Leedy and Ormrod (2010) argue that the language used for compiling the questionnaire should be unambiguous, and care should be taken that what is stated clearly in the survey instrument is not ambiguous to the survey participant. Moreover, the research instrument should be designed to fulfil a specific research objective, as questions are often inexpertly written, and this may lead to a low response rate during the data collection stage (Leedy & Ormrod, 2010). Questionnaires are chosen as the preferred research method because it is relatively quick to collect information using a questionnaire tailored for construction professionals. The responses are gathered in a standardised way, so questionnaires are more objective (Carter & Williamson, 1996).

The survey instrument was developed based on the literature review covered in Chapter Two. The following publications by different authors provided the basis for compiling the questionnaire, namely Al-Shibly *et al.* (2013:22); Qammaz (2007:89); Zou, Zhang and Wang (2006:8); and Mhetre, Konnur and Landag (2016:153). The major causes of risks in construction projects were classified as design-related risk, environment-related risk, project management-related risk, construction-related risk, finance-related risk, socio-political-related and right of way-related risk. In addition, the effects of construction risks on project performance were categorised into organisational and project performance. Furthermore, the effective strategies for mitigating risks were categorised into design strategy, construction and project management, and financial strategy.

3.4.2 Format of Questionnaire

A questionnaire survey was designed for the study, where closed- and open-ended questions were developed to solicit respondents' opinions concerning the major causes of risks during construction projects and the detrimental effect on project parameters.

The following section provides a comparative discussion concerning open-ended and closed-ended questions and how both approaches have been adopted in the design of the questionnaire.

3.4.3 Open-Ended

According to Kumar and Phrommathed (2005:175), open-ended questions are questions that are asked without providing a precise guide to possible answers, because this form of question is usually designed with the respondents' undiluted opinions in mind. Hopkins (2014:132) affirms that the validity and reliability of the research may be ascertained through the use of open-ended questions. In addition, Pietersen and Maree (2007b:225) and Leedy and Ormrod (2010:215) highlight the following as the merits and demerits of open-ended questions:

Merits of using open-ended questions

- The survey participants are able to respond to questions honestly with the assurance of remaining anonymous.
- The views of respondents are revealed.
- Complex questions are duly answered with detailed justification.

Demerits of using open-ended questions

- The coding of data tends to be difficult.
- It requires a great deal of time for respondents to complete (thinking and writing).
- Due to the unstructured nature of the questions, respondents' answers may vary significantly in terms of content.
- The use of statistical tools for analysing open-ended data has been proven to be a futile exercise.

3.4.4 Closed Questions

Kumar (2005:176) describes closed-ended questions as questions that delineate possible responses in questionnaire design. Similarly, Pietersen and Maree (2007b:52) opine that closed-ended questionnaires provide a set of sequential questions, requesting the respondents to choose the most appropriate answers. Burns (1997:320) affirms that the use of closed-ended questions in research gives the researchers the benefits of obtaining sufficient information to reach a more generalisable conclusion. Closed-ended questions invoke the possibility of discouraging respondents who find none of the alternatives suitable, heightening the probability of inappropriate responses (Kumar & Phrommathed, 2005:176). Leedy and Ormrod (2010:218) identify the following as the benefits of closed-ended questions:

- The questions are succinct, precise and easy to answer.
- The coding of data and statistical analysis can be easily computed.

Although there are benefits associated with closed-ended questions, Pietersen and Maree (2007b: 52) argue that there are shortfalls associated with closed-ended questions as well, these include:

- The questionnaires are generally too lengthy.
- The answers are structured, hence considered very simple with no background details.

- There are limited options; hence the respondents' true views might not be represented on the questionnaire.
- Responding to the questions is too easy and answers given may at times mislead the researcher.

The research instrument for the survey was divided into different sections, with each section aimed at achieving a particular objective of the study. Section A, the background information, is the first section of the questionnaire. The information collected includes the gender, age, qualification, experience, organisation's role and the respondents' current position in the industry. The second section (section B) collected data with respect to the major causes of risks during construction projects. A five-point Likert scale question where 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, and 5 = Very critical was used to collect information regarding major causes of risks. Section C, the third section of the questionnaire, requested information about the effect of construction risks on project performance. A five-point Likert scale where 1 = Minor extent, 2 = Near minor extent, 3 = Some extent, 4 = Near major extent, and 5 = Major extent was used to collect information regarding the effect of construction risks on project performance. In Section D, perceptions of respondents were evaluated regarding the effective strategies for mitigating risks. A five-point scale where 1 = Not effective, 2 = Slightly effective, 3 = Somewhat effective, 4 = Effective, and 5 = Very effective, was adopted as well to collect information regarding effective strategy for mitigating risks.

3.5. Piloting the Questionnaire

A pilot test of a questionnaire survey is a process in which a researcher may revise or amend the survey instrument based on feedback from a group of individuals or experts in the area of study who evaluate the instrument (Creswell, 2011:390). Before administering the questionnaire to gather data, a pilot study for testing the questionnaire is usually conducted to reveal any weakness in the questionnaire (Kothari, 2002:17). A pilot study was undertaken on completion of the first draft of the questionnaire. It should be noted that the questionnaire was administered to ten (10) construction owners and managers selected from construction sites based in Cape Town. The aim was to check the clarity and validity of the questions. The responses helped to determine errors, and corrections were made before the final draft was sent to the larger research sample.

3.6 Population and Sample Size

O'Leary (2013: 120) defines population as the total unit of a particular class or group from which a sample is drawn. Bryman (2015:52) further describes a population as a collection of people or items considered for a research study, as the term population does not out-rightly refer to a group of people being considered for the study, but varies depending on the nature and field of study. Considering the large population size, an appropriate sampling method was adopted to determine the number of participants to be surveyed.

According to Flick (2011:34), the sample derived from any population in a research study is a minimised representation of the population. Nonetheless, for the purpose of result validity and generalisation in quantitative research, it is considered that the larger the sample size, the higher the possibility of achieving the aim of the research unbiased (O'Leary, 2013:120). The population of this study involves architects/designers, construction project managers, contractors, clients/owners, engineers, quantity surveyors, and risk management teams in the Western Cape. With regard to construction professionals, the list was extracted from the 2018 Professionals and Projects Register. It can be seen from Table 3.2 that 637 registered professionals formed the total population within the Western Cape. In addition, the population for contractors was obtained from the CIDB database for contractors. It is evident from Table 3.3 that 750 contractors registered between Grades 3 to 9 were used as the population. Therefore, the total population for the study amounted to 1387, as depicted in Table 3.4

Table 3.2: List of professionals in the Western Cape

List of professionals	No
Architects	324
Construction project managers	37
Engineers	148
Quantity surveyors	128
Total	637

(Source: Professions and projects register, eMagazine, 2018)

Table 3.3: List of contractors in the Western Cape registered with CIDB

Contractors - Grade	No
Grade 3	136
Grade 4	188
Grade 5	114
Grade 6	154
Grade 7	94
Grade 8	44
Grade 9	20
Total	750

(Source: CIDB official website, January 2018)

Table 3.4: List of combined professionals and contractors

Population	No
Professional	637
Contractors	750
Total	1387

3.6.1 Sampling Techniques

O'Leary (2013:141) describes the "process of selecting elements of a population to be included in research as sampling". This notion is corroborated by Pietersen (2007b:37) who explains the process as making a random selection from a population in order to derive a generalised finding from the entire population. It is important to note that how well a sample represents a population is dependent on the sampling design, sample size and sample frame (Leedy & Ormrod, 2010:182). Furthermore, Leedy and Ormrod (2010:182) explain that a sample frame is a set of people likely to be selected, depending on the sampling technique adopted. Therefore, this study employs a random sampling technique in selecting the construction professionals in the Western Cape. Lavrakas (2008:2) postulates that random sampling is a variety of selection methods that are used for selecting sample members by chance, but then based on a known probability selection. Lavrakas adds that in most agricultural, business and social science surveys, the selection of sample units or respondents is carried out based on random sampling techniques. The sample units may be persons, establishments, land points, or other units for analysis.

The technique of random sampling is a critical element to the overall survey research design. The researcher considered random sampling technique appropriate, due to the vast concentration of construction practitioners in the Western Cape Province and the fact that the province has been the second largest in terms of the volume of construction projects that have taken place in South Africa. To determine a suitable representative sample, the formula recommended by Czaja and Blair (2005) (cited in Ankrah, 2007:141; Akadiri, 2011) was used:

$$ss = \frac{z^2 \times p(1-p)}{c^2}$$

Where:

ss = sample size

z = standardised variable

p = percentage picking a choice, expressed as a decimal

c = confidence interval, expressed as a decimal

The sample size was calculated based on a given degree of accuracy. In this case, the worst case percentage picking choice of 50% was assumed, as suggested by Ankrah (2007:142), Akadiri, 2011 and Oyewobi (2014:112); and a 95% confidence level was also assumed, as in other studies with a significance level of α = 0.05; z = 1.96 at 95% confidence level; and a confidence interval (c) of ±10% was taken.

Considering the above parameters, the sample size was calculated as follows:

: $\mathrm{ss} = \frac{1.96^2 \times 0.5(1-0.5)}{0.1^2} = 96.04$

From the above computation, the required sample size for the questionnaire survey is 96 professionals. Nevertheless, this figure is required to generate a new sample size from the research population using the following formula, as suggested in Czaja and Blair (2005):

$$\text{New } ss = \frac{ss}{1 + \frac{ss - 1}{pop}}$$

Where:

pop = population

$$\text{New } ss = \frac{96.04}{1 + \frac{96.04 - 1}{1387}}$$

New *ss* = 89.88

From the foregoing calculations, the appropriate sample size is approximately 90 professionals. A study conducted by Takim, Akintoye and Kelly (2004) reveals that the response rate in a survey could range between 20 – 30%. Thus, in order to make provision for non-response, the sample size was adjusted accordingly. With this in mind, a suitable assumption of 30% in relation to the response rate was considered, and the appropriate sample size was derived as follows:

$$Survey\ ss = \frac{new\ ss}{response\ rate}$$

$$Survey\ ss = \frac{90}{0.3} = 300\ professionals$$

Based on the preceding calculation, it is worth noting that the survey sample size is approximately 300 construction professionals. A random sampling method was adopted to select 300 professionals from the population, and Table 3.5 depicts the number of construction professionals and contractors who constituted the sample size.

Table 3. 5: List of contractors and professionals surveyed in the Western Cape

Contractors and professionals	Total No	Sample	Percentage %
Architects	324	45	15.00
Construction project managers	37	30	10.00
Engineers	148	30	10.00
Quantity surveying	128	40	13.33
Grade 3	136	35	11.67
Grade 4	188	40	13.33
Grade 5	114	30	10.00
Grade 6	154	20	6.67
Grade 7	94	10	3.33
Grade 8	44	10	3.33
Grade 9	20	10	3.33
Total	1387	300	100%

3.7 Survey Administration

The research tool for the study was administered to the surveyed respondents through two different methods, namely web-based survey, and hand delivery. The responses were retrieved through the same method. A web-based survey was used concurrently, in order to ensure wider coverage of the survey to all the selected construction professionals and firms whose contact emails are provided on the professional register list and CIDB list of registered companies. The research utilised an online Google Form, which is an internet-mediated platform for data collection. Creswell (2009:149) supports the use of an internet-mediated platform for quantitative data collection, since it allows for a larger population to be considered at minimal cost and saves time. Also, the hand delivery of the study questionnaire was undertaken by the researcher. It should be noted that 250 questionnaires were sent via email and 50 questionnaires were distributed by hand. Two hundred and fifty (250) questionnaires were distributed via web-mail to the survey participants; though 40 of the distributed questionnaires bounced back and thus delivered mails only numbered 210. It should be highlighted that 40 out of 210 respondents willingly participated in the web survey. 50 questionnaires were delivered by hand, 20 were duly completed and returned. Overall, 60 questionnaires were collected, and the response rate was 23%.

3.8 Quantitative Data Analysis

Closed-ended questions constitute the quantitative empirical data, therefore, The Statistical Package for Social Scientists (SPSS) Version 25 was used to capture and compute relevant analyses of the data. A quantitative analysis is a syntax of mathematical operations utilised to investigate the properties of the data (Walliman, 2001:302). For the purpose of the study, quantitative data was analysed statistically using both descriptive and inferential statistics. Descriptive statistics measure the central tendency (mode, median and mean) and the dispersion (standard deviation). Inferential statistics was used to validate the data collected through the paired sample t-test, and the analysis of variance (ANOVA).

3.8.1 Descriptive Statistics

After the information has been collected and captured on a computer as numbers, called data or raw data, the analysis process usually starts with descriptive statistics (Maree, 2007:183). The term *descriptive statistics* is a collective name for a number of statistical methods used to organise and summarise data in a meaningful way (Maree, 2007:183). This serves to enhance the properties in a meaningful way. Descriptive statistics can be categorised into two methods of representing or describing data, namely graphical and numerical (Maree, 2007:183). The purpose of this statistical tool is to provide the characteristics of respondents, check the variables for any violation of the assumptions underlying the statistical techniques that were used to address specific research questions; and to have an overall and straightforward picture of a large amount of data (Henn, Weinstein & Foard, 2006:206; Struwig & Stead, 2007:158; Pallant, 2011:53). Descriptive statistics used in this study are frequency distribution and measurement of central tendency, such as mean and standard deviation.

