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Development of an optimised risk-management model for improved construction-project operational performance

Siphiwe Emmanuel Gogo

Dissertation
Submitted in fulfilment of the requirements for the degree
Magister Technologiae in Operations Management
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THE FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT
SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING
DEPARTMENT OF QUALITY AND OPERATIONS MANAGEMENT
UNIVERSITY OF JOHANNESBURG

January 2018

Supervisor: Dr Kazeem Sanusi
Co supervisor: Mr Nelson Madonsela
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Department of Quality and Operations Management
The University of Johannesburg APB Campus
P O Box 524
Auckland Park 2006
Johannesburg
South Africa
Contact details as on title page can be repeated
Date:
Signature:………………..
DECLARATION

I, SIPHIWE EMMANUEL GOGO, assert that this research study is my own work with the exception as specified in the list of references and salutations. It is submitted in partial fulfilment of the requirements for the degree MASTER OF TECHNOLOGIAE in Operations Management at the University of Johannesburg. This work has not been submitted earlier for any degree or examination in this or any other university.

__________________________________________  ____________________________
Siphiwe Emmanuel Gogo                       Date

University of Johannesburg

Auckland Park Kingsway Campus
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First, I want to thank the Almighty for protecting me throughout my life and the uncountable blessings he bestows upon me. I would like to significantly and honestly thank my supervisor, Dr Kazeem Sanusi and my co-supervisor, Mr Nelson Madonsela, without whom this research would not have been accomplished. I am really grateful for their support, knowledge and guidance throughout the study. I would also like to thank the companies of Eskom, Babcock, Mitsubishi Hitachi Power Systems Africa, Murray & Roberts Power and Energy, TUV and Black & Veatch for giving me their consent to do the study. I would also like to thank all of my family members and friends for their continued motivation throughout the duration of this study. Last but not least, I need to especially thank my partner and my children, for all their never-ending care and reassurance. Without them, I would not have completed this research study and obtained the qualification.
DEDICATION

I dedicate this dissertation to my mother, Christina Nana Gogo.
ABSTRACT

The South African construction industry has long been characterised by the influx of labour, strike action, longer than usual projects, budget misuse, nepotism, racial imbalance, and other problems. Notably, the national development program, the infrastructural development plan, the infrastructural maintenance strategy, etc. These are the government’s frameworks that have given the mandate to the State-owned enterprises to embark on structured renewal and expansion projects, most of which would result in major construction projects. Although these projects are planned and executed by experts in various fields, they still bring about a number of different sets of risks for all the stakeholders.

The key purpose of this research was to develop an optimized risk-management model that can be useful in the turbulent and often unpredictable construction projects in South Africa, in order to derive success under those conditions. As part of the required attributes for project success, the capacity of the project team to recognize, measure and achieve inherent risks throughout the lifecycle of the project, is very crucial. This allows the operations of the project to be managed and maintained within set strategic goals; and to be optimised for streamlined performance.

The study was descriptive in nature; and it was conducted through the use of quantitative research methods. A survey questionnaire was employed to collect the primary data from workers in engineering companies involved in construction. A sample 86 respondents was involved in the study. The findings were significant of the correlation coefficient value.

The findings in this study demonstrated poor participation and a lack of inclusion regarding stakeholders in various capacities to manage risk throughout the project’s lifecycle. It also showed the increased responsibility that these issues place on the project manager. The Literature review also demonstrated that risk identification and valuation were of the greatest use in risk-management plans.
The researcher then went further to develop a model that encapsulates stakeholder participation in the formulation of risk-management plans. The model developed incorporated stakeholders in all the levels of the risk management input community; and it was named: The all-level stakeholder-risk model (ALSRM).

The model benefited significantly from the involvement of the stakeholders from all the different levels, which had previously been identified as non-essential for any specific input in risk-management participation. The importance of recognising all the levels of stakeholder participation was established by the findings of the. Further to this, a brief model implementation, as well as its impact in construction projects’ operational performance was also discussed.
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**Construction**: The commercial activity involved in repairing old structures, or in constructing new ones

**Develop**: Grow, or cause to grow, and become more mature, advanced, or elaborate

**Enterprise**: A project or undertaking, especially a bold or complex one / a business or company

**Epistemology**: The concept of information, especially with regard to its approaches, validity, and range, and the difference between acceptable trust and estimation

**Hypothesis**: An assumption or planned description made on the foundation of inadequate evidence as a starting point for further investigation.

**Model**: A thing used as an example to follow or imitate

**Ontology**: A set of ideas and groups in a subject area or domain that shows their properties and the relations between them

**Operational**: Pertaining to a process, or a series of actions, for achieving a result

**Optimised**: Modify to achieve maximum efficiency in storage capacity, time or cost

**Performance**: Process, or manner of functioning, or operating

**Qualitative**: Relating to, measuring, or measured by the quality of something rather than its quantity

**Quantitative**: Relating to, measuring, or measured by the quantity of something – rather than its quality

**Stakeholder**: A person or organization with an interest or concern in something
ABBREVIATIONS

AHO: (German) Committee of Engineer Associations and Boards of Engineers
AIRMIC: Association of Insurance and Risk Managers
ALSRM: All-level Stakeholder-Risk Model
ANOVA: Analysis of Variance
CCRAM: Correlated Cost-Risk Analysis Model
CIDB: Construction-Industry Development Board
CIPC: Companies and Intellectual Property Commission
CMM: Construction-Maturity Model
CTR: Cost-Time Risk
ERIC-S: Evaluating Risk in Construction Schedule
ERM: Enterprise-Risk Management
FNQ: National Quality Foundation
GDP: Gross Domestic Product
IBGC: Instituto Brasileiro de Governança Corporativa
IBM: International Business Machines
IFRS: International Financial Reporting Standard
IRM: Institute of Risk Management
ISO: International Standardization Organisation
IT: Information Technology
OHS Act: Occupational Health and Safety Act 85 of 1993
PERT: Program evaluation and review technique
PMBOK: Project Management Body of Knowledge
PMI: Project-Management Institute
RAM: Risk-Assessor Model
R&D: Research and Development
SMME: Small, Medium and Micro-sized Enterprises
SPSS: Statistical Package for the Social Sciences
UAE: United Arab Emirates
UK: United Kingdom
WBS: Work Breakdown Structure
CHAPTER 1

INTRODUCTION AND BACKGROUND

1.0 INTRODUCTION

Project success relies heavily on the project team’s ability to identify, assess and deal with inherent risks. Up until now there has been a predominant subject of unsuitable skills, obvious deficiency in understanding of and regard for the risk-management course globally. In South Africa, this is echoed on multiple failed-infrastructure projects and the subsequent bankruptcy of companies involved in such projects [1].

The main intent of this research project is the demonstration of the research design and strategy that could be adopted with regard to determining the most effective risk-management model that can be used in the turbulent and often unpredictable construction projects in South Africa, to attain success under changing conditions [2].

The current research project has been particularly directed at small to medium enterprises involved in public infrastructure, construction projects, where the technical nature and magnitude of the projects is subjected to continued uncertainty. The causes of uncertainty in these projects can be attributed to the behaviour of the economy, the political climate of the country, a plethora of policies by stakeholders, as well as the general nature of operations within the construction environment [3].

Furthermore, the research is aimed at measuring the effectiveness of current methods, the further development of a more robust model for application in the construction risk-management process to improve operational performance, as well as the testing of the developed hypothesis through statistical analysis [4].
1.1 RESEARCH CONTEXT: BACKGROUND

Risk assessment and management together comprise an age-old theme that has been thoroughly developed and tested in the literature; but it still lacks a systematic application in South African construction projects, particularly emerging companies and SMMEs [2]. This means that these projects suffer similar shortcomings as those of their global counterparts; but the problems may be amplified by the uniquely South African context, such as the contrasting economic status, previous governments’ policies and population distribution, as well as economic participation. Improper risk applications may have detrimental effects on smaller companies; and that can have a very undesirable effect on the nation’s already inadequate entrepreneurial participation and economic growth.

Hubbard [5], defines Risk Management as the proof of identity, valuation, and the arrangement of risks in the order of priority, corresponding and reasonable resource utilisation for reducing, displaying, and controlling the possibility and or influence of unsuccessful proceedings or to increase the consciousness of chances. The International Standardisation Organisation (ISO) 31000 defines it as the result of ambiguity on goals. This therefore shows a correlation between risk, uncertainty and control. The need to maintain control in uncertainty is the fundamental theme arising from these definitions. Risk management’s aim is to guarantee that indecision does not rebound the endeavour from the business objectives [5]. Hence, risk can be a source of premeditated decisions; it may be an effect of indecision in the administration; or it might just be fixed in the actions of the organisation [6]. This definition suggests a correlation between the organisations strategy and the risks that it faces.

Development is constrained by poor electricity supply, ageing railway network and transport, a lack of railways in the emerging economic centres and residential areas; and an ageing water infrastructure, all of which are not capable of meeting the needs of the newly developed consumers
This means that governments worldwide regard efforts in infrastructural development highly. Nonetheless, main infrastructural projects have a past of problems. Cost attacks, interruptions, unsuccessful attaining, or inaccessibility of private funding are common. South Africa has a similar list of chances, being an emerging economy, that is subject to risks.

As a global trend, the estimation by the World Bank states that 1% point rise of the GDP in a country is a direct result of 10% rise in infrastructural assets. Underdeveloped or insufficient infrastructure brings major problems for financial expansion and community growth globally. South Africa in 2015 spent 57.1% of the public sector infrastructural expenditure on construction.

Organisations adopt Enterprise Risk Management and other forms of risk-management programs; and they can predict downturns on the projects. They are also able to control some of the anticipated risks as they arise, to a sufficiently acceptable level. This allows them to thrive. In a capital expenditure construction project, however, the nature of the ever-changing climate both operationally and project-wise, means that the risks are also constantly changing.

Failure to produce deliverables for a contractor is usually linked to a budget overrun and delays on the project as a result. This means that the contractor who will take over will be exposed to already strained budgets and delivery milestones. This also means that if the new contractor is an SMME, it could also experience rapid growth; and would need to develop a risk portfolio that would be able to meet the challenges inherent in high speed business growth.

**1.2 PROBLEM STATEMENT**

South Africa is listed in 52nd place in a rank of the effectiveness of 61 countries by the World Competitiveness Report. This is an improvement over that of the previous year. A serious part of competitiveness is having the suitable risk strategy that is linked to the organisations strategy.
system adopted should be dynamic enough to allow for real-time deviations; and it should be able
to accommodate them in anticipation. It should also be able to address calculated risk failure,
should it occur. Visser and Joubert [2] found that the majority of South African organisations
surveyed in their research on the subject matter, lacked formal risk-management policies and
actions, as well as a considerable absence of risk-management training was observed within these
organisations. To add a better perspective to this, Mbachu and Nkado [12] also reflected on these
findings in their study, by highlighting client dissatisfaction in construction projects, which is a
direct result of failure to achieve set objectives, despite the project constrains being known.

The lack of continued growth and the extension of the market share for these South African
companies impact the country’s economic growth negatively. This also means that there is
increased South African dependence on foreign companies’ expertise, which comes with a
significant financial burden in expatriation costs.

Furthermore, the following related issues have been identified:

- Project scope over-commitment potential problems and associated risks;
- Failure to take sufficient business risk to maintain brand presence and profitability;
- Difficulty in meeting the demands of rapid business growth for operational performance;
- Ineffective application of a strategic risk-management model; and
- A strategic organizational risk portfolio in operational excellence.

1.3 AIMS OF THE STUDY

This study aims to develop a risk-management model applicable to construction business
operations, for performance improvement, by exploring the literature and empirical research. To
achieve its objectives, the study will evaluate the application of the ISO framework in
construction project-scope selection and limits, particularly when organisations undergo rapid
growth. The success of the study will be proven by the fulfilment of its objectives.
1.4 RESEARCH OBJECTIVES

The research seeks to meet the following objectives:

- Development of a system to apply ISO 31000 more effectively on construction project scope selection.
- Development of a risk-profiling mechanism to be applied to meet the demands of continuous and rapid growth of an organization in construction projects.
- Testing of hypotheses regarding the limits of project scoping that would influence the successful operation and would establish grounds for these limits.
- Development of a robust risk-management model, from the literature and hypothetical testing, applied in real-life or simulated construction business operations.
- Further review of construction-risk management and operational performance under rapidly changing conditions.

1.5 PRIMARY RESEARCH QUESTION

Given the research problems explained in the preceding sections of this dissertation, the primary question that will need to be answered by this research is:

Can a model to determine the risks associated with project scope limits and operational needs, be strategically applied in construction, efficiently to allow the business to thrive under conditions of uncertainty?

1.6 SECONDARY RESEARCH QUESTIONS

The primary research question asked embodies the ideals and character of the research topic in its entirety; and it renders the secondary questions as follow-ups to it. Therefore, in relation to the primary research question, the secondary questions thus follow:
• How will the developed model find balance in its applicability and usefulness in industry, with regard to construction, operation and risk?
• How can better application of a risk-management model impact on construction operations and enhance its contribution to business success?
• Why are construction companies failing to be sustainable in such a lucrative environment?
• How can smaller companies better deal with rapid growth in construction with regard to their operations?

1.7 RATIONALE AND SIGNIFICANCE

Today’s market and competitive forces need rapid changes, in order to accommodate a better performance; and that also means adhering to principles of unceasing upgrading; and this frequently needs a model change. This shift entails taking risks, opening up the company values and an unlimited ability to learn and adjust [13]. You et al. [14] propose that the relationship between company value qualities like reliability, mission, participation, as well as flexibility and corporate performance are there. Swiftly altering competitive surroundings likewise places new demands on companies. This rapid change can also be associated with the organisation’s own market presence and growth.

As such, a risk model that can link organisational operations, in order to excel in operations needs to add value to the organisation. The developed model through this research needs to meet the provision of the following rationale to organisations at the specified levels below.

At micro-level, this research may provide construction organisations with an effective model that they can adopt to improve their operational risk in a construction-project environment for them to remain globally competitive, profitable and reputable. Secondary benefits may include the ability to quote better for future projects, to cope more effectively with scope expansion; and to plan their operations more efficiently under anticipated changing conditions, as well as inherent uncertainty.
At macro-level, this research may provide a platform where a specific model can be developed to address a solution, in order to define the problems. And one that can also increase the available knowledge in operations management risk and strategy, nationally; and this may also have a global reach. The context will still be predominantly African in nature; but it could be compatible with companies in common-wealth countries outside of Africa, as well as other emerging economies, such as member countries of BRICSA.

The knowledge base developed is aimed at enhancing the subject matter in the literature reviewed. It will also aim at forming a reference and a starting point in future research endeavours on the risk operation in construction companies.

1.8 REVIEW OF THE LITERATURE

There are notable studies on the application of effective methods on different variables contained in each theme, in order to effect a specific outcome. The following themes will be used as an approach to demonstrate the overall knowledge base of this research:

- Development of an operational Enterprise Risk-Management framework
- ISO 31000 – Risk Management in a South African Infrastructural construction context
- Tools for operational excellence in South African construction industry
- Strategic Risk-Management effective development and application
- Critical thinking and concepts relevant to project risk and their application
- Business model for success in uncertain environments

Researchers, such as Mafimidiwo and Iyagba [3] have explored the problems facing the building contractors, the SMME’s in Nigeria; and they have utilised a comparative approach to establish the validity of the research findings using companies of the same class located in South Africa. In their paper, they provide an insight into the general nature of infrastructural construction projects and the companies involved in them, as well as the impact that small and big organisations have on
each other and on the project at large. Their research provides an excellent framework, which can be used as a starting point in exploring the applicability of developed academic literature in the context of construction companies.

Beckers et al [7] have completed a research paper on the risk-management approach to a successful infrastructure project. The research explored four phases that range from selection to asset operation in international projects undertaken by public, private, as well as partnerships between public and private companies. It highlights the most typical causes of project failures, such as the failure to build risk-mitigating factors into the design by engineering companies. The article also covers frameworks, such as enterprise-risk management (ERM); and it explores its concepts and their applicability in depth.

The current research further seeks to make a risk-management structure that can be applied in construction developments, in order to stimulate success; while maintaining compliance with the legislation and constraints. The hypothesis developed by such researchers will be used as a reference base in testing the existing or currently researched hypothesis in the subject matter, particularly on the nature of the infrastructural construction projects. Visser and Joubert [2] and Mbachu and Nkado [12] also completed research projects that have made a notable contribution to the subject in question; and these will be examined for their completeness and relevance.

ISO 31000 is a standard that defines the components of a risk-management implementation framework. The management of risk associations, such as the (IRM) Institute of Risk Management; UK based (AIRMIC); the Association of Insurance and Risk Managers, as well as the State-owned risk-management association (Alarm) have completed a guide that offers commentary on a planned method to ERM and compliance with the necessities of ISO 31000 (Alarm, IRM, AIRMIC, 2010). In their guide, they have discussed in depth, the principles of risk management; and they have described methods that should serve as advice on the implementation
of the ERM initiative. A simplified risk-management process is presented in Figure 1.1.

![Risk-management process](image)

**Figure 1.1: Risk-management process (Source: ISO 31000 [159])**

Operations management improvement concepts have also been developed comprehensively in the literature; and as such, quantitative methods, such as Six Sigma methodology (manufacturing enhancement technology) have been developed to promote the systematic use of specific improvement techniques. The list of authors in the literature can be exhaustive; but a few, such as Slack, Chambers and Johnson [15] that focus on the correlating concepts to construction projects will be explored as the literature sources of the theoretical framework for this research.

### 1.9 RESEARCH DESIGN

For the purpose of this research, the structure of the methodology will be as follows:

- Review the current risk-management models applied in business operations on construction projects.
• Collect the data necessary to evaluate the current trends with regard to the application of the management of risks in construction projects.
• Conduct a statistical analysis, thereby coming to conclusions.
• Develop the theoretical model that can be applied more effectively, in order to fulfil the research aims.

The primary focus has been on enhancing the current models adopted; and to develop one that incorporates optimised applicability in context, as defined in the introduction [16]. This makes this research quantitative in nature. This will enhance its validity and provide a structure of comparison.

The theoretical approach, which is to be used, is a result of the research questions and the projected research methods shown in sections below. Each theoretical view has a dissimilar perspective on how to make clear and understand the knowledge. According to Crotty’s [17] framework, which will be shown on a figure below, the theoretical perspective provides a framework for the procedure, thereby laying the foundation through its logic and criteria.

![Figure 1.2: Theoretical perspective and philosophical stance (Source: Neuman [161])](image)

The theoretical perspective has been recognised, grounded on the methodology and the study research questions. Crotty [17] contended that the final step would be to decide on the theoretical
position on which the research will be grounded. However, researchers have diverse opinions on how information is generated; and how the ‘truth’ or knowledge are identified, it is nevertheless important to clearly state the theoretical framework that the research will adopt [18]. Furthermore, it is vital to mention the ontological and epistemological assumptions underpinning the research, in order to ensure its authenticity and excellence [19, 20].

1.10 POPULATION AND SAMPLING

Polit and Hungler [21] define the population as a collective of all the items, subjects or members that adapt to a set of terms. In this research, the population will be South African engineering companies that are primarily engaged in construction; their divisions or departments that carry out construction work, particularly in infrastructural development. To represent this population, risk practitioners, engineers, technicians, project managers, construction managers, construction supervisors and other technical personnel will be key to the research, as a sample and population thereof.

The procedure of choosing a portion of the population to symbolise the whole population is known as sampling [22, 21]. Brink [23]; Polit and Hungler [21] define a sample as a subdivision of a population chosen to contribute in the research; it is a portion of the entire population, selected to participate in the research project.

The stratified sampling of companies involved in Eskom's newly built projects in three engineering disciplines comprises: mechanical; civil and electrical. This is because there are currently over 40 contractors working on these projects; and the reports surrounding these projects have largely brought forward notable challenges, which these contractors, as well as the parastatal are facing throughout these projects.

Specific criteria defining the features that people, or entities in the population, must have for them to be involved in the research should be well-defined at the beginning of the research [21]. The
eligibility criteria in this research will be that the participants must be South African construction companies, be actively or historically involved in infrastructural development projects; and they must be at least a SMME.

Risk participation in companies is not limited to risk practitioners only; but also to different groups of personnel and levels that may have direct or indirect influences on business risks and decisions arising therefrom. It follows immediately that a minimum of 6 companies across the different disciplines and 10 respondents in each would form a good measure that would satisfy the demographics of these companies.

1.11 DATA-COLLECTION PROCEDURES

1.11.1 PRIMARY DATA

The data collection will mostly be done through retrieving archived data from reliable databases, such as those available from the following list of organisations:

- World Bank
- Statistics South Africa
- Companies and Intellectual Property Commission (CIPC) (former CIPRO & OCIPE)
- Department of Trade and Industry, South Africa
- Construction Industry Development Board (CIDB)
- Private construction organisations and their affiliations
- Department of labour, etc.

1.11.2 THE SECONDARY DATA

The secondary data collection will include published research articles, theses and academic literature, which would only serve the purpose of hypothesis comparison, testing and literature
Simple tables and summaries will be used. Survey questionnaires, company publications and internal project records will be utilised.

1.12 DATA ANALYSIS AND INTERPRETATIONS

“Epistemology is concerned with providing a philosophical grounding for deciding what kinds of knowledge are possible and how we can ensure that they are both adequate and legitimate” [17]. Statistical and mathematical practices are vital to gaining a good research, which follows the precisely planned research methods, in order to find out single and objective truth [20]. To fulfil a positivist approach, this research will adopt the use of quantitative, statistical methods.

Tools for the analysis of statistics like IBM SPSS Statistics will be used to perform the data analysis, hypothesis testing and reporting. The produced results will be linear or multiple-regression graphs, other types of graphs, in addition to tables and charts. Contained in the report, will be the standard and mean deviation generated from the survey participation results.

1.13 RESEARCH TRUSTWORTHINESS

To fulfil its mandatory trustworthiness on the quantitative approach, a construct proposed by Guba [25], will be adopted. Guba [25] suggests four benchmarks that the author trusts should be used as follows:

- Trustworthiness;
- Transferability;
- Reliability;
- Confirmability.

This is because this research subscribes to positivism paradigm and is therefore grounded on a quantitative approach. The provisions for these criteria will be applied to all quantitative data that will be gathered for the research, in order to establish their trustworthiness.
1.14 LIMITATIONS

To provide a manageable model, this research will be limited to a South African context; but it will exclude the following, because of the dilution of its aim:

- Political bias. Political influence on certain entities will be examined; but this research will not make comments of any political bias; and it will not promote or demote any political ideals and representatives.
- Non-ethical mode of accessing information.
- Inclusion and distribution of confidential information. To enhance the validity of this research, consents will be obtained from the intellectual property owner prior to use.
- Racial bias. The effects of these entities will be examined in the research; but they will not be a focal point for the researcher.

This research will be funded through private financing by the researcher; and all the costs will be met by a sufficient financial savings account that has a considerable amount specifically kept for this undertaking. Research estimates are not easy to attain at this stage; but the key is that the project will be confined to the borders of South Africa, as far as travel is concerned. The following will be a few considerations for the budget:

Software to run statistical analysis will be bought at a student-special rate; but the evaluation of the prices for different packages still needs to be verified. Alternatively, statistical analysis will be outsourced to UJ’s Statistical consultancy division, Statkon.
1.15 ETHICAL CONSIDERATIONS

Scientific honesty is a very important ethical obligation when doing research. Untruthful behaviour includes the manipulation of the design and approaches, and retaining or manipulation of the data [26]. This research subscribes to scientific honesty and the maintenance of confidentiality throughout the research, particularly where sensitive data are being handled.

The South African Bill of Rights is the basis of democracy in the Republic of South Africa; and it safeguards the rights of all the people in the nation; and it sustains the free morals of human self-respect, fairness and liberty. The administration of the country must value, guard, encourage and actualise the principles within the Bill of Rights. The same goes for the researcher in relation to the protection of the rights of others and respect of their privacy and dignity. It is because of this, that the research will seek to collect written consents prior to the use of all intellectual, as well as personal information received via the described data-collection methods [15].
Chapter One deals with a general idea to the study; and it introduces the problem that leads to the relevance of the research. The objective and purposes of the study are drawn together with the motivation and procedure of the research. The arrangement of the dissertation is also explained in this chapter.

Chapter Two provides an analysis of literature in relation to the study; and it forms a theoretical basis for the study. Numerous theories and concepts linking to the development of an optimized risk-management model are discussed. Furthermore, models of risk analysis are reviewed. Risk analysis techniques are also discussed.

Chapter Three emphasizes the research methodology. It offers an understanding into the study and the questionnaire design. The data-collection methods and sampling are explained. The statistical analyses used to analyse the data are also emphasized.

Chapter Four demonstrates the outcomes of the study by using tables and graphs. Important findings are also discussed in the light of the literature review.

Chapter Five provides a synthesis of the previous chapters putting forward recommendations with reference to the findings of the study. Potential research recommendations are discussed in this chapter also.

The remaining sections of the dissertation comprise a list of the references used throughout the dissertation, as well as the additional information that is relevant to supporting the dissertation, attached as annexures.
CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A detailed evaluation of the literature related to risk management will be presented in this chapter. A synopsis of the risk-management procedure and the significance of the management of risks in organisations and society is outlined in this chapter. In addition, the risk management from an organisational perspective is discussed, as well as its affect on project performance. Furthermore, the risk-analytical techniques and responses are also discussed. The theoretical information will be contextualized in regard to the prevalence of the management of risks in the construction industry.

2.2 DEFINITION OF RISK

According to Juttner [27], most organisations have recognized risk for some time; and there is a massive literature on this issue in the subjects of economics, finances, strategy and construction. The term risk is perceived as a multi-dimensional concept; and it can be credited with occurring inside or outside an organisation; and that decreases the certainty of results (for instance, political, environmental and market risks). In addition, risks can be explained, as the possible consequences of an incident (e.g. functioning, individual and service risks).

The Project Management Body of Knowledge [PMBOK] [28], states that risk is an unexpected incident, which has optimistic or undesirable impacts on project goals, time, cost and scope or value. Krane et al. [29] suggest that a risk can be known or unknown.

The Brazilian National Quality Foundation [30] Excellence Model recognises the need for organisations to recognise perceived company risks; and it describes risk as a mixture between the likelihood of an event and the significance of an unwanted occasion. In addition, the company’s risk is a risk to the accomplishment of a company’s objectives in the face of market doubts, the
company’s area of operation, the macro-economic situation and the company’s own procedures. Chapman and Ward [31] note that risk encompasses everything of any kind that might have an influence on the achievement of a task. Raz et al. [32] point out that all projects have risks. Hence without question, risks can be controlled successfully; however, this does not necessarily mean that risks can be eliminated entirely. Nevertheless, overall project stipulations, an agreement stating that the efficient management of risk improves the project’s performance and accomplishment was reached. The word ‘risk’ is used as mentioned above within the whole of this thesis. Certainly, this is how it is mostly understood in concept and particularly in the exercise linked to construction projects.

The literature is replete with numerous studies on contractors, risk management, strategic management and operational management in general. The following themes will be used as an approach to demonstrate the overall knowledge base of this research:

- Development of an operational enterprise risk-management framework
- ISO 31000 – risk management in the South African infrastructural construction context
- Tools for operational excellence in South African construction
- Strategic-risk management: The effective development and application thereof
- Critical thinking and concepts relevant to project risk and their application
- A business model for success in uncertain environments

According to Mbachu and Nkado [12], over the past decades, many researchers and organisations have embarked on extensive research; testing and development; and they have subsequently made a significant contribution to the literature through various studies on risk; risk management; construction; strategic management and operational management in general. In recent years, studies relating to the relationship between infrastructure and financial development have become
one of the most important economic topics in both academic and policy circles [33]. This research extends across four knowledge fields, as listed below:

- Operations Management – Driving efficiency of operations in the business
- Construction – Infrastructural development projects in South Africa
- Risk Management – application of Enterprise-risk management plus risk models
- Strategic Management – application of risk-model strategies in business

Literature will be grounded on the applicability in such construction projects in South Africa. To achieve an intuitive and grounded research output, the four themes will be examined in interdependence and not in isolation, despite their concepts being satisfactorily defined individually.

2.2.1 Types of organisational risks

According to Segal [34], any risk disclosure can be a danger or a hypothetical risk. Hypothetical risk is a condition in which income, cost or no cost is likely; and the choice to undertake fresh markets, to buy the latest tools, expand on the current product line, to enlarge or lower the spheres of operations, to improve advertising, to access extra funding, to transport risks characteristic to the trade in the context of an optimistic or undesirable result [35]. Montagne and Norell [36] acknowledge that vulnerability risks happen – due to unintentional failure involving the option of failure and success. In addition, Segal [34] highlights four key classes of risks: hazard, financial, operational and strategic risks.

- Hazard risk: Business disturbance exposure; experiences with criminals; Environmental accountability exposure; Common liability exposure; Health and safety exposure; Machinery and boiler exposure; Exposure to natural disasters; Product liability exposure; Property exposure.
• **Financial risk**: Financial exposure; Credit exposure

• **Operational risk**: Fleet operation and marine exposure; IT and Electronic exposure; Personnel and human capital exposure; Production, technological and R&D exposure; Project risk exposure; Supply-chain exposure [34].

• **Strategic risk**: Compliance, regulatory and legal exposure; Corporate governance and ethics exposure; Intellectual-property exposure; Marketing and product-management exposure; reputational and brand exposure; social, economic and political exposure.

### 2.3 RISK-MANAGEMENT PROCESSES

Risk management processes include a number of steps, as explained below. The application of a risk-management system is a long-term, active, communicating process that needs to be constantly upgraded and included in the organisation’s strategic forecasting (Brazilian Corporate Governance Institute [30]).

#### 2.3.1 Step 1: Identification of risks

Guba [25] is of the opinion that risks which are invisible are hard to measure and deal with. Nonetheless, an entire exposure of the risks is difficult. In addition, he further highlights that the duty of risk management is to protect the crucial risks fully. Identifying risk ought to be done by a means that is progressive and in line with the development of the project, because prior to the project, not every risk is entirely identifiable, as well as the fact that in the course of the project execution, additional risks will possibly appear [26].

As shown in Figure 1.1, the initial step in the risk-management process is in identifying the risks. There are numerous ways of identifying risks in an organisation. However, Figure 2.2 offers an outline of numerous approaches for recognising risks. Rules, imaginative and directed approaches are differentiated. The first category gives the likelihood to realise new kinds of risk. Directed
approaches like agendas for recognising risks, with the help of which the imaginable forms of risk are checked.

![Figure 2.2 Methods of identifying the risks (Source: Goeke [38])](image)

In relation to projects, Hampton [39] highlights that the following risks happen, which are grouped depending on the risk forms:

- **Quality risks**
  - Faults in provisional outcomes
  - Unable to apply methods of the project
  - Very few controls / tests

- **Personnel risks**
  - Lack of skills
  - Disagreements in the team

- **Cost risks**
  - Forecasting changes
- Complex project state of affairs
- Customer’s inability to pay

- **Set date / deadline risks**
  - Not surrendering in adequate time
  - The time taken to finish the project is lengthened

- **Risks of strategic decisions**
  - Inability to be aware of opportunities
  - Inability to constantly utilise the odds

- **External risks**
  - Natural occurrences
  - Changes politically
  - Societal changes
  - Entering new markets
  - Legal developments
  - Changes in sectoral trends
  - Changes in technology

### 2.3.2 Step 2: Risk Analysis

Key aspirations of risk analysis are clarifying risk state as wholly and accurately as probable and to rank the risks [37]. In addition, Haimes [40] points out that the known risks need to be examined with respect to possibility of them happening, and the result of the project. Project folders, together with risk expenses valuation correspondingly help for grouping reasons. Standards must be put in place on the foundation which different risks can be measured and matched with other risks.

A risk must continuously refer to damage involving occurrence, whereby a certain value can be
given. Damage can be measured as overheads and also chance of happening, the worthiness of risk can be designed [Fig 2.3].

Jorion [37] states that there is more than one way to assess the identified risks, which are the cause of the trouble, their likelihood and the effect evaluation, the risk selection and risk-team investigation.

![Figure 2.3 Risk classification (Source: Jorion [37])](image)

### 2.3.2.1 Error, possibility and influence analysis

According to Jorion [37], error possibility and the influence of evaluation is a mostly formal systematic technique used for logical analysis of the imaginable errors and approximation of the risks related to them. Probable errors are found aided by an ordinary fault, likelihood and influence analysis form, penalties examined and the reasons are recognised as well as measured.