According to Isotalo (2001:24), the sample mean of the variable is the sum of observed values in a data divided by the number of observations; it is the most commonly used arithmetic technique for measuring the central tendency for quantitative variables. Contrariwise, Isotalo (2001:34) posits that the sample standard deviation is the most frequently used measure of variability, although it is not as easily understood as ranges. It can be considered as a kind of average of the absolute deviations of observed values from the mean of the variable in question. Hence, the mean ranking was adopted in this study to evaluate the degree of importance of the major causes of risks in construction projects and the negative effect on project performance, as well as the importance of mitigation measures for minimising the causes of risk in construction projects.

3.8.2 Inferential Statistics

According to Simpeh (2013:49) inferential statistics use examples of observations to ascertain observations found in a study. This method of data analysis provides room for researchers to generalise the results obtained from a population within a given margin of error (Fox & Bayat, 2007:125). This implies that the application of inferential statistics gives room for the data obtained from descriptive statistics to be used to draw conclusions as regards the entire population (Fox & Bayat, 2007:125). Inferential statistics consists of statistics such as parametric and non-parametric (Struwig & Stead, 2001). The paired sample t-test and Analysis of variance (ANOVA) were used for comparing the mean ranking and establishing whether there was a significant difference or not in agreement of respondents concerning the respective factors.

3.8.3 Paired Sample T-test

According to Maree (2007:183), the paired sample t-test is a technique that can be used:

- When comparing two independent groups based on their mean score on a quantitative variable;
- When comparing the mean scores on two quantitative variables in a single sample, and
- When comparing the mean of a quantitative variable with a specified constant value in a single sample.

3.8.4 Analysis of Variance (ANOVA)

Maree (2007:183) states that the analysis of variance technique is an inferential statistical tool adopted for comparing the means or averages for more than two independent groups on a single quantitative measure or score. Specifically, it tests whether the groups have different mean scores. ANOVA is adjudged to be suitable if the quantitative variable is normally distributed in each population; that is, the spread (variance) of the variable is the same in all populations. Table 3.6 provides a summary of hypotheses to be tested.

Table 3.6: Test of hypotheses

Hypothesis	Variables	Analysis
Hypothesis 1 Hypothesis 2	5-point Likert scale on major causes of risks during construction and construction participants' perception	Mean ranking Paired-samples t-test ANOVA
Hypothesis 3	5-point Likert scale on the detrimental effect of risks on project performance and the perception of construction professionals	Mean ranking ANOVA
Hypothesis 4 Hypothesis 5	5-point Likert scale on the effective strategy for mitigating risks and the perception of construction professionals	Mean ranking Paired-samples t-test ANOVA

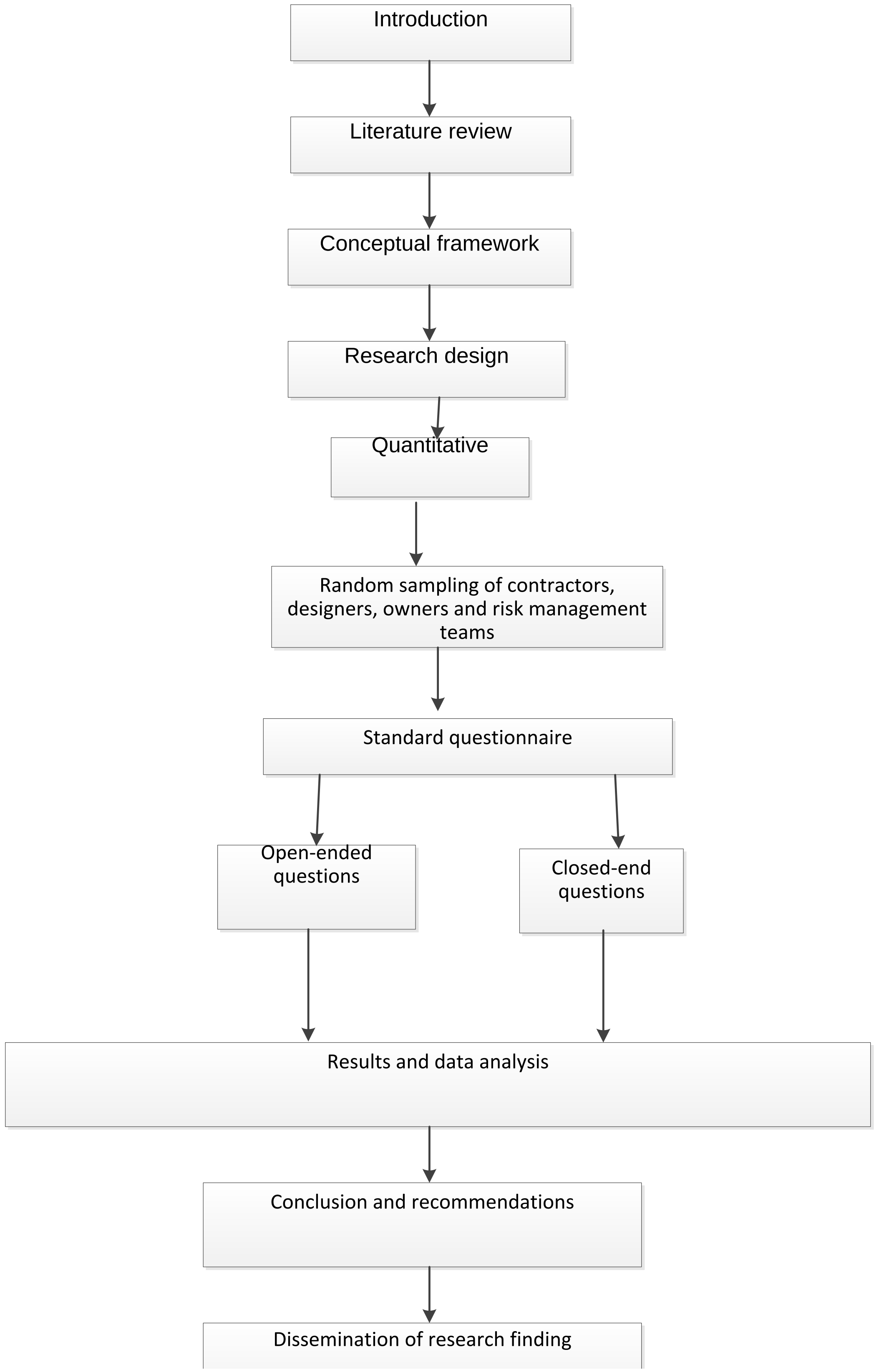

Figure 3.1: Research flowchart

3.9 Validity and Reliability

Polit and Hungler (2001) contend that there is a clear distinction between reliability and validity. According to the authors, reliability refers to the stability of the data over time and over conditions. A dependable research study should be accurate and consistent. Reliable data is dependable, trustworthy, unfailing, authentic and reputable; hence consistency is the main measure of reliability. In contrast, validity refers to the accuracy of the data. Validity exists when the research findings reflect the opinions of the population under study. Validity is important in qualitative research, as researchers are able to demonstrate the reality of the participants through detailed description of the discussion (Polit & Hungler, 2001).

3.9.1 Validity

Lakshmi and Mohideen (2013:2752) consider two essential components of validity as internal and external validity. Internal validity addresses whether the results of the study are legitimate because of the way the samples were selected, data was gathered and analysis performed. External validity explores whether the results are transferable to other populations of interest. In order to address these two essential components, the researcher ensured that both internal and external validity, based on the inferences made from the measuring instrument, were appropriate, meaningful, and useful (Lakshmi & Mohideen, 2013:2754). A measure is valid if it measures what it is supposed to measure cleanly.

3.9.2 Reliability

Reliability is the degree to which measures are free from error and yield consistency. According to Lakshmi and Mohideen (2013:2752), reliability is a common threat to internal validity. They further explain that reliability is often at risk when assessments are taken over time, are carried out by different people and are highly subjective. Lakshmi and Mohideen (2013:2753) list different ways of measuring consistency or homogeneity, the split-half method, the alternate-form method and Cronbach’s alpha method:

(i) *Split-half method:* measures the degree of internal consistency by checking half the result and comparing it against the other half (it demands equal item representation against the two halves) (Lakshmi & Mohideen, 2013:2753).

(ii) *Alternate-form method:* this is used to correlate measures between alternatives which are as equivalent as possible, and it is administered in the same group of subjects, such as the technique of creating a make-up exam because students already know the earlier exams (equivalent/alternative form) (Lakshmi & Mohideen, 2013:2753).

(iii) *Cronbach's coefficient alpha:* according to Lakshmi and Mohideen (2013:2754), this is the coefficient alpha method and the most commonly method adopted for attaining consistent reliability. Cronbach's alpha is the average of all possible split-half estimates which measures inter-item reliability or degree to which items measuring variables attain constant results. The coefficient varies from 0 to 1; a value of 0.6 or less is considered unsatisfactory, while values ranging between 0.7 to 0.8 are acceptable. For the purpose of the research study, the internal reliability is tested on scales questions using Cronbach's coefficient alpha and the cut-off point of 0.6 is unreliable (Lakshmi & Mohideen, 2013:2753).

3.10 Ethical Considerations

- This study was carried out according to the Cape Peninsula University of Technology (CPUT) postgraduate guidelines with respect to research and other policies of the University relevant to the study, and also in compliance with internationally-accepted standards.
- The names of the participant organisations and individuals were not recorded on the study instruments, and no compensation was paid to any respondent or participant in the study.
- Quality assurance was carried out with regard to correctness and completeness of questionnaires.

3.11 Summary

The research design and methodology were discussed in this chapter. The population size, research location, data collection, and analysis methods that were utilised have been discussed. The researcher applied the quantitative method in order to achieve the aim and objectives of the study. The geographical area of the research was the Western Cape Province of South Africa, hence, only construction professionals and contracting firms based in the Cape Peninsula area were surveyed. The survey participants included designers, contractors, owners and risk management teams. The total sample size for this study was estimated to be 300 construction professionals comprised of contractors registered with the CIDB and consultant team members such as engineers, designers, contractors, owners and risk management teams. A questionnaire survey was judged to be the most suitable technique for collecting data, aided by utilising random sampling in selecting the participants for the study. This chapter also discussed issues related to ethics, reliability and validity. The next chapter presents and discusses the results of the study.

CHAPTER FOUR: DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents the analysis of data elicited from the questionnaire administered. The chapter describes the response rate of the questionnaire survey and the information provided by the respondents. It also provides a systematic discussion of the findings obtained from the survey, which allows the researcher to draw conclusions and make some recommendations. The results of the statistical analysis were interpreted using SPSS version 25.

4.2 Response Rate for the Survey

The data was collected via a survey from a total of 300 questionnaires distributed to respondents based in the Cape Peninsula area of the Western Cape Province. The survey participants were construction professionals (architects, consulting engineers, quantity surveyors and project managers) and construction firms in the general building category with a grade ranging from 3 to 9. Both webmail and hand delivery method was adopted to distribute the survey instrument. It should be noted that 250 questionnaires were sent via e-mail, but only 210 were delivered, whilst 50 questionnaires were hand-delivered. Overall, 60 questionnaires were retrieved, and the response rate was 23%.

4.3 Research Participation

In the first section of the questionnaire, the respondents' general information was collected. The information related to gender, years of experience and level of education from the completed questionnaires was analysed.

4.3.1 Respondents' Gender

Table 4.1 presents the gender of the respondents of the survey. It is shown that the sample was made up of 11.7% females and 88.3% males. While both genders were represented in the survey; the higher percentage of male respondents indicates the norm of higher participation ratio of males in the construction industry.

Table 4.1: Gender of respondents

Gender	Frequency	Percentage
Female	7	11.7
Male	53	88.3
Total	60	100.0

4.3.2 Age Group

Table 4.2 depicts the age groups of the survey respondents. It is evident that 3.3% of the respondents were below the age of twenty-five. The age group between twenty-five to thirty years made up 21.7% of the study participants. The highest percentage of respondents fell between the ages of thirty-one and forty, representing 28.3% of the total respondents. The age group between forty-one to fifty made up 23.3% of the study participants. The age group between fifty-one to sixty years made up 10% of the study participants. The table indicates that 86.7% of survey respondents were not older than sixty years of age, while 13.3% of the respondents were above sixty years of age, suggesting that most of the respondents were middle-aged.

Table 4.2: Age group of respondents

Age of respondents	Frequency	Percentage
Under 25	2	3.3
25 - 30 years	13	21.7
31 - 40 years	17	28.3
41 - 50 years	14	23.3
51 - 60 years	6	10.0
Over 60 years	8	13.3
Total	60	100.0

4.3.3 Highest Formal Qualifications

Table 4.3 presents the educational qualifications obtained by the study participants. The analysis shows that 33.3% of the respondents hold bachelor’s degrees as their highest educational qualification, 31.7% hold diploma certificates, 20% hold master’s degrees, 6.7% hold honours degrees, 5% also hold postgraduate diplomas, 1.7% hold Matric certificates, and

1.7% hold other qualifications. This suggests that the survey respondents are educated and qualified to provide reliable information for the study.

Table 4.3: Highest formal qualifications

Type of qualifications	Frequency	Percentage
Matric certificate	1	1.7
Diploma	19	31.7
Bachelor's degree	20	33.3
Honours degree	4	6.7
Postgraduate diploma	3	5.0
Master's degree	12	20.0
Other	1	1.7
Total	60	100.0

4.3.4 Working Experience of Respondents

Table 4.4 outlines the work experience of the survey participants in the construction sector. The descriptive analysis discloses that respondents with less than 5 years' work experience in the construction industry represented 25% of the total respondents. Respondents having five to ten years' construction work experience represented 16.7% of the total, while 58.3% of the respondents had been working in the construction sector for more than ten years. The years of experience of respondents were sufficient to achieve the purpose of the study, as a significant 58.3% of the study respondents had more than ten years of work experience in the construction industry. This is not to suggest that the input and work experiences of the respondents working only between 1-5 years is not significant this research.