Afterwards, the reasons for the errors can be thoroughly measured in relation with the likelihood of how they happen, importance of purchasers and likelihood of them getting exposed. Lastly, appropriate actions can then be implemented.
2.3.2.2 The risk portfolio

Warwick [41] explains that within the risk folder, the arrangement of risks depends on the quantity of harm or damage, as well as the chance of them happening. Therefore, the impact to project as well as the necessity to do something will be assessed.

2.3.2.3 Risk-team analysis

In terms of risk-team analysis, Hillson [42] maintains that risks are found and examined depending on the kinds and pointers for the happening of risk are calculated. Possible actions are expounded and characterised and persons accountable for the risk checking and announcement are found [38].

2.3.3 Step 3: Assessing risks

Gupta [43] asserts that risk assessment is made up of qualitative evaluation and quantitative capacity of different risks comprising of the interrelationship of their properties. Using the assistance of outcomes of risk valuation, such as the risk portfolio of a project may be demonstrated and then compared with others. Vose [44] describes that the banking and insurance industry has the statistically precise systems of measuring the risks; and these are very beneficial. Nevertheless, they are unable to determine the usual risks within the industry. Hillson [42] identified the approaches of risk evaluation and risk evaluation that can be used in construction projects.

2.3.3.1 Key indicators of performance

Performance pointers depend on quantitatively calculable situations. Therefore, their foundations are meant for evaluation. According to Hillson [42], key performance indicators are accessed for risk valuation when a vast amount of data and statistics need to be matched with the main presentation pointers, standards from which risk caution may be derived [38].
2.3.3.2 Qualitative assessment

In relation to qualitative assessment, Gupta [43] explains that when there are no neutral data accessible, risks have to be measurable and made quantifiable anyway. The technique used is qualitative approximation and allowance; using the method, risks can be evaluated individually – given their chance of happening and the quantity of harm they can inflict [38].

2.3.3.3 Probable maximum loss

Likely extreme loss involves the measureable risk determination that focuses on approximating the chances of hazardous incidences in a risky state of affairs. The evaluation of the risk of main harm for example the total loss likely can be determined [40].

2.3.3.4 ABC analysis

ABC analysis is grounded on the fact that regularly comparative minor issues make up the major portion of an entire project’s risk portfolio. The aim of this evaluation is to discover the reasons that create the major component project worthwhile whereby a larger preparation as well as a direct expense is acceptable [40].

2.3.3.5 Risk map

A risk map shows an initiative’s risk profile. It is also known as a risk landscape, risk map or risk matrix [2]. In a risk map, it can be arranged in the order of importance in which the risks must be handled. However, the risks will not be tolerated, those which can threaten the sustained presence of initiative, are ranked first. Risk organisation within a risk matrix therefore allows two arrangement ways, which are: the likelihood of happening and the projected value [38].
2.3.4 Step 4: Controlling risks

Monitoring risk is dynamic impacting of the risks established with the perspective of risk investigation. The risk-evaluating processes is categorised among the causes and effects [45]. Cause-related methods are meant to lower risks, whereas effect-related methods help to reduce or defend in opposition to the quantity of harm anticipated in the occasion of the loss or decreased tracking occasion [37]. According to Brink and Wood [26], risk can be controlled by prevention, lessening, transferring the risk and facing the risk.

2.3.5 Step 5: Monitoring risks

Visser and Joubert [2] state that risk monitoring is the incessant functioning control of the efficiency of the risk-control procedures. The aim of risk management is not to remove risks completely from the project. Perceiving risk assists assurance that the risk location of the project agrees with the risk condition struggled for. This job is maintained instrumentally through evaluations of alterations. The inside control system is a part of the observation of risks. The non-stop monitoring of the early signs and the recurring risk confirmation are carried out by the people accountable in each situation, not later than the separate due dates [37]. A requirement for this is that a reporting and meeting structure in the organisation and for the project is insisted on.

Moreover, the search for the risk status and the development of the measures, new additional risks must be positioned if the project matches the risk situation strived for [2].

According to Mbachu and Nkado [12], risk monitoring is reinforced instrumentally through evaluation of the differences between the set baseline and the changes that arise. The inside control system is used as part of the monitoring of the risk. The continuous monitoring of the early pointers and the repetitive risk verification are carried out by the people accountable in each case, no later than the particular due dates. Guba [25] confirms that a precondition for variance analysis
is a reporting and meeting structure in the organisation and for the project these must be specified. In addition, the pursuit of the risk status and the progress of the measures, new additional risks must be included. Risks that have happened must be recorded with the appropriate quantity of harm; serious circumstances of management must be stated and the state of the project links to the risk state wanted [12].

2.3.6 Step 6: Controlling goals

After the recognising, investigation and valuation of risks, methods for controlling the goals must be taken [40]. According to Nasir, McCabe and Hartowo [46], the control procedure may be broken down into sub-processes: Determination of the target value; determination of the actual value, target/actual comparison and an analysis of variances. In addition, risk monitoring, identification, analysis, and controlling are checked to find out whether the risk control is applied in a suitable way. Furthermore, in the occasion of differences between the real risk circumstances and the risk situation wanted, measures must be put in place to correct the reasons. Founded on these acknowledgements, the risk plan must then be modified or reviewed [38].

2.4 Risk management in the progress of the project

Raimes [47] highlights that the project manager is accountable for carrying out the risk management. The role of the project management in the occurrence of risk identification is to determine any evolving risks of a construction project and contain these in a risk record. In practice, risk records that have been made up based on experimental values from similar construction projects work as normal support ways [48]. In order to inspire enthusiasm to accept risk management in the construction industry, normal risk checklists should be drawn up by the project managers. In addition, project managers and teams should have risk-reducing procedures that are easy to devise, which makes it likely to deal more easily with the project risks [40].

Hampton [39], attests that it is important to instal a risk-management system when potential risks
have been identified before or at the beginning of the project. However, the effects and damage of the risks can only come to light in the succeeding advancement of the project. Thus, Jorion [37] adds that the risk-management process should be recognised and combined into the whole project process as an ongoing activity of the project management. Furthermore, Jorion [37] adds that the identification, examination and valuation of risks must be focused on the whole project and on the distinct features of the individual project stages. Overall, the advancement of a project can be separated into three stages: the beginning stage, the management stage and the finishing stage.

In addition, the phases must be combined into the risk-management procedure, in order to prevent the progress of the project from being affected.

According to Chapman [31], when dealing with risks in projects, the following principles apply:

- Accountability for carrying out the chance and risk management is borne by the project manager.
- Only taking risks that one can effect oneself;
- Protection against risks that are influenced by others (customers, subcontractors);
- As far as possible, pass on the risks taken; and
- The concern of probabilities and risks is a part of the project reporting.

With the assistance of particular questions characteristic of the individual stages, it is presented where the tasks of risk management are combined with the development of the project. Some questions are specified as examples, whereby the form and range of the questions can be stretched and accompanied at will. The project analysis carried out concludes the project stages of the choice of services of project management, which was established for project management by the AHO commission of specialists in three stages [40].
2.5 TASKS OF RISK MANAGEMENT

Throughout the project lifecycle, certain risk management tasks and activities are performed at each phase. Each phase presents a different set of challenges and risks. Below, is an outline of these phases.

2.5.1 Start-up phase (project preparation; planning)

The start-up stage matches with the project steps 1 and 2 from the range of services of the project control [49]. In the initial stage, the emphasis of risk management above all is on the check of the contractual and general situations of the project environment. The task of risk management is to identify probable risks that can distract the real progress of the project [40].

2.5.2 Manage phase (preparation of the implementation and implementation)

Zou, Wang and Fang [50] attest that the task of risk management in the managing and execution stage of the project are categorised by the goal of the project advancement. In principle, during the project execution, it is basically a question of observing known risks from the start-up stage and their variations [50]. The influence of the methods used to deal with risk must be evaluated and the risks must be investigated frequently in a result-oriented method. For the managing stage, there are questions which can then be asked.

2.5.3 Closing phase (project completion)

The project end is reached upon the performance of the service and the delivery of the structure to the principal (for instance a real-estate developer). Chapman [31] explains that it is serious if the principal declines to accept the finished project to the results that are below the quality expectations of the principal. Risk management can aid in the escape of such let-downs by following some questions.

In addition, Hillson [42] states that, in order to improve the risk-management system, it is
significant that stock is taken as a reflection on the advancement of the project. In this, the appropriate questions are: What recognised risks have happened? What difficulties that have really happened in the advancement of the project were not recognised as risks and why?

2.6 RISKS IN THE PERSONNEL SECTOR

According to Shen et al. [51], structural disturbances in the world of technology, coupled with vibrant variations in the sales markets can only be grasped successfully if the personnel of an organisation identify with this and are dedicated to this. Mostly, for enterprises that give highly competent services, focused employees acting on their own responsibility are vital for market success. For this reason, personnel risk management is very critical, in order to escape damages in functioning capability and new possibilities through the departure of employees. Vulnerable risk fields can be shared into four areas: Bottleneck risk field; departure risk field; adaptation risk field and motivation risk field [40].

2.6.1 Bottleneck-risk field

It is important to identify at the right time areas where there will be absent future top performers. In this way, the following questions stand as the focus:

- What are the key qualifications for the future?
- Are strategically important staff positions safeguarded?
- How will the quantitative need for employees change in the future?
- How do the qualitative requirements of the employees change due to new scopes of service or technologies?

2.6.2 Departure risk field

Departures of top performers usually establish a very high risk – especially in long-term projects in which the project manager is the confidant of the real estate developer. According to Hubbard [5],
the organisation should consider having a good organisational climate, positive outline conditions for employee development, extensive non-material motivations on the side of the enterprise, payment structures sufficient for the act, appropriate organizational structures and marked distribution of power possibilities to decrease departure risk.

2.6.3 Adaptation risk field

Hampton [39] states that falsification of qualifications by employees constitutes an adaptation risk. Therefore, as a protection, requalification or new qualifications are essential. In construction projects, there are continuing extra training and refresher training courses to equip the personnel to cope with technological and legal changes. In construction, the project management altered possibilities of service must be considered through a superior alliance of services in the execution of the construction work.

2.6.4 Motivation risk field

Shen et al. [51] explain that when employees are not motivated, they engage in behaviour, which is risky to the organisation. For instance, low motivated employees engage in unproductive behaviour, such as absenteeism and undertaking less competitive work, among others. Therefore, Taleb [52] attests that promoting personnel development in an organisation, as well as implementing motivational techniques is crucial.

2.7 IMPORTANCE OF RISK MANAGEMENT TO ORGANISATIONS AND SOCIETY

Shunmungan and Rwelamila [1] state that risk management is a significant skill that project managers must grow, regardless of the company concerned. Certainly, it is significant for the risks to be efficiently decreased and removed, wherever possible in the society [53]. Nonetheless, risks are part of life; and frequently projects are very multifaceted, creating even more possibilities for scheduled activities to go wrong. Therefore, those accountable for dealing with risks need to be
gifted in recognising risks, measuring their influences, and planning response plans. In such situations, projects that have been completed on time, may fall behind schedule, be completed after due dates, include cost over-runs, and said not to have been accomplished correctly [54].

It is noted by Chapman and Ward [31] that risks are caused by doubts; and that doubts themselves arise; since each project is different in its structure and thus, involves a different approach. However, regardless of such an appreciation of the truth of construction projects, and the latest efforts of many construction organisations to impact risk management, it can be perceived that numerous projects have not enjoyed the advantages to be gained from organised and established risk management [55].

A way in which an organised approach can be embraced is when there is acknowledgment of the mixture of stakeholders between the stakeholders in a construction project [56]. In construction organisations, the stakeholders are varied and the client should aim to recognise the level of awareness towards risks by all of these stakeholders, and want to examine the numerous strategies that are in place in this respect [57]. In such a condition, it is easy for the client to see the significance of risk management when making a decision to continue with a project, as the risk will be recognised in advance; and later, the prerequisite for management will be clear. In addition, in cases where risks is recognised at the beginning; it will be stated in the contract at the beginning of the project. Organisations and societies involve in risk analysis in advance of large projects and they all have a tendency to focus more on disaster management rather than risk management for real response, with the result that the risk-management strategies that do exist are insufficient [58]. This has led to the significance of research in numerous scopes of risk management. Especially with regard to the construction sector, Al Zarooni et al. [59] observed that the construction industry is accountable for 60% of the gross fixed capital creation during the last three decades. Accordingly, it appear vital to find the risks and their impacts in the construction sector, and to formulate strategies that would allow suitable, fruitful and operative answers that would please
both clients/end users, as well as all the other project stakeholders [60].

2.8 RISK MANAGEMENT FOR CONSTRUCTION PROJECTS: THE ORGANISATIONAL PERSPECTIVE

In South Africa, the amount of people with entrance to the electricity grid must increase by at least 90 per cent by 2030, with non-grid options available for the rest [57]. This will fulfil the objectives of the national development plan. The nation would need an additional 29 000MW of electricity by 2030. About 10 900MW of current capacity is to be discharged, suggesting new building of more than 40 000MW. At least 20 000MW of this capacity should come from renewable sources [61].

As part of its own sustainable asset creation, dimensional strategy and to fulfil its mandate of supplying the country with electricity, Eskom has embarked on building two, new coal-fired power plants that would see its capacity being increased by 9600MWe upon their completion [62]. This would see each construction site having over 17000 in employment through various contractors and subcontractors, and they would peak at around 23 000, making the combined sites, the largest construction projects in the world at that particular moment [62].

Mafimidiwo and Iyagba [3] explored the challenges facing the building contractors in Nigeria; and they utilised a comparative approach to ascertain the validity of the research findings, using companies of the same class located in South Africa. Mafimidiwo and Iyagba [3] provide an insight into the general nature of infrastructural construction projects and the companies involved in them, as well as the impact that small and big organisations have on each other and on the project at large. Their research provides an excellent framework, which could be used as a starting point into exploring the applicability of developed academic literature in the context of construction companies. Beckers et al [7] conducted a research on risk-management approach in a successful infrastructure project. The research explored 4 phases that range from selection to asset operation on international projects undertaken by public, private as well as partnerships between
public and private companies.

They highlighted the most typical causes of project failures, such as the failure to build risk-mitigating factors into the design by engineering companies.

According to Visser and Joubert [2], ISO 31000 is a standard that defines the mechanisms of a risk-management execution framework. Risk management associations, such as the Institute of Risk Management (IRM); the UK based Association of Insurance and Risk Managers (AIRMIC) as well as the public-sector risk management association (Alarm) have completed a guide that offers commentary on a structured approach to ERM and compliance with the requirements of ISO 31000. In their guide, they have discussed in-depth, the principles of risk management and have described methods that should serve as advice on the implementation of the ERM initiative [6].

Construction project achievement entails a sure viewpoint to be increased by everyone involved; since there is no one way to continue in terms of emerging a risk-management strategy [12]. The organisations frequently plan their own method to accomplish the risks related with their projects [6]. Nonetheless, one way of handling more efficiently the many doubts abounding in projects, is to search for opinions from many people; for example, stakeholders and clients [63]. Therefore, all stakeholders must improve their ability to observe the type and advantages of risk management; since the difficulty of projects is gradually growing.

Furthermore, inside and outside shareholders effect projects, and their separate fulfilment is vital; so it can be agreed that they will strive for the outcome which is best for them [64]. Kerzner [65], postulated that stakeholder involvement in risk management has been significantly better; because stakeholders learn from risks that occur recurrently in difficult projects and are predicting the behaviour essential to deal with these. This is in contrast to what happened earlier when participants had little information on their projects [65].

Risk-management awareness differs from one project, and from one nation to another, for a
number of different reasons. In the case of Malaysia, Yusuwan et al. [57] found that lower levels of risk management awareness in a client organisation; while the need to learn about it was very important. Collinge [66] has also found that the stakeholder factor establishes a source of risk in construction projects. Henceforth, real stakeholder management is vital if organisations want their projects to prosper. This entails stakeholders to be correctly knowledgeable about their legal and ethical duties; and how they are affected by these, in order that they involve in the suitable amount with all features of the projects [66]. It can thus be assumed that risk and stakeholder management is an area of research that should be pursued as a noticeable theme in the field of project-risk management.

2.9 RISK MANAGEMENT AND CONSTRUCTION PROJECT PERFORMANCE

Being unable to control project risks through the project life-cycle impacts the project performance [67]. However, research aimed at recognising an efficient approach to risk management is accumulative; as the aim of all organisations is to make sure there is good project performance [68]. Risk management must be measured as an essential part of project management. Good results are to be attained and general developments are to be made to the decision-making process [69, 70]. Thus, effective risk management is essential to deal with maintainable work stages within projects. Such value is seen to accumulate by escaping extra and pointless expenses, by being positive in predicting precisely, in acquiring the best tender, and in guaranteeing that all approximating is well-grounded.

Furthermore, value is located in keeping a project within its agreed timeframe, safeguarding that the design process runs efficiently, that the real construction is correctly performed, and that when the project is finished, the subsequent building is fit for its purpose. In addition, projects need to meet the mandatory quality, purposes and security, for there to arise a better understanding of the risks that might increase to a project, for the significances to be known, and fundamentally to learn
from previous errors. Derived from the complete list of value-added features, all stakeholders benefit from risk management, and not just the project team [71]; [6].

Measuring the project performance is a very difficult process, but as stated by Motaleb and Kishk [72], it is advisable to use the traditional standards of cost, time and quality, as a measure of project achievement during construction. Thus, Atkinson [73] states that it is wise for there to be more focus on in-time performance; since postponements are a common cause of failure, resulting in cost over-run and decreased profitability for the construction organisation. This type of performance is measured simply by launching the difference between the planned and the actual duration [74]. If a construction project is completed, according to the planned arrangements and in the expected timescale, then it is measured as successful; but in fact, time performance is not only concerned with whether a project is really accomplished on time, but also with whether, within the process of construction, cut-off dates along the way are met, such that the development of the work is seen to be in agreement with plans. Research on project performance, and exactly in terms of benchmarking in monitoring risks of the construction project interruption, and so doing in the general context of risk management, remains sparse [39].

2.10 THE NEED FOR RISK-MANAGEMENT PROCESS DEVELOPMENT

According to Simu [55], previous research studies have recognized the slow pace of growth of risk management as a managerial discipline, assigning this fundamentally to immature organisational systems, and to a lack of education and training in risk management. Simu [55] has claimed that the main management system is more of a hindrance than a support to the development of efficient and effective risk management. The author claims that the use of the informal and traditional management system is not enough to achieve control over risks, such as delays. This idea is reinforced by other researchers who trust that project risk is heightened by poor project management and the lack of combined systems, an issue picked up also by Yeo and Ren [75] who
discerned that risk management needs complete knowledge of the entire project, and an acknowledgement of the need to ensure value creation and success; so they claim to develop a multilevel agenda for the risk management.

Burtonshaw-Gunn and Simon [76] declare that project management in itself is risk-driven, since if there were no risks associated with project implementation, there would be no need for project management.

According to Jorion [37], there are differences in project stages, depending upon the project, as all projects are exclusive. Nevertheless, in spite of such differences, the content of the risk management process remains the same in the project lifecycle; and developments to it through hypothetical investigation, would represent the probability to improve all projects. Highsmith [77] suggests that the procedure consists of risk identification, investigation and response. Merna and Al-Thani [78] add that all risks must be correctly reported because risk management is a vibrant process of identification that should be revised frequently.

In 2004, the PMI printed a lot of information about risk management development in the project life cycle, converging on features, such as risk identification, qualitative and quantitative risk analysis, risk-response planning, and the observing and control of risks. Crawford [79] debates that there is a need to properly document all information about risk. In this undertaking, it is significant to recognise that the more difficult a project, the greater likelihood that more individuals/organisations will be involved; and in this respect, the owners of each potential risk must be identified, and involved in the development to safeguard appropriate risk modification by the deliberation of several different response options [40].

At that point also, the modification strategy for risk-response development should be measured, according to its competence; and that may be changed from one project to another. Unfortunately, as noted by Sarshar et al. [80], construction organisations have few methodological mechanisms to
undertake such assessments within the construction process.

Of those that are available, the Construction Maturity Model (CMM) was established specifically to help in such investigations within the construction industry. This model was planned by Crawford [79] to help construction organisations to improve their project-management processes. It tests five levels of maturity (risk identification, risk quantification, risk-response development, risk control, and risk documentation), which are considered essential in construction projects. The model was developed by Crawford [81], who suggests a process of continuous improvement orchestrated by a ‘maturity’ management system; and it is used in the present study to reflect the capability of risk-response development – particularly to overcome performance-related delay problems.

The model is based on the premise that lessons should be learnt and that construction system capabilities should develop accordingly, such that projects of all kinds can be successfully executed and delivered on time and according to standard [67].

2.11 RISK-ANALYSIS TECHNIQUES

Risk management is a logical process of identification, assessment, response and control project risks. This includes efforts to maximise the probability of optimistic events; and to minimise the probability of opposing events and effects to project objectives [28, 71]. Since construction is a risky undertaking, project-risk management must not be ignored, due to its criticality in managing with various opportunities [70]. Early risk identification and assessment ensure that the project to be on track and to support the response to risks. As part of this general identification and valuation of risk, the project schedule, budget, cost, and quality, may all be reviewed, with a view to reducing the risk and keeping a strong and integral focus on the project objectives [82, 29].

Nonetheless, regardless of the continuing research in the field of risk management in construction, many areas remain; and the analysis of project risk is one such area [83]. The project-risk analysis
must be performed with all types of project before any attempt to develop a risk-response strategy is made; since most projects include some degree of risk, given the presence of many stakeholders and the associated risk factors that involvement brings in the form of financial, client, contractor, consultant, designer, project management, and unforeseen, but related factors [84].

Gates and Hexter [85] state that the process involved in construction project risk management involves challenging the incidence of poor performance in practice by using both quantitative and qualitative risk analysis as part of that overall management. In this section of the research study, project risk analysis is considered, and regarded as an integral part of construction project management. It is noticeable that in previous research studies, and in all the above case studies, no genuine capability among personnel in respect of techniques used in risk analysis, has emerged. However, much consideration has been given to Risk Analysis Techniques in the literature, as described in the following sections:

2.11.1 Qualitative risk analysis

According to Tabash and Dhankar [86], qualitative-risk analysis is a process of risk investigation relating to risks that have been identified as potential, or risks that are actually occurring. Such analysis prioritises risks in a descriptive manner agreeing with their possible influence on project goals [87]. Therefore, it is useful for risk-response planning and for laying the foundation for quantitative analysis. In addition, Tabash and Dhankar [86], postulate that a review of process documentation from past experience or lessons learnt can be effective; as this allows for an update to the risk register to be made.

Many researchers use qualitative analysis techniques when analysing construction project risks. In this respect, del Cano and Pillar de la Cruz [88] considered many types of techniques; one of these being probability and impact description, which investigates the likelihood of each specified risk actually occurring. Figure 2.4 below illustrates another technique called the Probability-Impact
Risk Matrix. The Probability-Impact Risk Matrix is a method that defines risk-rating, and which can be tailored to a specific project; it stipulates the combinations of chance and influence that lead to ranking the risks to be encountered in a project as: low, reasonable, or of high importance [89]). In addition, ‘the term near-risk response’, sometimes called the ‘valuation of risk urgency’ can be joined with the Probability-Impact Risk matrix to rate a final risk-severity rating [28].

![Probability-Impact Risk Matrix](image)

**Figure 2.4 Probability-Impact matrix technique (Source: Dumbravă and Iacob [89])**

Cause-Effect or Fishbone Diagrams represent another technique that has been used in construction projects to reveal the root causes and effects of a particular risk, or the particular area within a project that requires more attention [90]. Once identified, the potential problems can be designated for immediate risk response, for further analysis, or for later response. Altman et al. [91] highlight other qualitative analysis techniques that are also useful in analyzing construction-project risks, such as the Checklist, which is useful for the risk register, as well as the Flowchart, and the Assumption Analysis which are also effective. However, it is important to note that any type of qualitative analysis of risk requires the collection of unbiased data; and in this respect, Data
Precision Ranking should be performed via the use of the techniques of Influence Diagram, and Event and Fault Trees [92].

Adams [93] contends that construction companies have not made important use of these methods in their projects since the 1980s. This may, in fact, be the reason behind the huge delays in dealing with risks in construction projects. Statistically, there are high optimistic correlations on the level of consciousness and the level of utilisation [94].

2.11.2 Quantitative-Risk Analysis

Hassan and Al-Tamini [95] state that quantitative study methods, based on their complicated mathematical, statistical, and scientific context, assures a comprehensive and detailed identification and assessment of risk, which is very significant for planning the response. The review of various quantitative risk-analysis techniques that appear in the literature enabled the researcher to gain a complete consideration of numerous present quantitative techniques for construction project-risk analysis. The techniques identified were: Decision-Tree Analysis, Expected Value Analysis, Sensitivity Analysis, and Monte Carlo Simulation Analysis.

Fatemi and Fooladi [96] describe a Decision-Tree Analysis as a graphic method that includes diverse circumstances and consequences within each situation in a project scenario; and it compares them, in order to provide options from which the best can be chosen. The considerations include the cost of each option, and the probability of risk occurring within each option, and the values established in these respects will decide the outcome; since they help the analyst to form a balanced picture of what risks are likely to be present [97].

As illustrated in Figure 2.5 below, decision-tree analysis is best suited for sequential activities [98].
Expected Monetary-Value Analysis is a statistical model that quantifies the product of two numbers: risk-event probability, and risk-event value [100]. According to Stefanovic and Stefanovic [101], the value may be positive for opportunities and negative for threats. However, the technique considers all the chances of every choice; and it multiplies separately all the probable results with its chance; then it adds all the outcomes collectively to gain an aggregate outcome.

Sensitivity Analysis is a study of how the doubt in the yield of a mathematical model can be allocated to diverse bases of hesitation in its contributions [102]. Sensitivity analysis aids in shaping the risks that have the greatest possible effect on the project [28]. Saltelli [102] explains that sensitivity analysis is used to establish the sensitivity of a model to the parameters related to a project, and to the effect of any structural change. Sensitivity analyses can be performed by fluctuating the values of one parameter contribution; and then seeing which of the productions changes; and what degree of that alteration impacts the project goals. Therefore, sensitivity
analyses give a rank of the model contributions based on their inputs to the inconsistency of the model and insecurity.

Monte Carlo Simulation is a mathematical process to replicate unplanned variables that reserve the stated distributional properties [31]. According to Pengelly [103], the Monte Carlo simulation technique was not used often until computer technology and power increased. As illustrated in Figure 2.6, Hulett [104] states that the Monte Carlo simulation is a technique for examining the influence of the key risks on a strategy, bearing in mind that such risks when simultaneous cause a non-linear communication, which might have an influence upon the results, or else nominal, or already established results.

Figure 2.6  Monte Carlo Simulation Technique Example (Source: Rezaie et al. [105])
Adedokun et al., [94] emphasise that all the above risk analysing techniques are beneficial because they assist to define preventive measures to reduce the probability of any risk factors from occurring. However, Jorion [37] posits that the major problem when trying to use any of these risk-investigation methods, as recognized in previous studies, is the trouble in attaining information about the unevenness of the risk issues. In addition, construction projects are normally exclusive, and design and construction teams change from one project to another. Furthermore, in the UAE, construction project proceedings are not usually saved in a properly functioning retrievable project-management system, as noted by Abraham and Rafael [106], who observe differences in the technical practice of different project teams. The development of the risk-response model should assist in implementing the strategy of risk analysis to choose the most appropriate plan of response.

2.12 TOOLS AND MODELS

According to Cavinato [107], there is a multitude of risk-management tools available; although with the exception of the banking and insurance industry, which has been standardised; these are not appropriate for numerous other industries, organizations and projects. Renn et al [108] attest that modern organizations increase the merits of handling risks in construction projects, official risk analysis; and organization methods are infrequently used because of lack of information and uncertainties on the appropriateness of these methods for construction projects.

As a standard business practice, contractors’ purpose is to make a satisfactory amount of profit margin. Profit margins in the industry have been little for most contractors on projects in recent years [109]. Proper risk understanding and allocation for these contractors would assist in avoidance of the erosion of the profit margin [106].

Through a belief network of PERT (program analysis and review technique) analysis, Nasir et al., [46] established a broad construction-plan risk model known as Evaluating Risk in Construction–
Schedule Model (ERIC-S). The ERIC-S model provides decision support to project owners, consultants, and researchers as a project-delay prediction tool [83]. Likewise, the Cost-Time-Risk diagram (CTR) proposed by Aramvareekul and Seider [110], assists project managers in considering project risk matters; whereas observing and monitoring their project plan and cost performance in one diagram, Okmen and Oztas [111] designed a simulation-based model called the correlated cost-risk analysis model (CCRAM) that evaluate the construction overheads in doubt after the costs and risk-factors are interrelated. In addition, the CCRAM model captures the correlation of costs and risk-factors indirectly and qualitatively.

Likewise, Ismail et al., [112] give a Level-Severity-Probability method to decide the serious risk foundation and influences. Fuzzy logic is used in the planned methodology for assessment of the risk level, harshness and chance. In addition, Zeng et al., [113] state that the use of fuzzy reasoning methods delivers an active tool to handle the doubts and biases rising in the construction project.

Haghshenas et al. [114] evaluated the methods that can be used for the growth of risk-management tools for engineering projects. Methods for framework formation, risk identification, risk valuation and action were delivered. Furthermore, the application of risk-management tools was influenced by the type of the project, organization’s policies, project-management strategy, risk approach of the project team members, and the accessibility of the resources [114]. Jannadi and Almishari [115] developed a risk-evaluator model (RAM) that controls risk scores for numerous construction events. The model delivers a suitability level for the risks; and it defines a quantitative explanation for the planned remedy. There are a number of commercially available tools (for instance Base II, IFRS 9 and Solvency II) for managing enterprise risk in the market. Companies, such as Signavio have sold over 180000 licences to customers across the world that make use of this facility [109].
2.13 RISK RESPONSE

After reviewing the literature applicable to risk management, it seems that risk response is the most significant stage in the process of risk management; since this defines the capacity of managers to improve occasions and decrease fears in projects [116]. More precisely, the risk-response strategy has the possibility to make the vital circumstances for best risk identification and valuation; thus risk response action must be organized, characterized and updated on a regular basis [116].

Risk response has been debated and categorized in systematic management standards to be of the ‘acceptance’ type or the ‘reduction’ type. Banaitiene and Banaitis [117] propose that ‘acceptance’ must be the plan; if the risk influence is comparatively unimportant (using a contingency plan) and it is possible for change to new risks evaluations and appraise the risk plan. In addition, APM [71] attests that ‘reduction’ should be implemented where instant action is mandatory; and that in the decrease action, the overheads, investments and remunerations must be compared. One additional option is to transfer risk to another part [71]; and in this case it must be transferred to the party most skilled to manage it.

Hillson [56] proposes guarantees and agreements as efficient risk-transfer measures for response. Other research by Zhi [118], on risk response to be dealt with through the three channels of: response by contracts, by retention, and by insurance. Chapman and Ward [31], state that the total removal of risks is wanted – where such risks are intolerable, in order to define the responses in advance. This might have an optimistic influence on the project results; but in truth, it is impossible to completely eliminate all risks.

On the other hand, risk response is not frequently cost effective; since projects face unforeseen deviations ranging from simple to chaotic fluctuations [119]. One additional option exists, that is to monitor risks with mature systems; and in this case it should be established and then achieved
by the party most skilled in monitoring it. This type of management is perceived as the work undertaken by Veil and Turner [120]; when they claimed that the idea of project management (PM) in construction organizations mostly comprises the view that management truly focus on a single project, a single location, and on project yield and contribution, rather than on the real project procedure; thus, there is no care taken to process development. Maturity refers to the level of organizational growth, and the grade to which it functions in faultless circumstances and works, according to best practice benchmarks [121, 122].

According to Motaleb and Kishk [72], the official identification and conversation of the features of risk response specify the significance of the subject in the United Arab Emirates (UAE); since the expenses related with postponement risks of construction projects have reached $767 billion, and 60% of such projects are on stand-by as a result of the downturn that began in 2008-2009. Despite the importance of risk response, Motaleb and Kishk [72] state that research in the area of risk response is still abandoned; and this is a condition that must be transferred; since decrease, security, contingency, approval, and handover forms are all known to affect the complete plan of the project, albeit in limited areas of risk [71].