Table 4.4: Working experience of respondents

Years of working experience	Frequency	Percentage
Less than 5 years	15	25.0
5 – 10	10	16.7
Over 10 years	35	58.3
Total	60	100.0

4.3.5 Participants' Companies

The results in Table 4.5 present the characteristics of the respondents from different work divisions, professions and companies. The information obtained was from both the private and public sector of the construction industry, with 10% of the respondents from architectural firms; 25% of respondents from construction firms; 8.3% from quantity surveying firms; 23.3% from project management firms; 13.3% from engineering firms; and other firms making up 20%. From this result, it is evident that most respondents were contractors.

Table 4.5: Participants' companies

Participants' companies	Frequency	Percentage
Architect	6	10.0
Contractor	15	25.0
Quantity surveyor	5	8.3
Project manager	14	23.3
Engineering (civil, electrical, mechanical)	8	13.3
Other	12	20.0
Total	60	100.0

4.3.6 Profession of the Respondents in their Organisations

Table 4.6 presents the positions held by the survey participants. The largest group of respondents (45%) were managers, followed by directors, which represented 18.3%. Technicians made up 8.3%; site agents 5%; 5% were plans examiners; engineers 5%, executive chairmen 3.3%; and junior QS, store designer, consultant, principal architect, CEO, and superintendent, were 1.7%. This result indicates that the respondents surveyed represent a broad spectrum of different professions across the built environment.

Table 4.6: Profession of the respondents in their organisations

Position	Frequency	Percentage
Technician	5	8.3
Junior Q S	1	1.7
Site Agent	3	5.0
Store designer	1	1.7
Plans examiner	3	5.0
Manager	27	45.0
Director	11	18.3
Engineer	3	5.0
Consultant	1	1.7
Executive chairman	2	3.3
Principal architect	1	1.7
CEO	1	1.7
Superintendent	1	1.7
Total	60	100

4.3.7 Organisation's Operation

The results in Table 4.7 present the operation of the organisation where the participants work. The information obtained was from both the private and public sector of the construction industry. It is important to note that 63.3% of the participants operate in the building construction industry, 6.67% in the road construction sector, bridge construction was 1.7%, industrial construction was 10%, while the remaining 18.3% operate in other industry, including petrochemical construction regulators, high voltage power and consulting high voltage.

Table 4.7: Organisation's operation

Organisation's operation	Frequency	Percentage
Building construction	38	63.3
Road construction	4	6.67
Bridge construction	1	1.7
Industrial construction	6	10.0
Other	11	18.3
Total	60	100.0

4.4 Presentation of Findings

In presenting the survey findings, each research question was presented in sections and subsections. The findings were presented in tables, using SPSS to generate the mean value and standard deviation for ranking. Accordingly, the three sections of the questionnaire relating to the major causes of risks during construction project, effect of construction risks on project performance and effective strategies for mitigating risks, including their different subsections were presented.

4.4.1 Interpretation of the Results

The following 5-point scale was adopted with each number indicating the following:

- 1 = Not critical at all;
- 2 = Slightly critical;
- 3 = Somewhat critical;
- 4 = Critical; and
- 5 = Very critical.

In order to describe the statistics for the not critical/very critical scale, the following ranges and terms will be used to discuss the mean scores:

- Not critical at all to slightly critical, with the statement: ≥ 1.00 to ≤ 1.80
- Not critical at all to slightly critical/slightly critical with the statement: > 1.80 to ≤ 2.60
- Slightly critical to somewhat critical/somewhat critical: > 2.60 to ≤ 3.40
- Somewhat critical to critical/critical, with the statement: > 3.40 to ≤ 4.20
- Critical to very critical/very critical, with the statement: > 4.20 to ≤ 5.00

The following 5-point scale was adopted with each number indicating the following:

- 1 = Minor extent
- 2 = Near minor extent
- 3 = Some extent
- 4 = Near major extent, and
- 5 = Major extent.

The following ranges and terms will be used to discuss the mean scores for the minor/major extent scale:

- Minor to near minor extent: ≥ 1.00 to ≤ 1.80
- Minor to a near minor/near minor extent: > 1.80 to ≤ 2.60
- Near minor extent to some extent/some extent: > 2.60 to ≤ 3.40

- Some extent to a near major/near major extent: > 3.40 to ≤ 4.20
- Near major extent to major/major extent: > 4.20 to ≤ 5.00

The following 5-point scale was adopted with each number indicating the following:

- 1 = Not effective
- 2 = Slightly effective
- 3 = Somewhat effective
- 4 = Effective, and
- 5 = Very effective.

The following ranges and terms will be used to discuss the mean scores for the not effective/very effective scale:

- Not effective to slightly effective: ≥ 1.00 to ≤ 1.80
- Not effective to slightly effective/slightly effective: > 1.80 to ≤ 2.60
- Slightly effective to somewhat effective/somewhat effective: > 2.60 to ≤ 3.40
- Somewhat effective to effective/effective > 3.40 to ≤ 4.20
- Effective to very effective/very effective: > 4.20 to ≤ 5.00

4.4.2 Major Causes of Risks during Construction Project

One of the objectives of this research study is to identify the major causes of risks in construction project. To achieve this objective, the need to evaluate the level of contribution of various risk factors in construction project is essential. In the descriptive analysis, major risks associated with construction projects were explored in terms of design-related, environmental, project management-related, construction-related, finance-related, socio-political and right of way to help find ways and solutions to mitigate the impact of risk on project performance.

Design-Related Risk

This section evaluated the extent of contribution of design-related factors as major causes of risks during construction project; where U = Unsure, 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical, and a mean value (MV) ranging between 1.00 to 5.00. It is notable from Table 4.8 that all the MVs are > 3.00, which indicates that generally design-related factors may be very critical in contributing to the major causes of risk during construction projects.

Furthermore, Table 4.8 shows that design errors and omissions in drawings had the highest ranking, with a MV = 4.25. The MV indicates that respondent extent of agreement, can be considered to be between critical to very critical/very critical, since the MV > 4.20 to ≤ 5.00. Incomplete design had the second highest ranking, with MV = 4.12, and late design changes requested by the client had the third highest ranking, with MV = 3.88. Evidently, the survey participants' level of consensus may be estimated to be between somewhat critical to critical/critical since the MVs are > 3.40 to ≤ 4.20. The level of contribution of design-related risk factors to major causes of risks had an average mean value (AMV) = 3.71.

Table 4.8: Design-related factors as major causes of risks during construction

Design-related risk	Unsure	Response (%) Not critical……………………………Very critical					MV	SD	Rank
		1	2	3	4	5			
Design errors and omissions in drawings	5.0	1.7	3.3	8.3	16.7	65.0	4.25	1.34	1
Incomplete design	6.7	1.7	3.3	11.7	15.0	61.7	4.12	1.45	2
Late design changes requested by the client	5.0	3.3	1.7	16.7	35.0	38.3	3.88	1.32	3
Design process takes longer than anticipated	5.0	3.3	10.0	21.7	21.7	38.3	3.67	1.42	4
Late design changes requested by the municipality	6.7	3.3	15.0	13.3	28.3	33.3	3.53	1.50	5
Changes from other parties (e.g. engineers)	6.7	5.0	13.3	23.3	28.3	23.3	3.32	1.44	6
Late design changes requested by the contractor	6.7	10.0	16.7	11.7	33.3	21.7	3.20	1.54	7
Average mean value	3.71								

Environment-Related risk

Respondents were asked to rate the level of contribution of environment-related risks as major causes of risks during construction project; where U = Unsure, 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical, and a mean value (MV) ranging between 1.00 to 5.00. It should be noted that 3/5 (60%) factors' MVs are > 3.00, which indicates that generally the risk factors were seen as significant in contributing to poor project performance. Table 4.9 shows that incomplete environmental analysis had the highest ranking with MV = 3.63, however, the level of contribution according to the respondents can be deemed to be between somewhat critical to critical/critical since the MV is > 3.40 to ≤ 4. 20. Stringent regulation having an impact on construction firms' poor attention to environmental issues had the second highest ranking, with MV = 3.28, and new alternatives required to avoid, mitigate or minimise environmental impact had the third highest ranking, with MV = 3.10, this indicates that the degree of contribution of these risk factors can be deemed to be between slightly critical to somewhat critical/somewhat critical since the MVs are > 2.60 to ≤ 3.40. Overall, the level of contribution of environment-related risk factors to major causes of risks can be deemed to be between slightly critical to somewhat critical/somewhat critical, since the AMV = 3.15.

Table 4.9: Environment-related factors as major causes of risks during construction

Environment-related	**Unsure**	**Response (%)** Not critical……………………….Very critical					**MV**	**SD**	**Rank**
		1	**2**	**3**	**4**	**5**			
Environmental analysis incomplete	5.0	8.3	5.0	20.0	23.3	38.3	3.63	1.50	1
Stringent regulation having an impact on construction firms' poor attention to environmental issues	5.0	6.7	15.0	20.0	35.0	18.3	3.28	1.38	2
New alternatives required to avoid, mitigate or minimise environmental impact	5.0	13.3	11.7	28.3	20.0	21.7	3.10	1.48	3
Force Majeure: such as natural disasters	6.7	25.0	15.0	10.0	10.0	33.3	2.92	1.80	4
Weather and seasonal implications	6.7	11.7	21.7	28.3	16.7	15.0	2.82	1.43	5
Average mean value	3.15								

Project Management-Related Risk

Respondents were asked to rate the level of contribution of environment-related risk to major causes of risks during construction project; where U = Unsure, 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical, and a mean value (MV) ranging between 1.00 to 5.00. It is evident from Table 4.10 that all the MVs are > 3.00, which indicates that in general the level of contribution of project management-related factors as major causes of risk during construction projects are very critical as opposed to not critical. The hierarchy of the descriptive analysis shows that inadequate project planning had the highest ranking with MV = 4.13, inadequate project budgeting had the second highest ranking with MV = 4.02 and incompetence of local project team members had the third highest ranking with MV = 3.92. The results indicate that respondents' degree of concurrence that inadequate project planning, inadequate project budgeting, and incompetence of local project team members are major causes of project management –related risks can be deemed to be between somewhat critical to critical/critical since the MVs are > 3.40 to ≤ 4.20. Overall, the level of contribution of project management-related risk factors to major causes of risks can be considered to be between somewhat critical to critical/critical since the AMV = 3.84.

Table 4.10: Project management-related factors as major causes of risks during construction

Project management-related	Unsure	Response (%) Not critical……………………………Very critical					MV	SD	Rank
		1	2	3	4	5			
Inadequate project planning	5.0	3.3	3.3	5.0	28.3	55.0	4.13	1.36	1
Inadequate project budgeting	5.0	5.0	3.3	11.7	20.0	55.0	4.02	1.44	2
Scheduling errors/ill planned schedule	5.0	3.3	5.0	10.0	35.0	41.7	3.92	1.36	3
Incompetence of local project team members	5.0	1.7	11.7	11.7	18.3	51.7	3.92	1.44	4
Failure to comply with contractual quality requirements	5.0	1.7	11.7	16.7	28.3	36.7	3.72	1.38	5
Project team conflicts	5.0	6.7	3.3	25.0	28.3	31.7	3.60	1.40	6
Inadequately defined roles and responsibilities	5.0	6.7	8.3	15.0	35.0	30.0	3.58	1.43	7
Average mean value	3.84								

Construction-Related Risk

This sub-section examined the level of contribution of construction-related risk to major causes of risks during construction project; where U = Unsure, 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical, and a mean value (MV) ranging between 1.00 to 5.00. It is notable from Table 4.11 that 8 out of 10 (80%) MVs are > 3.00, which indicates that these construction-related factors may be critical in contributing to the major causes of risk during construction project. The hierarchy of the descriptive analysis shows that unavailability of sufficient cash flow had the highest ranking, with MV = 3.93. Non-availability of resources and late deliveries had the second highest ranking, with MV = 3.90. Inadequate contractor's experience was the third highest, with MV = 3.83. The results indicate that respondents' degree of concurrence that unavailability of sufficient cash flow, non-availability of resources and late deliveries, and inadequate contractor's experience are major causes of construction–related risks can be deemed to be between somewhat critical to critical/critical since the MVs are > 3.40 to ≤ 4.20. Overall, the level of contribution of construction-related risk factors to major causes of risks can be considered to be between somewhat critical to critical/critical since the AMV = 3.52.