2.14 CONCLUSION

This chapter has explored the literature related to risk management and linked it to the main aim and objective of the study. Important highlights from the chapter are that, actual risk management must saturate all areas, functions and procedures of the project. The goal then must be to negotiate risks, evaluate these, or even make these marketable and decrease them definitely. Risk management effectively fitted in the project gives the chance to gain a near perfect understanding of the objectives, roles and subjects of the service and the viability of the project.
CHAPTER 3

RESEARCH METHODOLOGY

3.0 INTRODUCTION

This chapter describes the research design, the research method and the research approaches that are used in this study. The chapter also clarifies the target population used, the sampling method, the research tools used; and how the data were analysed. Furthermore, this chapter summarises how the pilot study was engaged, the expectations and the limitations of the research, and the way in which ethical issues were measured.

3.1 RESEARCH DESIGN

Saunders et al [123] define research design as the overall strategy of how you answer the research question(s). It contains clear objectives resulting from the researcher’s question(s); it stipulates the resources from which the researcher aims to collect the data; and it clearly indicates how the researcher intends to collect and analyse these; and furthermore, it discusses the ethical matters and the limitations he/she will unavoidably meet.

The study was quantitative and descriptive – investigating the improvement of an optimized risk-management model for improved construction project operational performance. Cameron [124] researched business and management journals in seven arenas; and he concluded that quantitative studies rule all seven arenas, followed by mixed methods and qualitative studies. He concluded that quantitative analysis was the most common method used.

Descriptive studies are shown to answer: who, what, when where and how questions [125]. McGivern [126] states that descriptive research aims to construct a picture of the market; a set of consumers; or a social occurrence, or a set of experiences. The descriptive part of this study
defines why it is important to set up a risk-management model particular to business, as well as the importance of risk management.

The study uses a cross-sectional methodology, which is the most regularly used descriptive design in business-management research. Cross sectional designs include the collection of information from any given sample of population elements at almost the same time [127].

3.2 RESEARCH PHILOSOPHY

According to Saunders et al. [123], the term philosophy denotes a system of principles and expectations on the expansion of knowledge. In order to achieve a high level of quality research, it is imperative to ensure that the research design being used is thorough.

Research philosophy is determined by the researcher’s way of expressing the opinions of other researchers; and how the development of knowledge is being applied. There are two main views of research philosophy: these are positivism and phenomenology [128]. Saunders et al. [128] also mentioned that both philosophies are different; yet, both philosophies grow knowledge that plays significant role in the management of research. Positivist adopts the philosophical posture of the natural scientist. Remeniyi et al. [129] (cited [128]) stated that “the positivist prefers working with noticeable social realism; so that the end-product of such research can be generalised and related to those produced by the physical and natural scientists”.

Hussey and Hussey [130] also support the view that positivism tries to find the facts or reasons behind the social phenomena. Phenomenologist arguments assert that positivist that social world of company and organization is too problematic to describe assumption in the same way as the material sciences [128]. Hence, the phenomenological idea is focused on understanding human behaviour from the applicant’s own frame of reference [131]. The table on the next page will show the differences.
Table 3.1 Comparison between a Positivistic Paradigm and a Phenomenological Paradigm

Source: Collis and Hussey [131]

<table>
<thead>
<tr>
<th>Positivistic Paradigm</th>
<th>Phenomenological Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produce Quantitative Data</td>
<td>Produces qualitative data</td>
</tr>
<tr>
<td>Concerned with hypothesis testing</td>
<td>Concerned with generating theories</td>
</tr>
<tr>
<td>Use large samples</td>
<td>Uses small samples</td>
</tr>
<tr>
<td>High reliability</td>
<td>Low reliability</td>
</tr>
<tr>
<td>Low validity</td>
<td>High validity</td>
</tr>
<tr>
<td>Data highly specific and precise</td>
<td>Data rich and subjective</td>
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</tbody>
</table>

This research paper will be using the positivistic paradigm as the research philosophy, in order to study the issues that impact risk management and the impact of risk-management practices on organisational performance. The main reason for choosing this approach is because this paper will be testing the hypotheses. Also, the purpose of this research dissertation is to get the most reliable results; since the data are highly specific and precise – so that future research on similar topics can rely on this research project.
3.3 RESEARCH STRATEGY

3.3.1. Quantitative Approach

According to Saunders et al. [123], quantitative research seeks to analyse the subject matter in the context of the study’s guidelines and assumptions. In a quantitative research, an investigator relies on the numerical data to test the relationships between the variables; and the data concerned are analysed in terms of numbers. This requires careful planning of the data-collection instruments. A typical type of research study that employs quantitative research would be an experiment or survey study [132]. The results of quantitative research are relatively easy to analyse and interpret; as they emanate from a carefully designed instrument, which treats every individual in an identical manner; and therefore, it yields quantifiable data that can be handled rationally, objectively and numerically analysed.

In this research, a survey will be conducted in the form of a questionnaire. To improve knowledge, a researcher relies on a post-positivist approach to knowledge, which suggests the existence of an objective truth. The quantitative researcher experiments with the theories about reality; he looks for possible causes and effects; and he uses quantitative methods to gather the data – in order to test the hypotheses or answer the research questions. The researcher relates the variables to conclude on the significance and the occurrence of relationships. Quantitative studies are either descriptive or experimental. A descriptive study only links between variables; while an experiment establishes the probability connections, which are mathematical relationship between the studied variables [128].

According to Miriampolski [133], qualitative research includes a number of methodologies, approaches and methods for understanding and thoroughly documenting the various attitudes and the behaviour. This type of research is frequently done through the analysis of unstructured information. The data for qualitative research can be obtained in the form of open survey
responses, interview transcripts, notes, e-mails, feedback forums and focus groups. Unlike quantitative analysis, qualitative analysis does not rely on numbers. According to Zikmund and Babin [134], qualitative research is more particular than objective research. The outcomes are determined by the researchers’ understanding of the data obtained.

This study was quantitative in its nature because of the in depth-understanding of the phenomena it used. As a result, the focus was placed on the development of an optimized risk-management model for improved construction-project operational performance. This design was considered because of its ability to acquire expert scrutiny of the study under consideration. Furthermore, it was easy to gain access to the case, and faster access to the sought-after information. In addition, the descriptive design facilitated the use of questionnaires to gather the quantitative data for the study.

### 3.4 POPULATION AND SAMPLING

According to Saunders et al. [123], the population is the full set of cases, from which a sample is taken. It is from the target population that a smaller subset, called a sample, is selected for the study. Similarly, Polit and Hungler [21] refer to the population as a collective of all the substances, subjects or members that adapt to a set of stipulations. In this research, the population will be South African engineering companies that are primarily engaged in construction; as well as their divisions or departments that carry out construction work, particularly in infrastructural development.

In order to represent this population, risk practitioners, engineers, technicians, project managers, construction managers, construction supervisors and other technical personnel will be key to the research, as a sample or population.
3.4.1 Sampling

According to Wegner [135], sampling is a way of selecting the target population with respect to the chance in the study. A sample is a subdivision of the population [136]. It must be precisely representative of the population being studied, in order for the findings obtained from the explanations to be generalised. The sample size usually shows the degree of confidence (margin of error) in the data analysis: the larger the sampling size, the greater the data correctness and relevancy [128]. According to Cochran [137], sampling is the procedure of choosing a number of study units from a well-defined study population. There are two different types of sampling:

3.4.1.1 Probability Sampling

Probability sampling is also known as ‘random sampling’ or ‘chance sampling’ [137]. In this sampling design, every element has an equal probability of being included in the sample. Furthermore, the probability sampling technique includes the selection of a random sample from a list comprising the names of everyone in the population being tested. According to Saunders et al. [128], five main methods can be used to choose a probability sample, namely: simple random sampling; systemic sampling; stratified-random sampling, cluster sampling; and multi-stage sampling.

3.4.1.2 Non-probability sampling

Non-probability sampling is a sampling process whereby there is no basis for approximating the chance that each item in the population has a possibility of being included in the sample. Non-probability is also known by different names, such as deliberate sampling, purposive sampling and judgement sampling [138]. Non-probability sampling can also be called “haphazard sampling”; since it is liable to individual mistakes and bias [139]. According to Salkind [140], five main methods can be used to select a non-probability sample, namely: convenience sampling; quota sampling; purposive sampling; snowball sampling; and self-selection sampling.
In this study, stratified probability sampling of the companies involved in Eskom's new-built projects in 3 engineering disciplines: mechanical; civil and electrical were used. This is because there are currently over 40 contractors working on these projects; and the reports surrounding these projects have largely brought forward notable challenges that these contractors, as well as the parasternals, are facing throughout these projects.

Specific criteria defining the features that people, or entities in the population, must have – in order to be incorporated in the research should be well-defined in the beginning of the research [21]. The eligibility criteria in this research will be that the participants must be South African construction companies, be actively or historically involved in infrastructural development projects and be at least a SMME.

Risk participation in companies is not limited to risk practitioners only; but also to different groups of personnel and levels that may have a direct or an indirect influence on business risks and decisions arising therefrom. It follows immediately that a minimum of 6 companies across the different disciplines and 10 respondents in each would comprise a good measure that would satisfy the demographics of these companies. This means that the target sample would be 60 respondents.

3.5 RESEARCH INSTRUMENT CONSTRUCTION AND FIELD WORK

According to Cochran [137], the collection of the data must be precise; and where tests are used, they need to be recorded perfectly; and observations must be made methodically. Primary data were collected through the administration of a pre-tested structured questionnaire. This was the favoured method; because it was less complicated for the researcher, who sought to organize the quantitative data for analysis and to eliminate bias.

The questionnaire was distributed during June through August 2017. It had three sections created to make data collection possible. The first section incorporated the participants’ views on the risk
factor in light of its probability and impact to overall construction project accomplishment. The second section incorporated the participants’ judgment on the risk penalties for construction project performance channels, as well as the risk assessment and the response practices. The third section intended to gather the demographic data of the respondents, such as their age, gender, position, education, work experience and professional background.

The questionnaire for the initial study was dispersed either in person or via e-mail to 65 members of the pinnacle and middle management in the construction companies. A segment of 65 practitioners received the questionnaire and 56 valid questionnaires were returned for analysis, with a response rate of 98%. The second questionnaire was dispersed either face-to-face or via e-mail to 35 members of top and middle management in the construction companies. Of the 35 questionnaires circulated in the second survey, 35 were returned. However, 5 of these were incomplete; and they were therefore disqualified from the data analysis. The overall response rate was 86%.

In both surveys, the baseline features of the respondents were comparatively the same. Of the 56 respondents in the first study, site managers comprised 9%; project managers 16%; other positions and senior managers 12%; engineers 14%, and other discipline officers 49%. Of the 30 respondents in the second study, site managers, project managers, and other senior managers comprised only 19%.

To ensure analysis of the quantitative data, a Likert scale has been adopted in the survey questionnaires used in this research. The Likert scale is a tool that was developed, based on the principle of measuring attitudes by asking the respondents to supply their responses on a series of statements about a topic, in terms of the extent to which they agree or disagree therewith; and so tapping into the cognitive and affective components of their attitudes. Likert Scales have the advantage that they do not expect a simple yes or no answer from the respondent; but they rather
allow for degrees of opinion, and even no opinion at all. Therefore, quantitative data are obtained, which means that the data can be analysed with relative ease [141].

In this research, the Likert scale was chosen to find the chance of the risk influences in construction project that are recognized in the literature review. A 5-point Likert scale was adopted, where 1 represented “Strongly Disagree”, 2 “Disagree”, 3 “Unsure”, 4 “Agree”, and 5 “Strongly Agree”. Similarly, the Likert scale was chosen to get the impact of the risk factors in construction project that are acknowledged in the literature review. A 3-point Likert scale was used, where 1 represented “Option 1”, 2 “Option 2”, 3 “Option 3”.

In all surveys, most of the respondents have above 10 years’ experience in construction /project management or operational information of construction. With regard to work experience and employment position, it was deduced that the respondents have sufficient information of the actions connected to construction project risk. This makes them as dependable and trustworthy sources of information, which is critical to satisfy the research goal. The process, findings, and pertinent arguments of the examiners are examined in depth in the following section.

3.6 PILOT STUDY

In general, most consumers would prefer to test the sample of any product or buy in a small scale to test if that particular product satisfies their requirements in terms of quality and price. According to Zikmund and Babin [134], a direction-finder study is a minimal-research project that gathers the data from respondents, as if they are in a full study: as sort of a dry run.

A pilot study was done on all the different levels of employees that formed part of the sample. In addition this study pilot test was conducted by selecting ten random respondents who will not form part of the sample respondents; and who would participate in the pilot study. The reason for the pilot study is to verify the time taken to fill in the questionnaire, whether it is too long or too short,
too easy or too difficult; and to verify the clearness of the questionnaire items; and to get rid of uncertainties or complications in wording [142].

Furthermore, pilot studies help the researcher to anticipate challenges and other areas of ambiguity [143]. However, the conclusion of the pilot study did not disclose any faults in the questionnaire design. It did nonetheless point out that extra persuasion was necessary in compelling the respondents to answer the questions; since most of them were worried about their identity and time.

3.7 DATA ANALYSIS

Data analysis is a way of collecting, showing and changing data, with the intention of highlighting the information [144]. This study used descriptive research to explain the development of an optimized risk-management model for enhanced construction project performance. Descriptive research is a scientific method, which involves observing and describing the conduct of a subject without influencing it in any way [138]. The reason for employing descriptive research is the examination and description of phenomena in a real-life state of affairs [145]. In addition, it also involves statistical organising and the interpreting of numerical information. Once the data have been collected, the information obtained was captured using SPSS, a statistical software package, version 24.0.

SPSS is a windows-based programme that can be used to perform the data entry and analysis and to create tables and graphs. This is verified by the University of Johannesburg’s department of statistical consultation, Statkon.

For this study, the data were compiled, prearranged and presented using bar graphs and tables; since they are easy to understand; and to give an apparent picture and summary of the information.
collected. In addition, data analysis helps researchers to extract information that is meaningful and properly describes the inherent characteristics of the phenomena [139].

3.8 VALIDITY AND RELIABILITY

Validity means the degree to which a test of what the researcher desires it to measure, and the results imitate the occurrence under study [131]. Usually, research faults, such as damaged measures, poor samples and inexactness or deceptive measurements, can dent validity [131]. Validity arises as sample population chosen for a study actually stands for the whole population for which the study is intended [134].

A variety of approaches exist for establishing measurement validity; and these comprise translation, such as face or content validity, and also standard validity, such as projecting, simultaneous, convergent, or divergent validity [146], population and ecological generalizability [147]). Erford [147] additionally asserts that these methods can be grouped into two groups: internal and external validity, where the former refers to the accuracy or genuineness of the description being made; and the latter refers to its relevance to other cases, across places and time [148].

To guarantee both external and internal validity in this study, questions that were asked in the questionnaire were productively used in previous studies to examine the factors that have an effect on risk management and their impact on organisational performance.

Reliability, according to Saunders et al. [128], refers to the level of applicability of the data-collection techniques and the analysis in question. The more appropriate the techniques and analysis are, the more dependable will be the findings; but they would not automatically confirm the accuracy of the experiment [4]. Consistency means that the respondent should not offer a different answer every time the same question is asked by the investigators in dissimilar forms for
a particular problem [149]. Therefore, an instrument is reliable if its reply is always the same under recurring observations, fundamentally under the same circumstances [149].

Genuine information is obtained from a supply, which has credentials to give a statement on the problem [149].

To guarantee the reliability of the tool, each question in the questionnaire was phrased plainly and accurately, in order to avoid any ambiguity. It is understood that the bigger the sample, the more dependable the findings are. According to Sekaran and Bougie [150], a proper sample size falls between 30 to 500 respondents in this study. Generally, in addressing reliability, the study made use of uniform questionnaires and commands for respondents moving to completion. In addition, some of the questions were repetitive in different ways to test the reliability and the consistency of the results.

3.9 LIMITATIONS OF THE RESEARCH

According to Saunders et al [123], the limitations of the research avoid the possible weaknesses in the study, which are, in most cases, not under the researcher’s control. In this study, only quantitative research was done - due to the lack of time and available resources. Price and Murnan [151] advocate the importance of acknowledging the study. In this study, there was a possibility that some of the employees might have misunderstood some of the questions, due to the limitations in the terminology of risk-management concepts. However, the questionnaires were given to the respondents; and adequate time was allocated to them to complete all the sections.