Table 4.11: Construction-related factors as major causes of risks during construction

Construction-related	Unsure	Response (%) Not critical……………………………Very critical					MV	SD	Rank
		1	2	3	4	5			
Unavailability of sufficient cash flow	5.0	5.0	3.3	15.0	21.7	50.0	3.93	1.44	1
Non-availability of resources and late deliveries	6.7	3.3	5.0	5.0	38.3	41.7	3.90	1.43	2
Inadequate contractor's experience	6.7	3.3	6.7	16.7	16.7	50.0	3.83	1.52	3
Low labour productivity of local workforce	5.0	3.3	8.3	18.3	31.7	33.3	3.68	1.37	4
Changes in project scope and requirements	5.0	6.7	3.3	20.0	35.0	30.0	3.63	1.39	5
Inadequate safety measures in place for workers	6.7	8.3	13.3	13.3	21.7	36.7	3.45	1.61	6
Lack of protection on a construction site	6.7	6.7	11.7	18.3	26.7	30.0	3.42	1.52	7
Disputes between labour force on site	6.7	3.3	8.3	28.3	31.7	21.7	3.40	1.37	8
Changing sequences in construction activity	6.7	13.3	8.3	31.7	25.0	15.0	3.00	1.45	9
Technology changes/new technology	5.0	8.3	23.3	26.7	26.7	10.0	2.92	1.31	10
Average mean value	3.52								

Finance-Related Risk

The survey participants were requested to indicate the degree of contribution of finance-related risk to major causes of risks during construction project on a five point Likert scale; where U = Unsure, 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical, and a mean value (MV) ranging between 1.00 to 5.00. It is notable from Table 4.12 that 3/6 (50%) of the MVs are > 3.00, which indicates that generally these finance-related factors may be slightly critical in contributing to the major causes of risk during construction project. The hierarchy of the descriptive analysis shows that delay in payments from clients had the highest ranking, with MV = 3.89. Unprecedented increase in prices of raw materials had the second highest ranking, with MV = 3.42. Fluctuations in estimated finance had the third highest, with MV = 3.27. Given that the MVs for the first and second ranked factors are > 3.40 to ≤ 4.20, respondents' concurrence is deemed to be between somewhat critical to critical/critical. On the other hand, respondents' degree of concurrence is considered to be between slightly critical to somewhat critical/somewhat critical for the third ranked factor, since the MV is > 2.60 to ≤ 3.40.

Overall, the level of contribution of finance-related risk factors to major causes of risks can be considered to be between somewhat critical to critical/critical since the AMV = 3.64.

Table 4.12: Finance-related factors as major causes of risks during construction

Finance-related	Unsure	Response (%) Not critical……………………………Very critical					MV	SD	Rank
		1	2	3	4	5			
Delay in payments from clients	5.0	3.3	6.7	16.7	20.0	48.3	3.89	1.43	1
Unprecedented increase in prices of raw materials	6.7	6.7	5.0	25.0	33.3	23.3	3.42	1.43	2
Fluctuations in estimated finance	6.7	6.7	6.7	30.0	33.3	16.7	3.27	1.38	3
Availability and fluctuation in foreign exchange	8.3	8.3	15.0	30.0	35.0	3.3	2.85	1.31	4
Unanticipated increase in interest rate	8.3	6.7	21.7	30.0	23.3	10.0	2.83	1.37	5
Unanticipated increase in local taxes	10.0	13.3	15.0	28.3	25.0	8.3	2.70	1.45	6
Average mean value	3.64								

Socio-Political-Related

The participants of the survey were requested to indicate the level of influence of socio-political-related risk to major causes of risks during construction project; where U = Unsure, 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical, and a mean value (MV) ranging between 1.00 to 5.00. It is notable from Table 4.13 that 4/6 (67%) of the MVs are > 3.00, which indicates that generally socio-political-related factors may be slightly critical in contributing to the major causes of risk during construction project. The hierarchy of the descriptive analysis shows that labour strikes and disputes due to union issues had the highest ranking, with MV = 3.75. Excessive influence by government on court proceedings regarding construction project disputes had the second highest ranking, with MV = 3.25. Governments' inconsistent application of new regulations and laws had the third highest, with MV = 3.05. Given that the MVs for the labour strikes and disputes due to union issues is > 3.40 to ≤ 4.20, respondents' concurrence is deemed to be between somewhat critical to critical/critical. On the other hand, respondents' degree of concurrence is considered to be between slightly critical to somewhat critical/somewhat critical for excessive influence by government on court proceedings regarding construction project disputes, and governments' inconsistent application of new regulations and laws since the MV is > 2.60 to ≤ 3.40. Overall, the level of contribution of socio-political-related risk factors to major causes of risks can be considered to be between slightly critical to somewhat critical/somewhat critical since the AMV = 3.16.

Table 4.13: Socio-political-related factors as major causes of risks during construction

Socio-political-related	Unsure	Response (%) Not critical…………………………Very critical					MV	SD	Rank
		1	2	3	4	5			
Labour strikes and disputes due to union issues	6.7	0.0	11.7	16.7	23.3	41.7	3.75	1.45	1
Excessive influence by government on court proceedings regarding construction project disputes	11.7	6.7	8.3	20.0	25.0	28.3	3.25	1.66	2
Constraints on the availability and employment of expatriate staff	8.3	8.3	16.7	15.0	40.0	11.7	3.05	1.47	3
Governments' inconsistent application of new regulations and laws	10.0	8.3	15.0	25.0	16.7	25.0	3.05	1.61	4
Insistence on use of local firms and agents	6.7	6.7	28.3	15.0	25.0	18.3	3.0	1.47	5
Customs and import restrictions and procedures	10	13.3	15.0	21.7	25.0	15.0	2.83	1.56	6
Average mean value	3.16								

Right of Way-Related

This section examined the degree of contribution of right of way-related risk to major causes of risks during construction project; where U = Unsure, 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical, and a mean value (MV) ranging between 1.00 to 5.00. It is noticeable from Table 4.14 that 2/12 (17%) of the MVs are > 3.00, which indicates that generally right of way-related factors may be considered as slightly critical in contributing to the major causes of risk during construction projects. The hierarchy of the descriptive analysis shows that need for "permits to enter" not considered in project schedule development had the highest ranking, with MV = 3.27. Discovery of hazardous waste in the right of way phase had the second highest ranking, with MV = 3.07. Right of way datasheet incomplete or underestimated had the third highest with MV = 3.00. Given that the MVs for need for "permits to enter" not considered in project schedule development is > 2.60 to ≤ 3.40, respondents' concurrence is deemed to be between slightly critical to somewhat critical/somewhat critical. Concerning the second ranked factor, discovery of hazardous waste in the right of way phase, and the third ranked factor, right of way datasheet incomplete or underestimated, respondents' degree of concurrence is considered to be between slightly critical to somewhat critical/somewhat critical since the MVs are> 2.60 to ≤ 3.40. Overall, the level of contribution of right of way-related risk factors to major causes of risks can be considered to be between slightly critical to somewhat critical/somewhat critical since the AMV = 2.91.

Table 4.14: Right of Way-related factors as major causes of risks during construction

Right of Way-related	Unsure	Response (%) Not critical……………………………Very critical					MV	SD	Rank
		1	2	3	4	5			
Need for "permits to enter" not considered in project schedule development	6.7	11.7	5.0	23.3	28.3	23.3	3.27	1.53	1
Discovery of hazardous waste in the right of way phase	8.3	18.3	1.7	16.7	36.7	16.7	3.07	1.62	2
Right of way datasheet incomplete or underestimated	8.3	10.0	11.7	25.0	30.0	13.3	3.00	1.47	3
Expired temporary construction easements	8.3	10.0	11.7	28.3	31.7	8.3	2.92	1.41	4
Unforeseen railroad involvement	8.3	18.3	5.0	30.0	18.3	20.0	2.92	1.60	5
Condemnation process takes longer than anticipated	10.0	11.7	5.0	36.7	21.7	13.3	2.90	1.49	6
Resolving objections to right of way appraisal takes more time and/or money	8.3	13.3	10.0	26.7	33.3	8.3	2.88	1.44	7
Utility relocation requires more time than planned	6.7	8.3	20.0	33.3	20.0	11.7	2.87	1.35	8
Inadequate pool of expert witnesses or qualified appraisers	11.7	13.3	10.0	20.0	30.0	13.3	2.85	1.61	9
Acquisition of parcels controlled by a state or federal agency may take longer than anticipated	16.7	6.7	8.3	23.3	30.0	13.3	2.85	1.66	10
Utility company workload, financial condition or timeline	10.0	10.0	15.0	26.7	30.0	6.7	2.78	1.43	11
Seasonal requirements during utility relocation	10.0	18.3	13.3	21.7	26.7	8.3	2.63	1.52	12
Average mean value	2.91								

4.4.3 Effect of Construction Risks on Project and Organisational Performance

Project Performance

Respondents were asked to rate the level of contribution of the effect of construction risks on project performance; where U = Unsure, 1 = Minor extent, 2 = Near minor extent, 3 = Some extent, 4 = Near major extent, and 5 = Major extent, and MV ranging between 1.00 and 5.00. In Table 4.15, it is evident that all the MVs are greater than 3.00; generally, the findings imply that the survey participants can be deemed to observe that risk associated with construction projects may contribute in a serious way poor project performance. With regard to the mean rankings, cost overrun had the highest ranking, with MV = 4.50, quality degradation had the second highest ranking, with MV = 4.26, time overrun had the third highest ranking, with MV = 4.22, and the fourth ranked factor was low productivity on site, with MV = 4.20. The MVs of the top three ranked factors indicate that the respondents' degree of concurrence can be deemed to between a near major extent to major/major extent, since the MVs are > 4.20 to ≤ 5.00. Health and safety had MV = 3.87 and ranked fifth, whilst the impact of the environment on project performance was ranked sixth with a MV = 3.65. The extent of negative impact of these factors on project performance can be considered to be between some extent to a near major extent/near major extent, since the MVs are > 3.40 to ≤ 4.20. Overall, the level of contribution of effect of construction risks on project performance is considered to be between some extent to a near major extent/near major extent, since the AMV = 4.12.

Table 4.15: Effect of construction risks on project performance

Project performance	**Unsure**	**Response (%) minor extent …………………… major extent**					**MV**	**SD**	**Rank**
		1	**2**	**3**	**4**	**5**			
Cost overrun	0.0	3.3	1.7	5.0	21.7	68.3	4.50	0.93	1
Quality degradation	1.7	0.0	8.3	8.3	20.0	56.7	4.26	1.13	2
Time overrun	0.0	1.7	3.3	15.0	31.7	48.3	4.22	0.94	3
Productivity	0.0	1.7	6.7	10.0	33.3	48.3	4.20	0.99	4
Health and safety	0.0	3.3	8.3	28.3	18.3	41.7	3.87	1.16	5
Environment	0.0	11.7	6.7	20.0	28.3	33.3	3.65	1.33	6
Average mean value	4.12								

Organisational Performance

Respondents were asked to rate the level of contribution of effect of construction risks on organisational performance; where U = Unsure, 1 = Minor extent, 2 = Near minor extent, 3 = Some extent, 4 = Near major extent, 5 = Major extent, and MV ranging between 1.00 and 5.00. In Table 4.16, it is evident that all the MVs are above the midpoint score of 3.00, which indicates that in general the respondents can be deemed to perceive that risk associated with construction project may contribute towards the major end of the scale to organisational performance. With regard to the mean rankings, disputes between parties to the contract had the highest ranking, with MV = 4.03. The customer/client dissatisfaction had the second highest ranking, with MV = 3.98. The loss of future work had the third highest ranking, with MV = 3.93.

Contractual claims had MV = 3.80 and ranked fourth, disruption of the project plan had MV = 3.55 and ranked fifth, inter-organisational conflict had MV = 3.52 and ranked sixth. The least ranked factor was reduced profit margin, with MV = 3.37. Respondents' concurrence to the first six factors can be considered to be between some extent to a near major extent/near major extent, since the MVs are > 3.40 to ≤ 4.20. On the other hand, the degree of concurrence for the seventh ranked, reduced profit margin can be considered to be between near minor extent to some extent/some extent, since the MV is > 2.60 to ≤ 3.40. Overall, the level of contribution of construction risks on organisational performance is considered to be between some extent to a near major extent/near major extent, since the AMV = 3.74.

Table 4.16: Effect of construction risks on project performance

Organisational performance	Unsure	Response (%) minor extent …………………… major extent					MV	SD	Rank
		1	2	3	4	5			
Disputes between parties to the contract	0.0	1.7	8.3	15.0	35.0	40.0	4.03	1.02	1
Customer/client dissatisfaction	1.7	3.3	5.0	21.7	21.7	46.7	3.98	1.21	2
Loss of future work	0.0	6.7	6.7	18.3	23.3	45.0	3.93	1.23	3
Contractual claims	0.0	3.3	6.7	30.0	26.7	33.3	3.80	1.09	4
Disrupt the project plan	1.7	8.3	8.3	25.0	28.3	28.3	3.55	1.31	5
Inter-organisational conflict	0.0	6.7	8.3	26.7	43.3	15.0	3.52	1.07	6
Reduced profit margin	3.3	5.0	11.7	28.3	35.0	16.7	3.37	1.23	7
Average mean value	3.74								

4.4.4 EFFECTIVE STRATEGY FOR MITIGATING RISKS

Design Strategy for Mitigating Risks

This section appraised respondents' perceptions with respect to the effectiveness of design strategy as a mitigation measure in reducing/preventing risk during construction projects to enhance project and organisational performance. The responses were evaluated using a 5-point Likert scale question where U = Unsure, 1 = Not effective, 2 = Slightly effective, 3 = Somewhat effective, 4 = Effective, and 5 = Very effective, and a MV ranging between 1.00 and 5.00. In Table 4.17, it is noteworthy that all the design strategies' MVs are above the midpoint of 3.00, indicating that in general, respondents tended to agree that all the strategies are effective in mitigating risk during the design phase of construction projects.

The hierarchical ranking of the means shows that 'arrange and undertake comprehensive site investigation before construction phase' had the highest ranking, with MV = 4.18, followed by ‘specify construction extension clause in contract’ with MV = 3.87. ‘Organise for appraisal/vetting of drawings and design criteria by at least one independent engineering/architectural consultant’ had the third highest ranking, with MV = 3.62, and the ‘introduction of adjustment clauses in contract to review plan and constructability’ had MV = 3.43 and ranked fourth. Therefore, the level of contribution of design strategies to mitigating risk during construction projects can be deemed to be between somewhat effective to effective/effective, since the MVs are > 3.40 to ≤ 4.20. Overall, the level of contribution of design strategies to mitigating risk in construction projects is considered to be between somewhat effective to effective/effective, as the AMV = 3.78.