3.10 ELIMINATION OF BIAS

According to Barbie [4], bias means a form of methodical slip-up that can affect scientific investigations and alter the measurement process. Moreover, bias is when a person, place, or thing is viewed or shown in a consistently inaccurate way. In this study, all respondents had the same set
of questions; thus, there was no preferential treatment between employees and managers. The questionnaire was intended to guarantee all the respondents’ anonymity. Lastly, the language used was straightforward, apparent and reasonable to all the respondents. In this study, the next strategies were employed to reduce the incidence of possible shortcomings or bias in the research:

- Apparent and reliable directives to respondents for the completion of the questionnaires;
- Following-up activities to non-respondents of questionnaires; and
- Questionnaire items were scrutinized for things that support bias, for example, presupposed and leading items.

3.11 ETHICAL CONSIDERATIONS

Saunders et al. [128] insisted that all researchers be conscious of the morale behind the research activity; and that researchers can guarantee that: the respondents have agreed; no damage comes to respondents; and authorization to carry out the research has been approved. In this study, all communication was acknowledged in writing, and evidence of consent to carry out the study within the construction companies was approved. All the respondents were protected through privacy and anonymity. It is of the greatest significance that the identities of the respondents, who take part in a study, are at all times protected by the researcher.

According to Lilley and Wilson [152], ethics ensure that the data gathered from the participations will stay put, firmly classified and respondents’ identities will be reserved as anonymous. The reason for the study was explained to all the respondents in a covering letter attached to the final questionnaire. In addition, all the research information gathered from other sources, publications or other individuals have been accurately acknowledged in this study. A letter of informed consent was obtained from construction companies involved to conduct this research. Furseth and Everett [153] attest that it is important to obtain the consent of participants when doing research. The researcher is separated from his individual biases and views that might have an effect on the
research. The language used to create the questionnaire was cautiously checked and the addressees were guaranteed – that there was no intent to cause harm.

3.12 CONCLUSION

This chapter discusses the comprehensive research methodology and design followed to carry out the study. Research methodology covers significant aspects like the design, the data collection methods and the tools used to collect the data. The research viewpoint and strategies were also discussed. Furthermore, a quantitative research design was selected as the relevant research approach for this study. The research questions were used as a point of reference; and they served as a fundamental point from which to devise the plan for this research. For this study, no sampling was completed; since it was a survey method. The research tools, as well as the sampling methods were described. The data-collection management and also the data analysis were discussed and the events on how the questionnaires were managed for this research were explained. The next chapter (Chapter Four) is devoted to the arrangement of the results, discussion, and elucidation of the findings from the study.
CHAPTER 4

DATA ANALYSIS, FINDINGS AND DISCUSSION

4.1 INTRODUCTION

This chapter emphasises the presentation, the discussion and the analysis of the research findings on the optimised risk-management model for improved construction-project operational performance. For simple elucidation and understanding, the gathered data are presented in the form of graphs, charts, and tables. The analysis is completed by means of statistical inferences to give additional meaning to the data, following which tests are done to confirm whether the postulated hypotheses should be either received or discarded. A discussion of all the issues then ensues, with reference to the literature.

4.2 SURVEY RESPONSES

Questionnaires were randomly distributed to directors, senior managers, senior professionals, discipline officers, technical staff and construction staff to different companies in the construction industry. The names of respondents have been withheld for confidentiality reasons. The questionnaires for the survey were distributed via hardcopy, hand-delivery and through emails. 100 questionnaires were distributed to 100 respondents across the construction companies sampled. 91 valid questionnaires were returned for analysis with a response rate of 98%. Five questionnaires were incorrectly completed and were excluded from the data analysis. The overall response rate was 91%; and the valid response rate was 86%. This means that a total of 86 questionnaires were analysed.
4.3 RELIABILITY TESTS

Researchers endeavour to create reliable and valid questionnaires, in order to enhance the accuracy of their evaluations and assessments. Reliability and validity form the fundamental elements in the selection of a measurement instrument that can be used [154].

For this study, there was the use of Cronbach’s Alpha to measure inter-item reliability of each of the variables being studied. This is a measure of internal consistency, or how closely connected a set of items is [15]. The results are depicted in Table 4.1 below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ISO 3000</td>
<td>0.707</td>
</tr>
<tr>
<td>2 Enterprise Risk Management framework</td>
<td>0.835</td>
</tr>
<tr>
<td>3 Tools for operational excellence</td>
<td>0.778</td>
</tr>
<tr>
<td>4 Strategic Risk Management</td>
<td>0.768</td>
</tr>
<tr>
<td>5 Critical thinking and concepts</td>
<td>0.764</td>
</tr>
<tr>
<td>6 Business model</td>
<td>0.854</td>
</tr>
</tbody>
</table>

Table 4.1 – Reliability Statistics

As reported in Table 4.1 above, six themes had a relatively high Cronbach’s Alpha score of over 0.75, projecting a high degree of internal consistency. All the variables had a reliability score above the 0.70 minimum considered acceptable [155].

Cronbach’s Alpha interpretation of reliability is the correlation of test with itself. “Squaring this correlation and subtracting from 1.00 produces the index of measurement error” [156]. The increase in the reliability estimate will cause a decrease in the fraction of a test score that is attributable to error. The higher the coefficient, the more reliable the internal consistency of the data are [157].
The data that have been collected thus far have demonstrated a high degree of validity and reliability; and they have been used to present the results that will be discussed in the sections that follow.

4.4 RESULTS
The results were deduced from the data obtained from the questionnaires given to the respondents. The questionnaire was divided into three sections, to gather data on demographics, alternative determinants and risk analysis.

4.4.1 Demographics
The majority of the respondents were males (72%), which signifies the dominance of the male figure in the construction industry. The industry has relatively young workers with most workers in 22-35 and 35-45 age group (see Figure 4.2). Experience is normally distributed with majority in the 6-10 years’ experience, which shows that the majority of the respondents have been in construction industry for a comparatively lengthy time (see Figure 4.3). Qualification of the respondents is also normally distributed with the majority having a diploma. Most of the departments are well represented, as can be seen in Figure 4.5.

4.4.1.1 Gender Distribution

![Figure 4.1 Gender Distribution](image)
4.4.1.2 Age Distribution

Figure 4.2 Age Distribution

4.4.1.3 Experience Distribution

Figure 4.3 Experience Distribution (in years)
4.4.1.4 Qualification Distribution

![Figure 4.4 Qualification Distribution](image)

4.4.1.5 Department Distribution

![Figure 4.5 Department Distribution](image)
4.4.2 Analysis

4.4.2.1 Alternative Risk-Management Tool

Figure 4.6 indicates that over 70% of the respondents strongly agreed that there is a need for a defined management tool in the business. The majority of the respondents either agreed (43%) or strongly agreed (47%) that their organisation has defined a risk-management procedure that is shown in Figure 4.6. Most of the organisations have defined their risk-management tool. Only 4% of the respondents said they did not have one.

1. A defined risk-management approach is important for my type of business and environment:

![Defined Risk Management Tool](image)

Figure 4.6 Defined Risk-Management Tool Responses

The response on the management of risk responsibility was divided; since about 22% disagreed and 23% strongly disagreed that it should be the responsibility of risk managers or practitioners. 30% and 7% agreed and strongly agreed respectively on this; and approximately 17% were not sure. However, Banaitiene and Banaitis [117] highlighted that it is the responsibility of the project manager to manage any risks.
2. Risk management is better left with the risk managers/practitioners to handle and execute:

![Risk Management Responsibility](image)

**Figure 4.7 Risk-Management Responsibility Responses**

Most of the respondents agreed (41%) and strongly agreed (43%) that active risk is part of their job (see Figure 4.8). All the respondents agreed and strongly agreed that better management of risks can help improve productivity in the work place. As many as 25% agreed and 75% strongly agreed that the risk-management procedure should be properly communicated to all the stakeholders in the organisation. Stakeholders taking part in a project should be properly informed of their legal and moral responsibility [66]. However, there are still a significant number of respondents (14%) who think active risk is not part of their job; and 3% who are not sure.
3. Active risk-management is a crucial part of my job

![Figure 4.8 Active risk responses](image)

Most the respondents agreed (34%) and strongly agreed (38%) that construction risk can be eliminated through the application of a robust model. About 13% were unsure about it.

4. Construction risks can be eliminated through the application of a robust model:

![Figure 4.9 Construction Risks](image)
Thirty one per cent of the respondents disagreed that construction risks are difficult to mitigate; they should be accepted as they are; and their impact should be built into the price. Only 19% agreed, 15% disagreed and less than 6% were unsure (Figure 4.10). Ayyub et al. [67] highlighted that inability to manage risk right the way through all the stages of the project life-cycle; and this affects the project’s outcome.

Therefore, according to Tang et al. [69] and Siang et al. [158], risk management must be considered to be part of project management to improve performance. More than 60% said risk can be quantified in currency or time and its impact can be measured accurately.

5. **Construction risks are difficult to mitigate and should be accepted as they are and their impact built into the price:**

![Figure 4.10 Mitigation of Construction risks](image)

There was mixed response on risk management at strategic level: 15% strongly disagreed and 22% disagreed that project scoping should be founded on strong risk-management principles at strategic levels. On the other hand, 29% agree and 15% strongly agreed. This was the case also on whether risk ownership can be delegated. As many as 13% and 24% said it can be delegated; whilst 20% and 26% said it cannot. Details of the distribution are shown in Figure 4.11.
6. Risk ownership can be delegated:

![Delegation of risk ownership](image)

**Figure 4.11: Risk ownership can be delegated**

It was observed that construction risk had zero opportunity provisions in the construction business in some instances. 15% strongly agreed and 29% agreed with 15% strongly disagreeing and 22% disagreeing (Figure 4.12). Therefore, a general conclusion can be reached that in half of the company’s construction projects; risks have zero provisions.

7. Construction risks have zero opportunity provisions in the construction business:

![Construction Risks in Construction Business](image)

**Figure 4.12 Risks in construction business**
The majority of the respondents (88%) said that the Occupational Health and Safety Act (85 of 1983) does not properly communicate construction-project risks. The department of labour did not define risk ownership properly for the workplace. 30% and 23% strongly agreed and agreed respectively to this.

8. **Occupational Health and Safety Act (85 of 1993) does not properly communicate construction project risks:**

![Figure 4.13 Occupational Health and Safety Act communication of risks](image-url)
9. Rapid business growth requires rapid risk response and emergency planning to be outsourced for better efficiency and impact:

![Rapid Risk Response Chart]

**Figure 4.14 Rapid risk response**

It was strongly agreed (52%) that PMBOK [28] risk-management approach should be made standard at all levels in the organisation. Almost all the respondents said PMBOK and ISO31000 should be combined to form a model that would be applicable: both as a strategic approach and as an all-round tool (Figure 4.15). Most of them (77%) also said a 3-tier risk approach that incorporates OHSA Act, PMBOK and ISO31000 should be developed and applied by organisations. However, there was a mixed reaction on whether the risk management should be outsourced or not. Almost half 48% said it should not be outsourced; while 22% said it should be outsourced.

On the research and development of risk management, almost all (95%) the respondents said it needs to be increased. 14% strongly disagreed on whether the risk-management models should be mathematical; and 21% strongly agreed.
10. PMBOK and ISO31000 should be combined to form a model that would be applicable both as a strategic approach and as an all-round tool:

![PMBOK and ISO31000 combination](image)

**Figure 4.15 PMBOK and ISO31000 combination**

4.4.2.2 Risk Analysis

More than 70% of the respondents said the scope of the project is clear and understood. Historical books in most instances are available.

![Project Scope Definitions](image)

**Figure 4.16 Project Scope Definitions**
An integrated approach is effective in managing project risk [75]. 42% of the projects are based on Public Infrastructural Development Projects Work Breakdown Structure Spreadsheet and 37% on Project specific WBS. The preliminary project cost is based on public infrastructural development projects risk-based spreadsheet (53%); and the rest on other techniques. It was noted that for a significant proportion, 22%, funding is lower than the construction cost that was estimated; and/or its constancy is highly indecisive and about 41% of the projects funding covers estimated construction costs; and it likely to remain relatively stable. Budgeting, costing and schedule needs to be reviewed as part of the overall risk assessment [29].

The main contractor (98%) is more committed than the project owner (78%). Rezaie et al. [105] argued that management system is more of a barrier than a support to the growth of efficient and effective risk management (Figure 4.17). Therefore, there is a need of commitment from the management. However, according to the respondents, 15% of them said their company leadership is committed by default, but without any support. The rest said they were committed with support. Most of the managers (95%) have run a project like the current project. It was noted that about 12% of the functional team personnel had official schooling in the use of tools and techniques; but with only slight or no practical experience. In about half of the cases, cross functional team is located at a single site – but also in multiple work areas.

The existing technology being utilised was said to be mature or modern by most of the respondents (73%) and 12% said that it was cutting edge. 41% said the technology is complex; and 59% said it was like what other organisations in similar projects are using. Although a large proportion (87%) said the project is well planned; a slightly higher percentage (13%) said it, the project, was inconsistent.
4.5 CORRELATIONS AND ANOVA

There was positive correlation between the risk-management procedure being properly communicated and active participation and contribution in risk management with $r^2=0.194$ ($r=0.44$). A positive correlation, $r^2=0.179$ ($r=0.423$) between the risk-management procedure being properly communicated and organisational or the project risk-management model defining the level of applicability.

There was strong correlation, $r^2=0.54$ ($r=0.74$) between those who said PMBOK risk management should be made standard at all levels in the organisation and those who said PMBOK and ISO31000 should be combined to form a model that would be applicable both as a strategic approach and as an all-round tool. It was noted that most of the respondents who preferred that PMBOK risk management being made standard also preferred that a 3-tier approach that incorporates OHS Act, PMBOK and ISO31000. A positive correlation, $r^2=0.71$ ($r=0.84$), which is strong, was found between these two.
Analysis of Variance (ANOVA) was carried out to find out whether there was any influence of gender, race, qualification, experience or department on the results. The hypothesis carried out was as follows:

H₀: Demographic distribution has no influence on the responses.

H₁: Demographic distribution has an influence on the responses.

The test was carried out at the 5% level of significant. The p-values found were all significant, that is greater than 0.05; and it was therefore concluded that demographic distribution had no influence on the results; and that people did not respond to questions based on the demographic distribution. P-value for gender was 0.409 as shown in Table 4.2 qualification in Table 4.3 with p=0.333 and department in Table 4.4 with p=0.868.

**ANOVA**

Construction risks can be eliminated through the application of a robust model.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1.093</td>
<td>1</td>
<td>1.093</td>
<td>.689</td>
<td>.409</td>
</tr>
<tr>
<td>Within Groups</td>
<td>133.233</td>
<td>84</td>
<td>1.586</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>134.326</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2 ANOVA for Gender
ANOVA

Construction risks can be eliminated through the application of a robust model.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>7.302</td>
<td>4</td>
<td>1.826</td>
<td>1.164</td>
<td>.333</td>
</tr>
<tr>
<td>Within Groups</td>
<td>127.023</td>
<td>81</td>
<td>1.568</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>134.326</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.3 ANOVA for qualification

ANOVA

Construction risks can be eliminated through the application of a robust model.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>4.091</td>
<td>6</td>
<td>0.682</td>
<td>0.414</td>
<td>0.868</td>
</tr>
<tr>
<td>Within Groups</td>
<td>130.235</td>
<td>79</td>
<td>1.649</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>134.326</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4 ANOVA for Department
4.5 DISCUSSION

4.5.1 DISCUSSION OF FINDINGS BASED ON RESEARCH QUESTION ONE

Model applicable to construction industry’s operation and risk management

The results found that 70% of the respondents are in favour of a risk management tool that can be used by small and large business constructors in South Africa (Figure 4.6). Similar suggestions are noted in Mafimidiwo and Iyagba [3] whose study compared construction businesses in South Africa with those done Nigeria. In trying to comprehend the effect of project-risk management on operational performance, the study found a direct relationship between risk management and operational performance (Table 4.2). Operational performance, according to the results is influenced by risk management; as 84% of the respondents identified are in Figure 4.8.