Table 4.17: Design strategies for mitigating risk

Design strategy	Unsure	Response (%) Not effective………………… Very effective					MV	SD	Rank
		1	2	3	4	5			
Arrange and undertake comprehensive site investigation before construction phase	5.0	1.7	1.7	10.0	25.0	56.7	4.18	1.30	1
Specify construction extension clause in contract	5.0	3.3	5.0	11.7	36.7	38.3	3.87	1.35	2
Organise for appraisal/vetting of drawings and design criteria by at least one independent engineering/architectural consultant	6.7	5.0	5.0	18.3	33.3	31.7	3.62	1.45	3
Introduce adjustment clauses in contract to review plan and constructability	5.0	3.3	15.0	21.7	30.0	25.0	3.43	1.37	4
Average mean value	3.78								

Construction and Project Management Strategies for Mitigating Risks

Respondents were requested to indicate the effectiveness of construction and project management as mitigation measures in reducing/preventing risk during construction projects to enhance project and organisational performance. The responses were evaluated using a 5-point Likert scale question where U = Unsure, 1 = Not effective, 2 = Slightly effective, 3 = Somewhat effective, 4 = Effective, and 5 = Very effective, and a MV ranging between 1.00 and 5.00. In Table 4.18, it is noted that all the construction and project management strategies’ MVs are above the midpoint of 3.00, indicating that in general respondents tended to agree that all the factors are effective in mitigating risk during construction projects. The hierarchical ranking of the means shows that site quality management system had the highest ranking, with MV = 4.13.

Quality control had the second highest ranking, with MV = 4.10. Development of a proper risk management process and quality audits had the third highest ranking, with MV = 3.93. Development of a proper risk management process is ranked fourth, with MV = 3.93. Therefore, the level of contribution of construction and project management strategies to mitigating risk during construction projects can be deemed to be between somewhat effective to effective/effective, since the MVs are > 3.40 to ≤ 4.20. Overall, the level of contribution of construction and project management strategies to mitigating risk in construction projects is considered to be between somewhat effective to effective/effective as the AMV = 3.72.

Table 4.18: Construction and project management strategies for mitigating risk

Construction and project management	Unsure	Response (%) Not effective ……………………..Very effective					MV	SD	Rank
		1	2	3	4	5			
Site quality management system	5.0	1.7	3.3	8.3	28.3	53.3	4.13	1.31	1
Quality control	5.0	1.7	3.3	11.7	25.0	53.3	4.10	1.32	2
Quality audits	5.0	1.7	6.7	10.0	35.0	41.7	3.93	1.33	3
Development of a proper risk management process	0.0	1.0	2.0	3.0	4.0	5.0	3.93	1.42	4
Value engineering	8.3	1.7	6.7	10.0	25.0	48.3	3.87	1.53	5
Total reflection on the potential risks inherent with the project in tender documents	5.0	1.7	10.0	10.0	41.7	31.7	3.77	1.32	6
Adjudication of bids with senior management to assess the acceptability of various risks in tendering for a project	0.0	1.0	2.0	3.0	4.0	5.0	3.77	1.43	7
Select and commit the resources required for specific risk mitigation alternatives	0.0	6.7	8.3	20.0	31.7	33.3	3.72	1.20	8
Identify alternative mitigation strategies and tools for each major risk	5.0	6.7	8.3	15.0	23.3	41.7	3.70	1.50	9
Putting tags and conditions to risky price items or aspects of the tender bids	5.0	0.0	11.7	20.0	33.3	30.0	3.67	1.30	10
Characterise the root causes of risks that have been identified and quantified in earlier phases	1.7	10.0	5.0	20.0	33.3	30.0	3.63	1.33	11

of the risk management process									
Assess and prioritise mitigation alternatives	5.0	6.7	8.3	18.3	25.0	36.7	3.62	1.47	12
Evaluate risk interactions and common causes	0.0	13.3	6.7	20.0	28.3	31.7	3.58	1.36	13
Taking protective measures against risks such as liquidated damages	6.7	3.3	6.7	26.7	25.0	31.7	3.55	1.43	14
Lump sum adjustments to margin to cover identified risks	6.7	5.0	3.3	20.0	43.3	21.7	3.53	1.37	15
Transferring the risks onto other parties	6.7	1.7	8.3	30.0	26.7	26.7	3.48	1.37	16
Strategic withdrawal from the tendering by pricing non-competitively	0.0	1.0	2.0	3.0	4.0	5.0	3.30	1.63	17
Average mean value	3.72								

Financial Strategy

This section examined the survey participants' views regarding how effective financial strategies can be adopted as mitigation measures in reducing/preventing risk during construction projects to improve project and organisational performance. The responses were evaluated using a 5-point Likert scale question where U = Unsure, 1 = Not effective, 2 = Slightly effective, 3 = Somewhat effective, 4 = Effective, and 5 = Very effective, and a MV ranging between 1.00 and 5.00. In Table 4.19, it should be noted that all the financial strategies' MVs are above the midpoint of 3.00, indicating that generally respondents tended to agree that all the factors are perceived to be effective in mitigating risk during construction projects. The hierarchical ranking of the means shows that 'obtain assurances of ability to pay' had the highest ranking, with MV = 4.22. 'Execution plan and task list must be adhered to' had the second highest ranking with a MV = 4.05. 'Avoid assumption of design liability' had the third highest ranking with MV = 4.03. 'Observe corporate formalities' is ranked fourth, with MV = 3.40. Therefore, the level of contribution of finance-related strategies to mitigating risk during construction project can be deemed to be between somewhat effective to effective/effective, since the MVs are > 3.40 to ≤ 4.20. Overall, the level of contribution of financial strategies to mitigating risk in construction project is considered to be between somewhat effective to effective/effective as the AMV = 3.93.

Table 4.19: Financial strategies for mitigating risk

Financial strategy	Unsure	Response (%) Not effective ……………………..Very effective					MV	SD	Rank
		1	2	3	4	5			
Obtain assurances of ability to pay	5.0	0.0	5.0	6.7	25.0	58.3	4.22	1.28	1
Execution plan and task list must be adhered to	5.0	0.0	5.0	11.7	31.7	46.7	4.05	1.27	2
Avoid assumption of design liability	5.0	1.7	5.0	10.0	30.0	48.3	4.03	1.33	3
Observe corporate formalities	6.7	1.7	10.0	28.3	33.3	20.0	3.40	1.33	4
Average mean value	3.93								

4.5 Discussion of Findings

The findings of this survey were discussed in relation to the perspective of the primary data obtained from the respondents. Hence, this section will discuss the trend of the survey findings together with pertinent literature, and in connection with the research questions; the factors that contribute to major causes of risks during construction project, effect of construction risks on organisational and project performance, and the effective strategies for mitigating risks.

4.5.1 Causes of Risks During Construction Projects

The quantitative findings reveal that factors that contribute to the major causes of risk during construction projects are widespread within the South African construction industry, and these factors subsequently impact negatively on project and organisational performance. The hierarchical ranking of the average means for the major causes of risks, as depicted in Table 4.20, indicates that project management-related factors are the major cause of risks during construction projects, since the AMV = 3.84. The survey rated some of the key factors relating to project management as follows; inadequate project planning had the highest ranking, with MV = 4.13. This may imply that inadequate planning has a significant impact on project productivity. This is corroborated by Khalid (2019:1), who argues that poor planning and management of construction projects may incur several negative effects on the duration and completion of projects. Other project management-related factors that were revealed to be the causes of risk include inadequate project budgeting (MV = 4.02) and scheduling errors/ill planned schedule (MV = 3.92). These findings are in alignment with previous studies conducted by Odeyinka (2003:40) who reveals that inadequate project budgeting is considered a reason behind project failure or contractor insolvency.

Table 4. 20: Factors contributing to major causes of risks in construction project

Major causes of risks in construction project	Average MV	Rank
Project management-related risk	3.84	1
Design-related risk	3.71	2
Finance-related risk	3.64	3
Construction-related risk	3.52	4
Socio-Political-related risk	3.16	5
Environment-related risk	3.15	6
Right of Way-related Risk	2.91	7

Design-related factors are ranked second, with AMV= 3.71. The survey respondents rated some of the key factors relating to design-related risks. The first is design errors and omissions in drawings, with MV = 4.25. This finding is corroborated by Lopez *et al.* (2010:399) who opine that design errors and omissions are the major cause of accidents that result in the death and injury of workers and members of the public during construction. The second is incomplete design (MV = 4.12), which is consistent with the findings of Towner and Baccarini (2012:12) who identify incomplete design as one of the most significant risks during pricing of tenders. Furthermore, Towner and Baccarini (2012:17) contend that incomplete design is a well-known risk in construction projects, and contractors have very little control over it in a traditional procurement arrangement, but may have to bear the brunt of any financial consequences. The third ranked design-related factor is late design changes requested by the client (MV = 3.88). This finding aligns with that of Charles, Wanigarathna and Sherratt (2015:840) who state that changes requested by the client during the construction phase are unavoidable, which subsequently affects the standard of the project in terms of quality. According to Charles *et al.* (2015:840), these requests include extra works and variations in the design to meet client requirements, as well as reworking to correct errors. Some of these variations may have ripple effects such as generating extra work in other interconnected activities and thus leading to escalation in project cost.

Finance-related factors in major causes of risks in construction project was ranked third, with AMV = 3.64. The respondents rated some of the key factors relating to finance-related risks as follows: delay in payments from clients was ranked first with a MV= 3.89; followed by unprecedented increase in prices of raw materials with a MV = 3.42 and fluctuations in estimated finance than expected with a MV = 3.27. These findings are akin to previous studies undertaken by Ansah (2011:27) and Idoro and Jolaiya (2010). For example, Ansah (2011:27) reveals that delayed payments by clients on construction projects is regarded to be a factor of significant concern, which leads to severe cash-flow problems on the part of the contractor, with an associated ripple effect down the contractual payment chain. Idoro and Jolaiya (2010) express the same sentiments by highlighting that several projects experience schedule overruns as a result of price increases with respect to materials costs. According to Mishra and Regmi, (2017:1920) fluctuation causes at least 27 % price difference in construction inputs, and contractors lose at least 52 % of their expected profit.

The level of contribution of construction-related factors to major causes of risks in construction projects was significant, as the AMV = 3.52. The survey respondents rated some of the key factors relating to construction risk as follows: unavailability of sufficient cash flow with a MV = 3.93. This finding is corroborated by Jooste (2004:68), who states that the lack of alternative sources of funding for projects may affect the cash flow of the contractor, since the shortage of sufficient funds to cater for payment of interest and service debt may tarnish the image of the contract and subsequently affect the profit margin. Non-availability of resources and late deliveries was also identified as one of the construction-related risk with a MV = 3.90. This is similar to Acharya, Kim and Lee's (2004:5) assertion that resource shortfalls may lead to delays in project schedules. This delay factor is excusable for time extension, but non-compensable and/or excusable with compensation in contract documents. Another significant factor related to construction risk is inadequate contractor experience (MV = 3.83). Similar findings emerge in a study conducted by Hamzah, Khoiry, Arshad, Tawil and Ani (2011), and the study reveals a significant cause of delay is inadequate contractor experience.

Socio-political-related factors were ranked 5th with an AMV = 3.16. The survey participants rated some of the key factors relating to socio-political-related risk as follows: labour strikes and disputes due to union issues with MV = 3.75; excessive influence by government on court proceedings regarding construction project disputes with a MV= 3.25, and constraints on the availability and employment of expatriate staff with MV = 3.05. These findings are supported by Calzadilla, Awinda and Parkin (2012:1216) and Zou, Zhang and Wang (2007:611). For example, Calzadilla *et al.* (2012:1216) reveal that political situations such as national workers; strikes, nationalisation of basic industries and labour unions may lead to poor productivity on site, which subsequently affects project performance. Zou *et al.* (2007:611) also states that the role of government with respect to mitigating political risks in order to create an enabling environment for project development cannot be overemphasised. Nonetheless, overly-prescriptive requirements and bureaucratic approval procedures on the part of government departments may impact on project delivery. Furthermore, Singh, Deep and Banerjee (2017:131) identify several political risks and among them are limitations regarding the availability and employment of expatriate staff.

Additionally, environment-related factors underlying the major causes of risks in construction project are ranked sixth, with AMV = 3.15. Some of the key factors relating to environment-related risk include: environmental analysis incomplete (MV = 3.63); stringent regulation having an impact on construction firm's poor attention to environmental issues (MV = 3.28), and new alternatives required to avoid, mitigate or minimise environmental impact (MV = 3.10).

Furthermore, right of way-related factors influencing the major causes of risks in construction project are ranked seventh, with AMV = 2.91. Some of the key factors relating to right of way-related risk include: need for "permits to enter" not considered in project schedule development with a MV= 3.27; discovery of hazardous waste in the right of way phase with a MV= 3.07, and right of way datasheet incomplete or underestimated with a MV = 3.00. This finding aligns with Caltran's (2007) assertion that: lack of provision for entry permits during project schedule development, uncovering of harmful waste in the right of way and right of way datasheet incomplete or underestimated.

4.5.2 Effect of Construction Risks on Construction Projects

Table 4.21 displays the ranking of the average mean values for the effect of risks on construction projects.

The hierarchical ranking of the average means for the effect of risks on construction projects indicates that the effect on project performance is ranked first, since the AMV = 4.12. The survey participants rated some of the key factors relating to project performance as follows: cost overrun, with MV 4.50; quality degradation, with MV 4.26, and time overrun, with MV 4.22. These findings are supported by Ali and Kamaruzzaman (2010:110), Bodicha (2015:110), and Vaardini (2015:14255). For example, Ali and Kamaruzzaman (2010:110) state that the major factor contributing to cost escalations in construction projects was ascribed to either poor or imprecise cost estimates. Therefore, the most significant mechanism to adopt in order to control construction project costs would be accurate project costing and financing. Al-Bahar (1990), cited by Bodicha (2015:110) also reveals that risk factors such as incidents as a result of force majeure, economic and financial risks, design and construction-related risks, environment-related and political risks, as well as physical risks, can definitely impact on the project outcome in terms of cost and quality. Furthermore, Vaardini (2015:14255) reveals that time overruns have serious repercussions on project performance, and suggests that the factors influencing time overrun during construction projects can be categorised into 12 major groups, consisting of 70 sub-factors.

Organisational performance is ranked second, with an AMV of 3.74. The respondents rated some of the key factors relating to organisational performance. The first is disputes between parties to the contract, with MV = 4.03. This finding is akin to previous studies undertaken by Sithole (2016:4), who argues that disputes between parties may lead to waste of resources on contracts, and subsequently undermine the concepts of sustainability and value-for-money in contracts, thus affecting the overall health of the construction industry. The second is customer/client dissatisfaction, with MV = 3.98, and is consistent with the findings of Nkado and Mbachu (2002), who contend that client dissatisfaction has serious repercussions for the construction industry and its service providers. For instance, developers/clients would be reluctant to invest their resources in an industry that performs poorly with respect to financial returns. Loss of future work, with MV = 3.93. Love *et al.* (2010:418) in their study find that indirect costs caused by dispute lead to loss of future work

Table 4. 21 Factors that contribute to effect of construction risks on project performance

Effect of risks on construction project	Average mean value	Rank
Project performance	4.12	1
Organisation	3.74	2

4.5.3 Effective strategy for mitigating construction risks

Table 4.22 displays the ranking of the average mean values of subsets of effective strategy for mitigating risks.

The hierarchical ranking of the average means for effective strategy for mitigating risks indicates that financial strategy factors are the most effective strategy for mitigating risks, since the AMV = 3.93. The respondents to the survey rated some of the key factors relating to financial strategy as follows: obtain assurances of ability to pay, with a MV of 4.22; execution plan and task list must be adhered to, with a MV of 4.05, and avoid assumption of design liability, with a MV of 4.03.

In addition, design strategy is ranked second, with an AMV of 3.78. The significant design strategies include: arrange and undertake comprehensive site investigation before construction phase, with a MV of 4.18; specify construction extension clause in contract, with a MV of 3.87, and organise for appraisal/vetting of drawings and design criteria by at least one independent engineering/architectural consultant, with a MV of 3.62

Furthermore, construction and project management strategy for minimising construction risks is ranked third, with an AMV of 3.72. It is important to note that the significant mitigation strategies related to construction and project management include site quality management system (MV4.13), quality control (MV4.10), and development of a proper risk management process (MV3.93)

Table 4. 22: Factors that contribute to effective strategy for mitigating risks

Effective strategy for mitigating risks	Average mean value	Rank
Financial strategy	3.93	1
Design strategy	3.78	2
Construction and project management	3.72	3

4.6 Chapter Summary

This chapter was comprised of the presentation and analysis of the data gathering exercise. It explained the process followed in gathering the data and the results presentation. The data was gathered through online surveys and some were submitted by hand. A structured questionnaire was posted on the web with email requests for survey, and a follow-up email was sent to respondents. The respondents' gender reflects the construction industry's male dominance, though 11.7% of female participants also reflected participation of both genders in the survey. The survey was carried out within public and private sectors, with participation of highly educated respondents, with significant years of experience in different areas of specialisation in the construction industry. The chapter has shown acceptable reliability of research instruments used to gather the data. The chapter also presented the findings of the survey, and further discussed the findings of research areas put forward.

CHAPTER 5: TESTING OF HYPOTHESES

5.1 Reliability Testing

In order to the test the hypotheses, the reliability of all the scaled questions was checked. It should be noted that the Cronbach's alpha coefficient was adopted to scrutinise all the scaled questions. Table 5.1 displays a summary of the reliability test for questions 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 3, 4, 5.1, 5.2 and 5.3. Notably, the overall Cronbach's alpha coefficient for all questions combined ranged between 0.8 and 0.985, which satisfies the reliability test requirements.

Table 5.1: Test results of the reliability analysis

Question No	Factors	Number of items	Cronbach's alpha coefficient
2.1	Designed-related factors	07	0.936
2.2	Environment-related factors	05	0.882
2.3	Project management-related	07	0.958
2.4	Construction-related	10	0.955
2.5	Finance-related	06	0.952
2.6	Socio-political-related	06	0.924
2.7	Right of way-related	12	0.974
3	Organisational performance	07	0.876
4	Project performance	06	0.892
5.1	Design strategy	04	0.866
5.2	Construction and project management	17	0.968
5.3	Financial strategy	04	0.926
	All questions combined	91	0.985

5.2 Testing of Hypotheses

Leedy and Ormrod (2010) posit that research hypotheses may stem from the sub-problems, and that a one-on-one correspondence usually exists between the hypotheses and their equivalent sub-problems. Leedy and Ormrod (2010) further state that a hypothesis provides a position from which one may initiate an exploration of the problem or sub-problem, and acts as a checkpoint against which to test the findings that the data reveals. Leedy and Ormrod (2010) describe a "hypothesis as a logical supposition, a reasonable guess, an educated conjecture that provides a tentative explanation for a phenomenon under investigation". It is worth mentioning that hypotheses can either be sustained or rejected by the data. A confirmatory analysis of the hypotheses was conducted by means of the paired sample t-test and one-way analysis of variance (ANOVA). The hypotheses to be tested are as follows:

H1: There is no statistically significant difference between the mean rankings of construction participants' perceptions with regard to the importance of the major causes of risks during construction

H2: There is no statistically significant difference between the construction participants' perceptions with regard to the major causes of risks during construction

H3: There is no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance

H4: There is no statistically significant difference concerning the perception of construction professionals and the effective strategy for mitigating risks

H5: There is no statistically significant difference between the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks.

The analysis of the tests follows below.

H1: There is no statistically significant difference between the mean rankings of construction participants' perceptions with regard to the importance of the major causes of risks during construction

A paired sample test was performed to evaluate whether there was no statistically significant difference in the mean rankings of construction participants' perceptions with regard to the importance of the major causes of risks in construction. The paired sample t-test revealed no statistically significant difference between four pairs, namely: design-related - project-related; environment-related – finance-related; environment-related – socio-political related, and finance-related – socio-political-related. On the contrary, the analysis revealed a statistically significant difference between most of the paired risks (design-related – environment-related, design-related – construction-related, design-related – financial-related, and so on) since $p < 0.05$. This implies that the null hypothesis can be rejected. Therefore, the assumption that 'There is no significant difference in the ranking of the importance of the major causes of risks in construction' was rejected. Typically, the mean rankings for the majority of the factors did not happen by chance. The results are reported in Table 5.2.

Table 5.2: t-test for mean rankings of construction participant's perception

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Dev.	Std. Error Mean	95% CI of the Difference Lower	95% CI of the Difference Upper			
Pair 1	Design-related – Environment-related	.62500	.83277	.10751	.40987	.84013	5.813	59	.000
Pair 2	Design-related - project-related	-.06548	.75979	.09809	-.26175	.13080	-.668	59	.507
Pair 3	Design-related – construction-related	.25833	.73397	.09475	.06873	.44794	2.726	59	.008
Pair 4	Design-related – Financial-related	.61667	.86809	.11207	.39242	.84092	5.503	59	.000
Pair 5	Design-related – Socio-political-related	.61944	.88090	.11372	.39188	.84700	5.447	59	.000
Pair 6	Design-related – right of way-related	.85734	1.01025	.13152	.59407	1.12062	6.519	58	.000
Pair 7	Environment-related – project-related	-.69048	.77824	.10047	-.89152	-.48943	-6.872	59	.000
Pair 8	Environment-related – construction-related	-.36667	.64168	.08284	-.53243	-.20090	-4.426	59	.000
Pair 9	Environment-related – Financial-related	-.00833	.77951	.10063	-.20970	.19303	-.083	59	.934
Pair 10	Environment-related – Socio-political-related	-.00556	.79395	.10250	-.21066	.19954	-.054	59	.957
Pair 11	Environment-related – right of way-related	.25226	.73904	.09621	.05967	.44485	2.622	58	.011
Pair 12	Project-related – construction-related	.32381	.61171	.07897	.16579	.48183	4.100	59	.000
Pair 13	Project-related – Financial-related	.68214	.71525	.09234	.49737	.86691	7.387	59	.000
Pair 14	Project-related – Socio-political-related	.68492	.87471	.11292	.45896	.91088	6.065	59	.000
Pair 15	Project-related – right of way-related	.93119	.98716	.12852	.67394	1.18845	7.246	58	.000
Pair 16	Construction-related – Financial-related	.35833	.43602	.05629	.24570	.47097	6.366	59	.000
Pair 17	Construction-related – Socio-political-related	.36111	.74753	.09651	.16800	.55422	3.742	59	.000
Pair 18	Construction-related – right of way-related	.60819	.71066	.09252	.42299	.79339	6.574	58	.000
Pair 19	Finance-related – Socio-political-related	.00278	.82367	.10634	-.21000	.21555	.026	59	.979
Pair 20	Finance-related – right of way-related	.24435	.77603	.10103	.04212	.44658	2.419	58	.019
Pair 21	Socio-political-related – right of way-related	.26130	.62023	.08075	.09967	.42293	3.236	58	.002

H2: There is no statistically significant difference between the construction participants' perceptions with regard to the major causes of risks during construction

The ANOVA test was conducted to ascertain if there was no statistically significant difference concerning the construction participants' perceptions and the major causes of risks during construction. The ANOVA test in Table 5.3 revealed no significant differences concerning construction participants' perceptions and the major causes of risks, including design-related, environment-related, project-related , construction-related , financial, and socio-political-related risks since the significance level is $p > 0.05$. However, the ANOVA test revealed a significant difference with regard to construction participants' perceptions and right of way-related risk since $p<0.05$. Hence, the hypothesis that construction participants' perceptions do not vary significantly with regard to the major causes of risks during construction could therefore be accepted. The results are reported in Table 5.3.

Table 5. 3: ANOVA test for the major causes of risks during construction

		Degrees of Freedom	F	Sig
Design-related	Between Groups	12	.905	.549
	Within Groups	47		
	Total	59		
Environment-related	Between Groups	12	1.189	.319
	Within Groups	47		
	Total	59		
Project-related	Between Groups	12	1.116	.370
	Within Groups	47		
	Total	59		
Construction-related	Between Groups	12	1.355	.221
	Within Groups	47		
	Total	59		
Finance-related	Between Groups	12	1.440	.182
	Within Groups	47		

	Total	59		
Socio-political-related	Between Groups	12	1.353	.222
	Within Groups	47		
	Total	59		
Right of way-related	Between Groups	12	1.999	.046
	Within Groups	46		
	Total	58		

H3: There is no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance

The ANOVA test was carried out to establish if there was no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance. The ANOVA test in Table 5.4 revealed that there were no significant differences between the perception of construction professionals and the detrimental effect of risks on project performance, including effects on organisation and effects on project performance, since the significance level is $p > 0.05$. Hence, the hypothesis that the perception of construction professionals do not vary significantly with regard to the detrimental effect of risks on project performance could therefore not be rejected. The results are reported in Table 5.4

Table 5. 4: ANOVA test for effect of risks on project performance

		Degrees of Freedom	F	Sig
Effect on organisation	Between Groups	12	.759	.687
	Within Groups	47		
	Total	59		
Effect on Project performance	Between Groups	12	1.118	.371
	Within Groups	44		
	Total	56		

H4: There is no statistically significant difference concerning the perception of construction professionals and the effective strategy for mitigating risks

The ANOVA test was computed to ascertain whether the opinions regarding the effective strategies for mitigating risks differed amongst the respondents. The inferential statistical analysis presented in Table 5.5 reveals no statistically significant difference between construction participants' perceptions for financial strategy (p=0.791), design strategy (p=0.213), and construction and project management strategy (p=0.640). Therefore, the hypothesis that perceptions on the effective strategies for mitigating risks did not differ among construction participants was accepted. The results are reported in Table 5.5.

Table 5. 5: ANOVA test for effective strategies for mitigating risks

		Degrees of Freedom	F	Sig.
Financial strategy	Between Groups	12	.647	.791
	Within Groups	47		
	Total	59		
Design strategy	Between Groups	12	1.371	.213
	Within Groups	47		
	Total	59		
Construction and project management	Between Groups	12	.809	.640
	Within Groups	46		
	Total	58		

H5: There is no statistically significant difference between the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks

A paired sample test was performed to evaluate whether there is no statistical significance difference in the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks. It is important to note that the analysis revealed a statistically significant difference between the paired risks (design strategy - construction and project management, design strategy – financial strategy and construction and project management – financial strategy) since $p < 0.05$. This implies that the null hypothesis can be rejected. Therefore, the assumption that 'There is no significant difference in the ranking of the perception of construction professionals can be rejected. Typically, the mean rankings for the factors did not happen by chance. The results are reported in Table 5.6.