The operational part of the risk-management model was answered by the following findings. 47% of the respondents indicated that risk management should not be left in the hands of project managers; but everyone should be involved, including the stakeholders. These findings match those of Beckers et al. [7] findings and even confirm claims by several authors, who assert that risk management should not be left under the supervision of project managers; but all the stakeholders should participate and be concerned.

The key element for this assertion is that the study found that in South Africa, risk ownership is difficult to delegate; hence a holistic approach to risk management is necessary – Figure 4.11.

The need for a risk-management model that is useful in the construction industry in South Africa is supported by authors such as Yeo and Ren [75], whose study recommends an integrated-risk management approach to business. The aspect of an integrated approach is mentioned in several studies of different spectra, including that of Guba [25]. In this study, the data indicated that 52% of the respondents believed the PMBOK risk-management approach should be made standard at all the hierarchies in the construction industry. The respondents believed the PMBOK guidelines
shape the model and can help change the operational processes of especially small business constructors. Mafimidiwo and Iyagba [3] discuss similar findings when comparing the behavioural aspects of constructors in South Africa and Nigeria. Accordingly, in this study, it was found that South African businesses believe a robust management model coming from the use of PMBOK guidelines and ISO31000 could change the behaviour of businesses. Supporting this issue, the data in this study indicate that the respondents believe the Department of Labour has not defined some aspects of risk management in the construction industry very well or clearly.

These findings suggest that the Department of Labour should revisit those clauses that govern risk management in the construction industry.

4.5.2 DISCUSSION OF THE FINDINGS BASED ON RESEARCH QUESTION TWO

Application of the risk-management model and its impact on construction operations

The results found that 10% of the respondents were not aware of any defined risk-management tool in the business – Figure 4.6. With such a scenario, it is difficult to generalise an understanding on whether the application of the risk-management model has an impact on construction operations or not. In trying to recognise the impact of the risk-management model, the study found that the respondents believed that the risks are managed well; when critical thinking is brought in line with Work Breakdown Structure (WBS) and technology.

The respondents pointed out that the use of the Work-Based Structure in risk management has an impact, when it is merged with technology, critical thinking and a clear risk-management plan. Unfortunately, in the study, it was found that 41% of the respondents believed that the technology is too complex. These findings match the results that were presented by Krane et al. [29].

Besides these findings, it was found that the risk-management model contributes to the proper management of departments, as supported in Figures 4.1 and 4.4. This aspect is mentioned in several studies of different spectra including in Slacks, Chambers and Johnson [15]. However,
there were mixed responses in the study, as regards the ability of the model to assist in risk mitigation in the construction industry (See Figure 4.10). The respondents pointed out that risk mitigation in the construction industry in South Africa is difficult because companies do not have the financial means to support risky unpredictable endeavours. This however was criticised by those who believe if a robust risk-management model is put in place, risks can be minimised in a big way (Figure 4.10). Rezaie et al [105] explained that the risk-management model is like a barrier rather than a hold-up to the growth of efficient and effective risk management (Figure 4.17). This however was challenged by 85% of the respondents who said that they believed their company leadership was committed to seeing the model work.

4.5.3 DISCUSSION OF THE FINDINGS BASED ON RESEARCH QUESTION THREE

Why are construction companies failing to be sustainable in such a lucrative environment?

The finding revealed the need for a defined management tool in the business. This means that for a company to be sustainable, it should have a clearly defined management tool. Failure to define the management tool causes failure to sustain the business, apart from the industry being lucrative. The findings from the data presentation also revealed mixed feelings on the management of risk responsibility (see Figure 4.7). However, Banaitiene and Banaitis [117], highlighted that the project manager is accountable for risk management. Therefore, the project manager should clearly set the responsibility level, in order for the construction companies to be sustainable.

The other findings highlighted that all the respondents agreed and strongly agreed that better management of risks could help improve the productivity in a work place. Only 25% agreed and 75% strongly agreed that risk-management procedures should be properly communicated to all the stakeholders in the organisation. Stakeholders in a project should be properly informed of their legal and moral responsibility [66]. An organisation without well-communicated procedures to all stakeholders is less sustainable and this affects its sustainability negatively.
On the issue of construction risk, the findings reflected that risk can be eliminated through the application of a robust model (see Figure 4.10). A clear constructed robust, which is well explained to the stakeholders and employees is also vital in determining the sustainability of the organisations in the construction industry. Without the fulfilment of the robust model, the business would crumble, despite the lucrative environment in the industry.

4.5.4 DISCUSSION OF FINDINGS BASED ON RESEARCH QUESTION FOUR

How can smaller companies better deal with rapid growth in construction with regard to their operations?

Firstly, the findings from the data presentation of the study reflected that a well-defined management tool is important in construction, in order to tackle risk management. This can address the objective on how can smaller companies deal better with rapid growth in construction with regard to their operations. Most of the respondents either agreed (43%) or strongly agreed (47%) that their organisation has a well-defined risk-management procedure that they knew, as shown in Figure 4.6. Most of the organisations have a defined risk-management tool. Only 4% of the respondents said they did not have it.

Secondly, the data findings reflected the application of a robust model, as the other factors that would help the smaller organisations to deal with the issue of rapid growth in the construction industry with regard to their operations. Most of the respondents agreed (34%) and strongly agreed (38%) that construction risks can be eliminated through the proper application of a robust model. There was positive correlation between creation of the robust model and the elimination of risk \( r^2=0.333 \). A positive correlation, \( r^2=0.333 \) between the creation of the robust model and the elimination of risk revealed the importance of the integration that can be useful in dealing with the rapid growth of organisations.
There was a strong positive correlation \( (r^2=0.54) \) between those who said PMBOK risk management should be made standard at all levels in the organisation; and those who said PMBOK and ISO31000 should be combined to form a model that would be applicable: both as a strategic approach and as an all-round tool. It was noted that most of the respondents who preferred that PMBOK risk management be made standard also preferred a 3-tier approach that incorporates OHSA Act, PMBOK and ISO31000. A strong positive correlation \( (r^2=0.71) \) was found between these two. The integration of the ISO31000 and the PMBOK is also vital for smaller companies to better deal with rapid growth in construction with regard to their operations.

4.6 CONCLUSION

This chapter clearly shows that the data gathered from the survey were summarised in tables, charts and graphs. An analysis of the results was done from risk analysis and an alternative determination.
CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 INTRODUCTION

This chapter is devoted to summarising the main research findings that were presented in the preceding chapters, by dwelling on the analysed data in a bid to validate the objectives and the results of the study. The chapter discussed each research objective, in order to establish how it has been met by the research methodology; and it further discusses the contribution made by the study, leading to a proposed, enabling recommendation to the organisation and other relevant stakeholders.

5.1 SUMMARY OF THE MAIN RESEARCH FINDINGS

5.1.1 Objective 1

The first objective of the study sought to develop systems that apply ISO 31000 more effectively on construction projects. The outcomes of the research showed that the majority of the participants concur with the idea of PMBOK [28] and ISO31000 [159] being combined to form a model that would be applicable – both as a strategic approach and as an all-round tool. This would assist in the development of the system that is more effective in the selection of the scope of construction projects [114]. In the study, it was discovered as well that the creation of the robust model is vital in reducing risks in the construction business. This model would help in strengthening the system that is in place, thereby fulfilling the development of an effective project-scope selection.

The approach taken by the study shows that there is a need to have a defined management tool applicable to the construction business.
The researcher interpreted the data and found that there is a connection among the independent and dependent variable as from the data collected [59]. In this case, the data indicate that there is a direct relationship between risk-management procedures being properly communicated and organisational or project risk-management model defining the level of applicability.

The literature findings revealed that ISO 31000 is a standard that clearly explains the individual parts of a risk-management implementation framework. This means that the integration of the PMBOK and the ISO 31000 is vital in risk management; since the developed model would be in line with the generally accepted standards set for risk management in construction projects.

5.1.2 Objective 2

Objective number two was focusing on the development of a risk-profiling mechanism to be applied to meet the demands of continuous and rapid growth of an organization in the construction projects.

The findings from the literature revealed that risk management should be taken as a vital part of project management if good performance is to be the end result and general developments are to be set to the decision-making process [69, 158]. This means that effective risk management is essential to increase sustainable value levels within projects. The findings of the study showed that the participants agreed that their organization have defined the risk-management procedure that they knew; as revealed in Figure 4.6. Although there is the existence of risk-management procedures, the respondents strongly agreed that there is a need for a defined management tool in the business. Therefore, there is a need for further development of the risk-profiling mechanism in place to meet the demands of the continuous growth of an organization in the construction projects.

Besides the above findings, the other findings also disclosed that all the respondents agreed that better management of risks would help improve productivity in the work place. This means that a
well-defined risk-management plan could contribute to the increased performance of the organization in meeting the demands of their clients; while managing risk in an appropriate manner. This aspect is mentioned in several studies of different spectra.

5.1.3 Objective 3

Objective number three was based on the testing of the hypothesis regarding the limits of project scoping that would influence the successful operation; and thereafter establishing grounds for these limits. Relating the actual findings to the literature, it is established that the project scope for the organisation is well defined. The existence of the well-defined scope in projects reflects the positive influence in the operations set by the limits of project scoping.

5.1.4 Objective 4

Objective number four sought to develop a robust risk-management model gathering information from the literature and hypothetical testing, applicable to construction business operations.

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**Figure 5.1 Proposed risk management model development tool for improving operational performance**

Figure 5.1 shows a proposed risk-management model with elements that assist in the development of a risk-management tool applicable to real life in construction-business operations, in order to
improve performance. The successful development of this model is attributed to the literature and the results that came from the study. The literature includes the work of authors that were critically analysed in Chapter 2; and the results refer to the hypotheses tests coming from the previous chapter. In the study, it was found that a significant number of organisations recognise the importance of a defined-risk management tool in the business (see Figure 4.6). The approach taken by the study shows that there is a need to build risk-mitigating factors particularly in the South African construction industry. This is supported by Beckers et al. [7], who developed a risk-management framework that could be useful in construction projects, in order to stimulate success; while maintaining compliance with the legislation and the constraints.

Further afield to ensure that the model is well-monitored a significant number of respondents thought that risk-management work should be left in the hands of project-risk managers and practitioners – Figure 4.7.

The risk-management model developed under objective four shows that managers are at the centre of a project’s success. Furthermore, there is a section in the results where the respondents indicate that project leaders in the construction industry should study and understand the project scope, in order to help mitigate the risks. In the model developed in this study project scope is believed to be at the centre of stakeholder participation and project managers’ contribution. Issues written in the project scope are important and critical; hence they should be resolved if the risks are to be managed seriously in the long run.

Project success was however alluded to, in order to better manage the risks. In Figure 4.8, 83% of the respondents believe that if the risks are managed well, all construction projects would be successful. Another key element that came out and contributed to the model is that of stakeholders. This study found that the respondents were in favour of a leadership approach that values stakeholder participation. A desire to see the participation of the stakeholders and a strong belief
for active risk management by project managers would help to sum up the conceptual model; thus the link between the independent and dependent variables is important. In this study, the results indicate that there is a strong belief that project-risk management and stakeholder participation are key inputs necessary to the drafting of the management of risk plans in the South African construction industry.

There were mixed responses in the study as regards to risk mitigation in the construction industry (Figure 4.10). A majority of the respondents believe that construction-risk mitigation is difficult to achieve; and the risks should be accepted as they are. This however was criticised by those who believe that if a robust risk-management model is put in place, the risks can be minimised in a big way. The model above determines the importance of a risk-management plan; and it promotes the identification of risks as a key risk-management tool to which all the stakeholders can contribute.

In the study, it was found that the respondents believed that risk ownership cannot be delegated. These findings are backed by a gap of knowledge, which was found in the Department of Labour policy documents. Respondents pointed out that the Department of Labour does not define risk ownership properly. Having said this, it is worth bearing in mind that more than 70% of the respondents in this study revealed that they support the use of the Project-Management Body of Knowledge (PMBOK), when developing risk-management plans and mitigation tools.

To further support the use of PMBOK, the respondents indicated that PMBOK should be used together with ISO31000 to form a model that would be applicable both as a strategic approach and as an all-round tool. An all-round tool under this study is the final point of the risk-management model; and it should include risk analysis, a response plan and risk-control plans.

5.1.5 Objective 5

Objective number five sought to review the construction-risk management and operational performance under rapidly changing conditions. Regarding this subject, the study found that 72%
of the respondents believe that construction risks can be eliminated through the application of a robust model – Figure 4.9. Such a model is proposed in Figure 5.1; and it can be used to manage construction risks – even though other organisations believe risks that take place in the construction industry are difficult to mitigate. The approach taken by the study shows that there is a need for widening the scope of risk management in the construction sector; so that it involves more than meets the eye. Respondents in the study identified that construction risks had zero opportunity provision in the construction business. The problem that usually comes with this is that in case there are negative risk factors; construction businesses face pressures that threaten to close them down.

In this study there is a positive correlation between risk-management procedures being properly communicated and active participation and contribution in risk management with $r^2=0.194$ – Table 4.3. What this means is the implementation of strategies that include a consideration of risk management and communication for risk audits. This is important. In the study, the respondents pointed out that there is a need to push business to understand the importance of the project scope. Additional to the project scope, a project-management plan was also identified as an important factor in risk management and operational performance. In the study, risk-management questions also led to the identification of stakeholders as a key element in operational performance. The respondents pointed out that they believe that stakeholder contribution in identifying the risks can help mitigate the risks in the construction industry. By stakeholders it means that businesses believe the use of expert judgement is equally important when drafting project-risk plans. Risk management plans are therefore important – especially when they have the contributions of project managers, stakeholders and other important actors.

Also regarding risk-management plans the study found that there is consensus when it comes to risk management and performance. In Figure 4.10, the respondents pointed out that risk management must be considered to be an integral part of project management, in order to improve
performance. Moreover, the research found that 60% of businesses were in favour of adherence to the project life cycle. The respondents believe that the inability to manage risks in every stage of the project life-cycle has a great effect on the overall performance of the project. To conclude this matter, objective number five reviewed the relationship between construction-risk management and operational performance under rapidly changing conditions. The review found that the relationship of the two is critical when there are no risk-management tools.

5.2 THE PROPOSED MODEL

5.2.1 Introduction

Objective 4 of this study deals with the development of an all-level-stakeholder risk model (ALSRM), which will be further discussed in this section.

The proposed risk management model highlights the factors that provide a foundation for the development of a risk-management tool that could be implemented in day-to-day construction projects. The fact that it recognises the importance of stakeholders from different levels in an organisation, gives rise to its reference as an all-level stakeholder-risk model (ALSRM). ALSRM was developed under objective four; and it alludes to the importance of project managers and other stakeholders in any project’s success. The model incorporates the benefits from the contribution of the stakeholder community in projects.

Project managers can engage stakeholders at the appropriate level; so that they can have a multi-perspective in knowledge, as well as in offering sufficient support in identifying risk and applying their control mechanisms effectively. The model helps build consensus from the two parties’ input and participation in identifying operational challenges that emerge during construction projects.

Project leaders will benefit from the model because of their exposure to new ways of understanding the various methods of formulating risk-management tools. The success of the model is incumbent on the willingness of project managers in the construction industry to broaden
their understanding of the project scope, which is effective in mitigating risks. Construction projects benefit from the increased awareness that the project leaders and stakeholders have, as well as the project-management relationship between the two. This increases stakeholder effectiveness; and subsequently it optimises risk-management application in such operations.

Functionally, the model links independent and dependent variables by highlighting the improved project performance through the participation of the stakeholders, and a proactive approach by project managers on risk management.

5.2.2 Model application

Risk-management plans are therefore important, especially when they have the contribution of project managers, stakeholders and other important contributing factors. Project managers should commit to ensuring that the key stakeholders of the project understand the importance of sustainable-risk management in the project. It is important that the project managers establish risk-management tools that are in conjunction with the stakeholders’ responsibility and skills, and that they continue to face stakeholders’ interests, as the project evolves. Conditions during a construction project tend to change; and the interdependence of the key systems, stakeholders and their objectives also changes. The project manager should be able to frequently identify, analyse and control the risk associated with the stakeholders, particularly when there are changes in the project.

To do this, the project manager needs to create a standard risk-input tool, much like the risk-assessment templates used in the application of the ISO 31000 or the PMBOK activities (see Figure 1.1 and Table 5.1), which are directed at different individual levels of stakeholders within the operations.