Table 5.6: T-test for the effective strategy for mitigating risks

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Dev.	Std. Error Mean	95% CI of the Difference Lower	95% CI of the Difference Upper			
Pair 1	Design strategy - Construction and project management	8.68220	2.86502	.37299	7.93557	9.42883	23.277	58	.000
Pair 2	Design strategy – Financial strategy	8.46250	2.90522	.37506	7.71200	9.21300	22.563	59	.000
Pair 3	Construction and project management – Financial strategy	-.19915	.62300	.08111	-.36151	-.03680	-2.455	58	.017

Table 5.7 Summary of hypotheses' test

S/N	Path relationship	Hypotheses	Test used	Remark
H1	major causes of risks -> participants' perceptions	There is no statistically significant difference between the mean rankings of construction participants' perceptions with regard to the importance of the major causes of risks during construction	T-test	Not supported
H2	major causes of risks -> participants' perceptions	There is no statistically significant difference between the construction participants' perceptions with regard to the major causes of risks during construction	ANOVA test	supported
H3	perception of construction professionals -> project performance	There is no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance	ANOVA test	supported
H4	perception of construction professionals -> strategy for mitigating risks	There is no statistically significant difference concerning the perception of construction professionals and the effective strategy for mitigating risks	ANOVA test	supported
H5	perception of construction professionals-> strategy for mitigating risks	There is no statistically significant difference between the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks	T-test	Not supported

5.3 Chapter Summary

The reliability of scaled questions was verified with the aid of Cronbach's alpha coefficient test. The values of the co-efficient for all the scale questions were between 0.866 to 0.985 indicating that the scaled questions were reliable. Five hypotheses were tested, three were accepted and two were rejected. It should be noted that the first hypothesis tested whether there was no statistically significant difference between the mean rankings of construction participants' perceptions regarding the importance of the major causes of risks during construction. The paired sample t-test revealed no statistically significant difference between four pairs, namely: design-related – project-related; environment-related – finance-related; environment-related –

socio-political-related, and finance-related – socio-political-related. On the contrary, the analysis revealed a statistically significant difference between most of the paired risks. Hence hypothesis number 1 was rejected.

The second hypothesis tested whether there was no statistically significant difference between the construction participants' perceptions with regard to the major causes of risks during construction.

The ANOVA test revealed no significant differences between construction participants' perceptions and the major causes of risks, including design-related, environment-related, project-related, construction-related, financial, and socio-political-related risks. However, the ANOVA test revealed a significant difference with regard to construction participants' perceptions and right of way-related risk. Hence, hypothesis number two was accepted.

The third hypothesis tested whether there was no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance. The ANOVA test revealed that there was no significant difference between the perception of construction professionals and the detrimental effect of risks on project performance including effect on organisation and effect on project performance. Hence, hypothesis number three cannot be rejected.

The fourth hypothesis tested whether there was no statistically significant difference concerning the perception of construction professionals and the effective strategy for mitigating risks
The ANOVA test revealed no statistically significant difference between construction participants' perceptions. Therefore, hypothesis number four was accepted.

The fifth hypothesis tested whether there was no statistically significant difference between the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks. It is notable that the analysis revealed a statistically significant difference between the paired. Therefore, hypothesis five was rejected.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This section concludes the study by summarising how the research aims and objectives were achieved. It also outlines the conclusions relative to the research hypotheses postulated in Chapter One of the dissertation. The subsequent sections highlight the limitations that were experienced in the course of the study and offers recommendations based on the findings for further study. The study was aimed at identifying the major causes of risks during construction projects and their detrimental effect on project parameters such as cost, time, quality, and health and safety. To achieve this aim, relevant research objectives, together with their related hypotheses, were formulated.

6.2 Achievement of Research Objectives

Objective 1 - To determine the major cause of risks during construction projects

Objective 2 - To identify which construction risk is regarded as the most significant in militating against the success of construction projects

Objective 3 - To determine the detrimental effect of construction risks on project performance

Objective 4 - To establish an effective strategy for reducing risks associated with construction projects

6.2.1 Determining the Major Cause of Risks during Construction Projects

The first objective was to determine the major causes of risks that are prevalent in construction projects. It was apparent from the review of literature that the root causes of risk may be classified as design-related, environment-related, project management-related, construction-related, finance-related, socio-political-related, and right of way-related. Consequently, the causes of risks were examined based on the aforementioned categories. With regard to design-related risk, design errors and omissions in drawings, incomplete design, and late design changes requested by the client were identified by the respondents to be very critical. The most critical factors relative to environment-related risk included incomplete environmental analysis, stringent regulation having an impact on construction firm’s poor attention to environmental issues, and new alternatives required to avoid, mitigate or minimise environmental impact. In terms of project management-related risk, the hierarchy of the descriptive analysis revealed that inadequate project planning, inadequate project budgeting, and incompetence of local project team members may be considered to contribute to a large extent in influencing the occurrence of risk in construction. Relative to construction-related risk, the hierarchy of the descriptive analysis shows that lack of sufficient cash flow had the highest ranking, with MV = 3.93. Non-availability of resources and late deliveries had the second highest ranking, with MV = 3.90. Inadequate contractor's experience was the third highest, with MV = 3.83. The level of contribution in terms of influencing the occurrence of risk in construction can be deemed to be between somewhat critical to critical/critical. Delay in payments from clients, unprecedented increase in prices of raw materials, and fluctuations in estimated finance were the most significant factors related to finance-related risk. Concerning socio-political-related risk, the most critical factors influencing the occurrence of risks in construction include labour strikes and disputes due to union issues, excessive influence by government on court proceedings regarding construction project disputes, and governments' inconsistent application of new regulations and laws. Right of way-related risks include permits to enter not considered in project schedule development, discovery of hazardous waste in the right of way phase, and right of way datasheet incomplete or underestimated.

6.2.2 The Most Significant Construction Risk Militating Against the Success of Construction Projects

The second objective was to identify which construction risk is regarded as the most significant in militating against the success of construction projects. It is notable that the most significant risks include project management-related risk, design-related risk, finance-related risk, construction-related risk, socio-political-related risk, environment-related risk and right of way-related risk. The descriptive statistics revealed that project management-related risk is ranked first.

6.2.3 Determining the Detrimental Effect of Construction Risks on Project Performance

The third objective was to determine the detrimental effect of construction risks on project performance. The research examined the impact of risks on project performance and organisational performance. With regard to the impact of risks on project performance, cost overrun, quality degradation, time overrun and productivity, health and safety environment were highlighted by the respondents to a near major extent. The effects of risks on organisational performance were highlighted by the respondents to a near major extent. Disputes between parties to the contract, customer/client dissatisfaction, loss of future work, contractual claims disrupt the project plan, inter-organisational conflict reduced profit margin.

6.2.4 Effective Strategy for Reducing Risks Associated with Construction Projects

The fourth objective was to establish an effective strategy for reducing the incidence of risks in construction projects. The research suggested strategies for mitigation of risk. These strategies are design, construction and project management, as well as financial strategy. With respect to design strategies, factors highlighted by respondents to be effective included: arranging and undertaking comprehensive site investigation prior to construction phase; specifying construction extension clause in contract; organising for appraisal/vetting of drawings and design criteria by at least one independent engineering/architectural consultant, and introducing adjustment clauses in contract to review plan and constructability. For the second strategy, that is construction and project management, the factors included: site quality management system; quality control; quality audits; development of a proper risk management process; value engineering; total reflection on the potential risks inherent in the project in tender documents, and adjudication of bids with senior management to assess the acceptability of various risks in tendering for a project. Concerning financial strategy, some of the factors highlighted by respondents to be effective in managing risks included: obtain assurances of ability to pay, execution plan and task list must be adhered to, avoid assumption of design liability, and observe corporate formalities.

6.3 Conclusions Relative to the Research Hypotheses

H1: *There is no statistically significant difference between the mean rankings of construction participants' perceptions with regard to the importance of the major causes of risks during construction.*

The descriptive statistics revealed that there were seven risk factors that could influence the performance of the project during construction. These factors included: design-related, environment-related, project management-related, construction-related, finance-related, socio-political-related and right of way-related. A reliability test was performed to ascertain validity and reliability of all the scaled questions relative to the seven major factors. It is important to note that the reliability test displayed moderate to high reliability ranging from 0.936, 0.882, 0.958, 0.955, 0.952, 0.924, and 0.974. The means of significant risk factors were ranked in the following descending order: Project management-related risk (3.84; 1st); Design-related risk (3.71; 2nd), and Finance-related risk (3.64; 3rd).

A paired sample test was performed to evaluate whether there was no statistically significant difference in the mean rankings of construction participants' perceptions in respect of the importance of the major causes of risks in construction. Notably, the paired sample t-test revealed no statistically significant difference between four pairs, namely: design-related - project-related; environment-related – finance-related; environment-related – socio-political-related, and finance-related – socio-political-related. On the contrary, the analysis revealed a statistically significant difference between most of the paired risks (design-related – environment-related, design-related – construction-related, design-related – finance-related, and so on) since $p < 0.05$. This implies that the null hypothesis could be rejected. Therefore, the assumption that 'There is no significant difference in the ranking of the importance of the major causes of risks in construction' can be rejected.

H2: *There is no statistically significant difference between the construction participants' perceptions with regard to the major causes of risks during construction.*

The ANOVA test was conducted to examine if there was no statistically significant difference between the construction participants' perceptions and the major causes of risks during construction. The ANOVA test revealed no significant differences between construction participants' perceptions and the major causes of risks, including design-related, environment-related, project-related, construction-related, financial, and socio-political-related risks, since the significance level is $p > 0.05$. However, the ANOVA test revealed a significant difference with regard to construction participants' perceptions and right of way-related risk, since $p<0.05$. Therefore, the hypothesis that construction participants' perceptions did not vary significantly with regard to the major causes of risks during construction could be accepted.

H3: *There is no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance.*

The means of significant effect of risks on project performance factors were ranked in the following descending order: Project performance (4.12; 1st) and organisational performance (3.74; 2nd). The ANOVA test was carried out to ascertain if there was no statistically significant difference concerning the perception of construction professionals and the detrimental effect of risks on project performance. The ANOVA test revealed there were no significant differences between the perception of construction professionals and the detrimental effect of risks on project performance, including effect on organisation and effect on project performance, since the significance level is $p > 0.05$. Hence, the hypothesis that the perceptions of construction professionals do not vary significantly with regard to the detrimental effect of risks on project performance was supported.

H4: *There is no statistically significant difference concerning the perceptions of construction professionals and the effective strategy for mitigating risks.*

The means of significant strategy factors were ranked in the following descending order: financial strategy (3.93; 1st); design strategy (3.78; 2nd) and construction and project management (3.72; 3rd). The ANOVA test was performed to determine whether the perceptions regarding the effective strategies for mitigating risks differed among construction participants. The ANOVA test revealed no statistically significant difference between construction participants' perceptions for financial strategy ($p=0.791$), design strategy ($p=0.213$), and construction and project management strategy ($p=0.640$). Therefore, the hypothesis that perception on the effective strategies for mitigating risks do not differ among construction participants was accepted.

H5: *There is no statistically significant difference between the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks*

A paired sample test was performed to evaluate whether there was no statistical significance difference in the mean rankings of the perception of construction professionals with regard to the effective strategy for mitigating risks. It is important to note that the analysis revealed a statistically significant difference between the paired risks (design strategy - construction and project management, design strategy – financial strategy and construction and project management – financial strategy) since $p < 0.05$. This implies that the null hypothesis could be rejected. Therefore, the assumption that 'There is no significant difference in the ranking of the perception of construction professionals regarding the effective strategy for mitigating risks' was rejected. The mean rankings for the factors did not happen by chance.

6.4 Limitations

The geographical area of the research was the Western Cape Province of South Africa, hence, only construction professionals and contracting firms based in the Cape Peninsula area were surveyed.

Another limitation of the study was that the majority of the respondents were unwilling to participate in the study, and for this reason, only 60 responses (representing 23% of the respondents) willingly participated in the survey. Reasons for non-participation included lack of availability to participate due to other commitments in other provinces, questionnaire too long and the respondent was very busy at work. Although all attempts were made to solicit more responses, the efforts in terms of constant reminders on a weekly basis and follow-up site visits to retrieve the questionnaire in person proved futile.

With regard to the sample size, it is worth noting that only contractors registered on the CIDB database formed part of the study. In the category of construction professionals (including architects, construction project managers, engineering, and quantity surveyors), only those registered on the Professions and Projects Register and in good standing were sampled. For the contractors, it is important to mention that the survey was administered to construction firms in the general building category with a grade ranging from 3 to 9.

6.5 Recommendations

A systematic review of the literature revealed that various studies tended to focus on risk management practices and yet some projects still experience failure. Furthermore, the findings from the quantitative study revealed that there were major risk events influencing construction project performance. Thus, based on the findings presented in Chapter Four of the dissertation, as well as the conclusions relative to the objectives and hypotheses, the following recommendations are made to construction professionals and contracting firms in their quest to minimise the occurrence of risk in construction projects.

Creating awareness with regard to how risks may negatively influence project parameters is probably the most obvious intervention, and the starting point for gaining an in-depth understanding of the root source of risks. Hence, a comprehensive understanding of the causal nature of risks is an immediate issue that contracting firms, as well as construction professionals, should prioritise as one of their learning mechanisms, in order to minimise/prevent the causes of risk and the consequent detrimental effect on project parameters.

Also, construction professionals and contractors should consider forming a risk management team within their respective firms, and allocate a budget for the team to attend risk management-related training courses.

The research participants suggested strategies for mitigating risks. These strategies were classified as design, construction and project management, and financial strategy. In addition, the perceptions concerning the effectiveness of the strategies for mitigating risks do not differ among construction participants. Hence, construction professionals and contractors should develop a system for prioritising and monitoring these strategies to check their effectiveness in terms of minimising risks in construction projects. Managing risks is a way of successfully managing projects and the means to identify all future challenges that may adversely affect the progress of the project.

6.6 Suggestions for Further Study

With regard to theoretical underpinning, further research should focus on the adoption and application of risk-based thinking as a process approach for identifying, assessing and analysing, as well as managing and controlling risk in the construction industry.

In terms of statistical tools, the study recommends that the Pareto analysis should be adopted as a tool, based on the 80/20 principle, in order to assist in identifying which risk events may be considered as the vital few and which ones can be classified as the trivial many.

Further research or study should also focus on the development of a risk probability model for predicting the occurrence of risk events in all the project phases. The risk probability model may be adopted as a project management tool in order to assist project participants to discover which factors could influence the occurrence of risks during the design and construction phase.

The study was conducted in the Western Cape Province; therefore, the researcher suggests that further research should focus on extending the dataset to encapsulate the whole of South Africa.

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A & F Construction Consulting

A & F Construction Consulting

85 St Georges Mall, Cape Town

Subject: Approval Letter

Date: 01/06/2018

TO WHOM IT MAY CONCERN

Re: LETTER OF AUTHORIZATION TO CONDUCT RESEARCH AT OUR COMPANY

It is my understanding that Mr Abdarahim Salem will be conducting a research study at A&F Company on "Managing risk of construction projects to enhance project performance delivery". Mr Salem has informed me of the design of the study as well as the targeted population.

I support this effort and will provide any assistance necessary for the successful implementation of this study. If you have any questions, please do not hesitate to call. I can be reached at 0795847375.

Sincerely,

Fritz Nketia

Director of the company

....

Signature

APPENDIX A- QUESTIONNAIRE SURVEY

Faculty of Engineering
Department of Construction
Management and Quantity
Surveying

P.O. Box 1906, Bellville 7535, South Africa

Date: 08/03/2018

Dear Sir/Madam,

RE: PARTICIPATION IN A SURVEY

You are invited to participate in a research survey entitled "**Managing risk of construction projects to enhance project performance delivery**". It is a research study undertaken by a Master student towards fulfilling a Master of Construction Management degree in the Department of Construction Management and Quantity Surveying at Cape Peninsula University of Technology.

Participants to the survey include; design team members, risk management team, construction managers, site managers, trade supervisors, and owners.

Please answer each question carefully. The survey takes about 15 minutes to complete. All information obtained from participants will be kept strictly confidential and will be only used for research purposes.

Declaration by participant:

By signing below, I (name)………………………………………………………… agree to take part in this study and is aware that no compensation will be provided for participating.

Signature………………………….

Date………………………….

Please complete the survey and return to:

Name of the Student: Abdarahim Salem
Email: 215004094@mycput.ac.za
Mobile: 084 9112227

SECTION A: BACKGROUND INFORMATION

1.1 Please indicate your gender

Female ☐ Male ☐

1.2 Please indicate your age group

Under 25 years ☐ 41 – 50 years ☐
25 – 30 years ☐ 51 – 60 years ☐
31 – 40 years ☐ Over 60 years ☐

1.3 Please indicate your highest formal qualification.

Matric certificate ☐ Postgraduate diploma ☐
Diploma ☐ Master's Degree ☐
Bachelor degree ☐ Doctorate degree ☐
Honours degree ☐
Other ☐

1.4 Other please specify ………………..

1.5 How long have you been involved in the construction industry?

Less than 5 years ☐ Over 10 years ☐
5 – 10 years ☐

1.6 Which of the following best describes your company?

Architect ☐
Contractor ☐
Consulting Engineer ☐
Quantity Surveyor ☐
Project Manager ☐
Engineer (civil, electrical, mechanical) ☐
Other ☐

1.7 Other please specify …………..

1.8 In which area does your organisation operate?

Building construction ☐
Road construction ☐
Bridge construction ☐
Industrial construction ☐

1.9 What is your current position? ……………………………

1.10 How long have you been in your current position?

Less than 5 years ☐
5 – 10 years ☐
Over 10 years ☐

1.11 For the purpose of the study, please select only one project you recently completed. What was the facility type that best describes the project?

Administrative Hospital/Health ☐
Entertainment Industrial ☐
Hotel/Motel Educational ☐
Financial/Banks Residential ☐
Commercial Other ☐

1.12 If other in Q1.11, please specify …………..

1.13 How many construction projects have you managed?

1-10 ☐
10-20 ☐
20-40 ☐
More than 40 ☐

SECTION B: MAJOR CAUSES OF RISKS DURING IN CONSTRUCTION PROJECT

2. On a scale of **1 (Not critical at all)** to **5 (Very critical)**, please rate the effect of each risk on the success of project managers in carrying out a construction project **(Please note the 'Unsure' option)?**

Item	Risk	Unsure	Not critical……very critical				
2.1	**Design-related**						
2.1.1	Design errors and omissions in drawings	U	1	2	3	4	5
2.1.2	Design process takes longer than anticipated	U	1	2	3	4	5
2.1.3	Incomplete design	U	1	2	3	4	5
2.1.4	Late design changes requested by the client	U	1	2	3	4	5
2.1.5	Late design changes requested by the contractor	U	1	2	3	4	5
2.1.6	Late design changes requested by the municipality	U	1	2	3	4	5
2.1.7	Changes from other parties (e.g. engineers)	U	1	2	3	4	5
2.2	**Environment-related**						
2.2.1	Environmental analysis incomplete	U	1	2	3	4	5
2.2.2	New alternatives required to avoid, mitigate or minimise environmental impact	U	1	2	3	4	5
2.2.3	Weather and seasonal implications	U	1	2	3	4	5
2.2.4	Force Majeure: such as natural disasters	U	1	2	3	4	5
2.2.5	Stringent regulation having an impact on construction firms poor attention to environmental issues	U	1	2	3	4	5
2.3	**Project management-related**						
2.3.1	Failure to comply with contractual quality requirements	U	1	2	3	4	5
2.3.2	Scheduling errors/ill planned schedule	U	1	2	3	4	5
2.3.3	Project team conflicts	U	1	2	3	4	5
2.3.4	Inadequately defined roles and responsibilities	U	1	2	3	4	5
2.3.5	Inadequate project planning	U	1	2	3	4	5

2.3.6	Incompetence of local project team members	U	1	2	3	4	5
2.3.7	Inadequate project budgeting	U	1	2	3	4	5
2.4	**Construction-related**						
2.4.1	Unavailability of sufficient cash flow	U	1	2	3	4	5
2.4.2	Technology changes/new technology	U	1	2	3	4	5
2.4.3	Disputes between labour force on site	U	1	2	3	4	5
2.4.4	Changing sequences in construction activity	U	1	2	3	4	5
2.4.5	Non-availability of resources and late deliveries	U	1	2	3	4	5
2.4.6	Low labour productivity of local workforce	U	1	2	3	4	5
2.4.7	Changes in project scope and requirements	U	1	2	3	4	5
2.4.8	Inadequate contractor's experience	U	1	2	3	4	5
2.4.9	Inadequate safety measures in place for workers	U	1	2	3	4	5
2.4.10	Lack of protection on a construction site	U	1	2	3	4	5
2.5	**Finance-related**						
2.5.1	Delay in payments from clients	U	1	2	3	4	5
2.5.2	Availability and fluctuation in foreign exchange	U	1	2	3	4	5
2.5.3	Unprecedented increase in prices of raw materials	U	1	2	3	4	5
2.5.4	Fluctuations in estimated finance than expected	U	1	2	3	4	5
2.5.5	Unanticipated increase in interest rate	U	1	2	3	4	5
2.5.6	Unanticipated increase in local taxes	U	1	2	3	4	5
2.6	**Socio-Political-related**						
2.6.1	Excessive influence by government on court proceedings regarding construction project disputes	U	1	2	3	4	5
2.6.2	Labour strikes and disputes due to union issues	U	1	2	3	4	5
2.6.3	Governments inconsistent application of new regulations and laws	U	1	2	3	4	5
2.6.4	Constraints on the availability and employment of expatriate staff	U	1	2	3	4	5
2.6.5	Customs and import restrictions and procedures	U	1	2	3	4	5
2.6.6	Insistence on use of local firms and agents	U	1	2	3	4	5
2.7	**Right of Way-related**						
2.7.1	Utility relocation requires more time than planned	U	1	2	3	4	5
2.7.2	Unforeseen railroad involvement	U	1	2	3	4	5
2.7.3	Resolving objections to right of way appraisal takes more time and/or money	U	1	2	3	4	5
2.7.4	Right of way datasheet incomplete or underestimated	U	1	2	3	4	5
2.7.5	Need for "permits to enter" not considered in project schedule development	U	1	2	3	4	5
2.7.6	Condemnation process takes longer than anticipated	U	1	2	3	4	5
2.7.7	Acquisition of parcels controlled by a state or federal agency may take longer than anticipated	U	1	2	3	4	5
2.7.8	Discovery of hazardous waste in the right of way phase	U	1	2	3	4	5
2.7.9	Seasonal requirements during utility relocation	U	1	2	3	4	5

2.7.10	Utility company workload, financial condition or timeline	U	1	2	3	4	5
2.7.11	Expired temporary construction easements	U	1	2	3	4	5
2.7.12	Inadequate pool of expert witnesses or qualified appraisers	U	1	2	3	4	5

SECTION C: EFFECT OF CONSTRUCTION RISKS ON PROJECT PERFORMANCE

3. The following are examples of the consequences of construction project risks. On a scale of **1 (minor)** to **5 (major)**, how will you rate the effect of risks on your organisation success performance (**Please note the 'Unsure' option)**?

Item	Organisation	Unsure	Minor………………….Major				
3.1	Disrupt the project plan	U	1	2	3	4	5
3.2	Reduced profit margin	U	1	2	3	4	5
3.3	Customer/client dissatisfaction	U	1	2	3	4	5
3.4	Disputes between parties to the contract	U	1	2	3	4	5
3.5	Contractual claims	U	1	2	3	4	5
3.6	Inter-organisational conflict	U	1	2	3	4	5
3.7	Loss of future work	U	1	2	3	4	5

4. On a scale of **1 (minor)** to **5 (major)**, how will you rate the effect of risks on the overall project performance (**Please note the 'Unsure' option)**?

Item	Project performance	Unsure	Minor………………………….Major				
4.1	Time overrun	U	1	2	3	4	5
4.2	Cost overrun	U	1	2	3	4	5
4.3	Quality degradation	U	1	2	3	4	5
4.4	Health and safety	U	1	2	3	4	5
4.5	Productivity	U	1	2	3	4	5
4.6	Environment	U	1	2	3	4	5

SECTION D: EFFECTIVE STRATEGY FOR MITIGATING RISKS

5. On a scale of **1 (Not effective at all)** to **5 (Very effective)** please rate the effectiveness of the following mitigation measure for managing risk in construction project (**Please note the 'Unsure' option)**?

Item	Mitigation Measures	Unsure	Not effective………….very effective				
5.1	**Design strategy**						
5.1.1	Introduce adjustment clauses in contract to review plan and constructability	U	1	2	3	4	5

5.1.2	Arrange and undertake comprehensive site investigation before construction phase	U	1	2	3	4	5
5.1.3	Specify construction extension clause in contract	U	1	2	3	4	5
5.1.4	Organise for appraisal/vetting of drawings and design criteria by at least one independent engineering/architectural consultant	U	1	2	3	4	5
5.2	**Construction and project management**						
5.2.1	Characterise the root causes of risks that have been identified and quantified in earlier phases of the risk management process	U	1	2	3	4	5
5.2.2	Evaluate risk interactions and common causes	U	1	2	3	4	5
5.2.3	Identify alternative mitigation strategies and tools for each major risk	U	1	2	3	4	5
5.2.4	Assess and prioritise mitigation alternatives	U	1	2	3	4	5
5.2.5	Select and commit the resources required for specific risk mitigation alternatives	U	1	2	3	4	5
5.2.6	Putting tags and conditions to risky price items or aspects of the tender bids	U	1	2	3	4	5
5.2.7	Transferring the risks onto other parties	U	1	2	3	4	5
5.2.8	Lump sum adjustments to margin to cover identified risks	U	1	2	3	4	5
5.2.9	Taking protective measures against risks such as liquidated damages	U	1	2	3	4	5
5.2.10	Strategic withdrawal from the tendering by pricing uncompetitively	U	1	2	3	4	5
5.2.11	Development of a proper risk management process	U	1	2	3	4	5
5.2.12	Adjudication of bids with senior management to assess the acceptability of various risks in tendering for a project	U	1	2	3	4	5
5.2.13	Total reflection on the potential risks inherent with the project in tender documents	U	1	2	3	4	5
5.2.14	Site quality management system	U	1	2	3	4	5
5.2.15	Quality control	U	1	2	3	4	5
5.2.16	Quality audits	U	1	2	3	4	5
5.2.17	Value engineering	U	1	2	3	4	5
5.3	**Financial strategy**						
5.3.1	Execution plan and task list must be adhered to	U	1	2	3	4	5
5.3.2	Avoid assumption of design liability	U	1	2	3	4	5
5.3.3	Observe corporate formalities	U	1	2	3	4	5
5.3.4	Obtain assurances of ability to pay	U	1	2	3	4	5

6. Do you have any comments in general regarding the major cause of risks during construction project?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

7. Do you have any suggestions for an effective strategy for mitigating risk during construction project?

…….

……..

Thank you for your co-operation.