Subsequent to the findings described in Chapter 4, the ISO31000 and PMBOK methodologies need to be strategically incorporated, following the description in Objective 4 of this Chapter.
Rigorous and proactive management of the stakeholders involved, is a good tool to convert potential threats into opportunities for the project. Therefore, stakeholder management goes beyond simple risk management.

For the model to be effective, its application also needs to be proactive, rather than reactive.

<table>
<thead>
<tr>
<th>Participant’s Name:</th>
<th>Department:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>RISK ASSESSMENT CHECKLIST</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>1</td>
<td>Are the engineering standards defined for the task?</td>
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</tr>
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<td>2</td>
<td>Is the core team appointed?</td>
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</tr>
<tr>
<td>3</td>
<td>Does the core team understand the project’s purpose?</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Have the stakeholders been identified?</td>
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<tr>
<td>5</td>
<td>Have stakeholder management’s responsibilities been allocated?</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Have the project objectives been established?</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Have the project deliverables been identified and quantified?</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Are there clear deadlines and a project timescale?</td>
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</tr>
<tr>
<td>9</td>
<td>Are the project’s geographic locations in proximity?</td>
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</tr>
<tr>
<td>10</td>
<td>Have the product quality requirements been established and understood?</td>
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</tr>
</tbody>
</table>

Table 5.1: Risk-assessment checklist identifying the individual participants per department

Table 5.1 demonstrates a simple risk-assessment checklist that can be used as one of the input tools for the risk assessment. It is worth noting that this input method is generic to PMBOK framework; however, in PMBOK application, it is limited to specific, identified stakeholders, assumed to be of significant importance to the project. In ALSRM, the stakeholders are selected from all the levels and their perspective in risks is added into the system, thereby creating a broader perspective of the risks and offering the project manager an opportunity to manage risks more effectively.

Risk control is the facet in the model that mitigates risk in a construction project through evaluating potential losses, and taking action to mitigate or eliminate such threats. This technique in the model utilises the findings from the first phase of risk analysis, which involves identifying potential risk factors in construction business operations, such as technical and non-technical...
aspects of the business, financial policies, and other policies that may impact the well-being of the firm. The model benefits extensively from the involvement of the stakeholders from different levels, which have been previously identified as non-essential for the specific input. The importance of recognising all levels of stakeholder participation is echoed in the study’s findings. Stakeholders in these different levels act as active and readily available input sources to the process, making the process of risk identification faster and somewhat robust. The project manager does not need to redo an extensive risk analysis every time the project changes or progresses into the next phase. This improves the operational effectiveness.

Risk control then implements changes to reduce risk in these areas. At the final output of the model, response strategies are developed, which include the method or procedure, which could take some appropriate actions, or mitigate the further effects of the undesirable events for the successful realisation of a project that may be avoided, mitigated and transferred.

The overall process should be documented as the risk-management plan. Part of the project manager’s responsibilities is to define this at the beginning of the project; and he should further define the change-management methods for continuous application of the tool through the project’s various phases.

Reactive application of risk management, as well as methods used for disaster recovery, are beyond the purpose of this model. Further development of the model and the incorporation of specialised literature in the field of disaster recovery can tailor the model to deal with such issues.

**5.2.3 Impact in operational performance**

The aim of the risk-management model is the quantification of the undesirable and previously selected random factors. Successful project management requires risk analysis, which is executed through the identification of the factors impacting the project’s scope definition, cost, schedule, contracting strategy and work execution plan – through the input of project managers and
stakeholders’ participation. It helps determine the impact of these factors on time and the budget of a construction project, as well as the development of an alternative variant of realisation, the proactive strategies to mitigate damages or, for instance, the emergency time schedule.

The provision of ALSRM, as proposed by this study, benefits the project manager in the identification of interesting opportunities that would improve the project-performance optimization; and help to build sustainable relationships with the stakeholders at all levels. When all of this is considered, it becomes apparent that both project managers and stakeholders have a role in developing a risk management and a risk-mitigation plan that delivers improved operational performance.

5.2.4 Conclusion

The application of a tool that improves risk management has a direct impact on the operational effectiveness of any organisation or project. By managing the project risks through an application of tools from a developed, robust model, risk treatment can be implemented relatively fast in comparison to the conventional methods. Operational processes in the project tend to perform better with considerable consistency and predictability, if their risks are known and actively managed.

Performance is, therefore, linked to the improved risk-management processes that are able to shield the project from unwanted interruptions and unwanted costs caused by the failed risk-identification or control methods. This is consistent with the work of researchers, such as Tang et al. [69] and Siang et al. [158], who attested that risk management must be considered to be part of project-management tools that are used to improve performance.
5.3 CONTRIBUTION MADE BY THE STUDY

This study has contributed a lot to project management in the construction industry – especially the following:

- A risk-management model with elements that assist in the development of a risk-management tool applicable to real life in construction business operations.
- A hands-on approach for project managers that recommend better risk management in the construction industry with the stakeholders’ help.
- Development of a risk-profiling mechanism increases the ability to quote better for future projects, to cope more effectively with scope expansion, and to plan operations more efficiently under anticipated changing conditions, as well as the inherent uncertainty.
- Integration of the PMBOK and the ISO31000 in risk management that promote efficiency and compliance with standards set in risk management in construction projects.

5.4 GENERAL RESEARCH CONCLUSION

This study aimed to determine the most effective risk-management model that can be applied in the turbulent and often unpredictable construction projects in South Africa. The study was completed by participants in the construction industry. Previous studies on the area under discussion of risk management found that the identification of risk and the assessment of risk were the most used elements in risk-management plans. In this study, the researcher went a little bit further; and he developed a model that encapsulates stakeholder participation in the formulation of risk-management plans.

Stakeholder participation was identified by the respondents as an important part of the work of the project-management office. The overall results in this study were surprising; as they corresponded with claims by a number of researchers in the same field. The results also matched assertions by
several researchers who focused on the significance of risk management and operational performance. The study identified the need to develop a model that helps to mitigate risk, encourage risk audits and risk analysis.

To summarize the matter, the existence of a project scope and a risk-management plan was alluded to; and this was supported by two factors: firstly, project scope should be understood by project managers and their subordinates. Secondly, the identification of risks should be done by project managers and stakeholders. The latter idea suggests that stakeholder engagement should be made an integral element of risk-management formulation; otherwise the project scope will not be respected.

The study recommended that project planners use the PMBOK and ISO31000 guidelines when formulating risk-management plans and operational-performance strategies. However, it was noted that these suggestions pose a challenge, given that the construction business in South Africa works with zero opportunity provisions for risks. Having considered this fact, the whole purpose for using PMBOK guidelines and ISO31000 standards was somewhat defeated.

Lastly, the overall conclusion in previous studies on the issue of risk management in the construction industry has been that the size of the organisation, the type of contracts and the involvement of top management contributes to project success. The other issue was that the risk factor depends on how much Government intervention is available. This however is not the whole issue; as this study also found that there are other issues that matter, such as stakeholder participation, risk audits and the identification of risks prior to the commencement of construction work.

5.5 RECOMMENDATIONS

- The development of the system that is more effective in the selection of the scope of construction projects is recommended. Although the study revealed that the risk-
management tool of the organisation under study is clearly defined, the model that is going to be constructed should be supported by a framework that addresses clearly the scope of the construction. This framework will help in improving efficiency in risk management. The creation of a framework would also complement a well-defined risk-management plan that contributes to the improved performance of the organization in meeting the demands.

- The study recommends further development of the risk-profiling mechanism in place to meet the demand of the continuous growth of an organization in the construction projects. Early risk identification and assessment ensure that the project remains on track; and it supports the response to risks. As a division of this whole identification and assessment of risks, the project schedule, budget, cost, and quality, may all be reviewed, with a view to reducing the risk and keeping a strong and integral focus on the project objectives. The development of a risk-profiling mechanism would help in the early detection of risk; and this would facilitate the management to act swiftly, in order to achieve the objectives of the projects at hand without wasting of time and financial resources.

- The data findings reflected mixed feelings on management’s risk responsibility. It was found that the respondents were in favour of a leadership approach that values stakeholder participation. Therefore, it is recommended that the participation of various stakeholders should facilitate the risk-management process and the project-management process for effectiveness. The participation of the stakeholders in project management should however be backed up by well-defined legal and moral responsibilities.

- The study also recommends the widening of the scope of risk management. A widened scope of risk management in the organisation is vital; because it allows for the implementation of strategies that include a consideration of risk management and communication for risk audits.
5.6 LIMITATIONS AND AREAS FOR FURTHER RESEARCH

The chief restriction of the study was budget constraints. The research was funded through the researcher’s personal funding, which was met by a sufficient financial savings account that had a considerable amount specifically kept for this undertaking. This limited the scope of the study that was initially supposed to cover the whole country of South Africa. This also affected the generalizability of the study.

The recommendations for further study are as follows:

- Future researchers should consider testing the model created in this study to see if it can be used in real-life construction operations.
- Researchers should also consider testing the model against small and large businesses to see if it is useful in these types of business, which have different levels of hierarchy.
- Future researchers should also consider expanding the model to various other sectors, including energy, transport and communication, where various large projects often take place.
- Researchers should also try to narrow down the scope of the research, so that it looks at provinces or regions in the country. This would help them to exhaust the subject matter and look at issues including operational plans, risk audits and risk-analysis quorums.

5.6. CONCLUSION

The chapter discussed the summary of the findings based on the objectives. The discussion justified the objectives to the findings of the study. The chapter also outlined the contribution made by the study. The general conclusions of the study were also made before the recommendations of the study were made. Lastly, the chapter exposed the limits of the study and the recommendations drawn for further research.
6. REFERENCES


[48] P. M. Collier, Fundamentals of Risk Management for Accountants and Managers: Tools and


Good Day,

I trust that you've been well and hoping that your family is well too.

I'm currently completing a research thesis for my masters degree with the University of Johannesburg (UJ) and have developed a question regarding effective risk management at construction sites. This is because of the unique challenges that the construction site impose on project participants of various capacities. The idea is to understand these challenges and how different people view them and to further understand if a different method can yield better participation and increased effectiveness of the risk management systems adopted.

To this end, the three (3) attached, anonymous questionnaires have been developed in an effort to find this information. Please print them out and fill them completely and then resubmit to me a.s.a.p. It should take about 30 minutes to complete. Please use my private email to respond (the one I used to send this).

Remember, participation is anonymous and you don't need to provide any personal details. The signature at the bottom of the survey cover pages is needed to establish uniqueness of the participant and not to capture a person's information.

This information will only be used for the research purpose and will not be disclosed to anyone except the University of Johannesburg academic staff, should they need it for verification.

Please contact me or my academic supervisors on the information provided below, should you have any questions:

1. Dr. Kazeem Sanusi (PhD) - Supervisor:
   Cell: 0832071016 / 0617556872
   Email: kazeems@uj.ac.za

2. Mr. Nelson Madonsela (MTech) - Cosupervisor:
   Tel: 0115591630
   Email: nmadonsela@uj.ac.za

3. Mr. Siphiwe Gogo (Researcher):
   Cell: 0787655176
   Email: sgogo@live.co.za

Your participation will be highly appreciated. Thanking you in advance.

Regards,
ANNEXURE 2A – SURVEY QUESTIONNAIRE

RESPONDENT DEMOGRAPHIC

This survey questionnaire has been developed to collect data that will be used to contribute in determination of the need for an alternative risk management model to be applied in construction business.

INSTRUCTION FOR USING THIS QUESTIONNAIRE:

1) In the table, each of the 8 sections contain several options where only one can be selected.
2) Mark the applicable choice with an X at the provided check box.
3) The survey remain anonymous and any sensitive information will not be distributed or published without the owner’s consent, in writing. The signature area below does not constitute such consent. It is only to serve proof that the respondent has filled the questionnaire him/herself.
4) Please remember to fill in your details in the spaces provided below in this page before submitting the questionnaire.
5) The estimated time to complete this questionnaire is 3 minutes.

Company: ____________________________
Project Name: ____________________________
Project Site: ____________________________

Date: _______________  Sign: ____________________________
<table>
<thead>
<tr>
<th>ID</th>
<th>Demographic Identifier</th>
<th>Options</th>
<th>Please Tick (x)</th>
</tr>
</thead>
</table>
| 1  | **Current Designation** | a) Director / Project Lead  
b) Senior Manager  
c) Senior Professional (Engineer, Discipline Lead, etc)  
d) Discipline Officer (QC, Safety, HR, etc)  
e) Technical Staff (Engineering, Logistics, Finance, Projects, Contracts, Welding, etc)  
f) Construction Staff (Supervisor, Artisan, Semi-skilled, Assistant)  
g) Student / Junior Staff (Temporary Role) | |
| 2  | **Gender**             | a) Male  
b) Female | |
| 3  | **Race**               | a) African  
b) White  
c) Coloured  
d) Indian  
e) Foreign | |
| 4  | **Age (Years - Range)**| a) <21  
b) 22-35  
c) 36-45  
d) 46-55  
e) 56 plus | |
| 5  | **Experience (Years – Range)** | a) <1  
b) 1-5  
c) 6-10  
d) 11-20  
e) >21 | |
| 6  | **Current Qualifications** | a) No Matric  
b) Matric  
c) Certificate / Trade  
d) Diploma  
e) Degree  
f) Higher Degree | |
<table>
<thead>
<tr>
<th>7</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a) Engineering</td>
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<td></td>
<td>b) Finance</td>
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<td></td>
<td>c) Construction / Production</td>
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<td></td>
<td>d) Human Resource</td>
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<td></td>
<td>e) Quality and Operations</td>
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<td>f) Logistics / Project</td>
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<td></td>
<td>g) Executive</td>
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<td>8</td>
<td>Company Type</td>
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<tr>
<td></td>
<td>a) Owner</td>
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<td></td>
<td>b) Main Contractor</td>
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<td></td>
<td>c) Sub-contractor</td>
</tr>
<tr>
<td></td>
<td>d) Consultant / Expert</td>
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</tbody>
</table>

THANK YOU FOR YOUR PARTICIPATION
YOUR INPUT IS HIGHLY APPRECIATED
ANNEXURE 2B - SURVEY QUESTIONNAIRE

ESTABLISHING THE NEED FOR AN ALTERNATIVE RISK MANAGEMENT MODEL

UNIVERSITY
JOHANNESBURG

This survey questionnaire has been developed to collect data that will be used to contribute in determination of the need for an alternative risk management model to be applied in construction business.

INSTRUCTION FOR USING THIS QUESTIONNAIRE:

1) The table contains a scale with 5 choices and a reason column to the right. Only one choice selection per question is allowed.
2) Mark the appropriate choice with an X at the provided check box. Briefly state the reason for your choice.
3) The questions are based on your knowledge and experience in your application and participation in risk management within your business organisation.
4) As far as reasonable practicable, please avoid selection of “Unsure” option, unless it is absolutely the only options you can think of.
5) Please remember to fill in your details in the spaces provided below in this page before submitting the questionnaire.
6) The estimated time to complete this questionnaire is 15 minutes.

Company: ____________________________
Project Name: ____________________________
Project Site: ____________________________
Date: ____________________________ Sign: ____________________________

PROFESSIONALS ON VARIOUS ASSIGNMENTS AT THE PROJECT

Please read the statement and then select the applicable response from the options provided by marking your choice with an (X).

<table>
<thead>
<tr>
<th>No</th>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Please provide a brief reason for your answer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A defined risk management approach is important for my type of business and environment.</td>
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<tr>
<td>2</td>
<td>My organisation has a defined risk management procedure in place that I know of.</td>
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<tr>
<td>3</td>
<td>Risk management is better left with the risk managers/practitioners to handle and execute.</td>
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<tr>
<td>4</td>
<td>Active risk management is a crucial part of my job.</td>
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<td>5</td>
<td>Better management of risks better can help improve productivity in a work place.</td>
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<td>6</td>
<td>Risk management procedure should be properly communicated to all stakeholders in the organisation.</td>
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<td>7</td>
<td>Construction risks can be eliminated through application of a robust model.</td>
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<tr>
<td>8</td>
<td>Construction risks are difficult to mitigate and should be accepted as they are and their impact built into the price.</td>
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<tr>
<td>9</td>
<td>Construction risks have zero opportunity provisions in the construction business.</td>
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<tr>
<td>10</td>
<td>Project scoping should be founded on strong risk management principles at a strategic level.</td>
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<tr>
<td>11</td>
<td>Occupational Health and Safety Act (85 of 1959) does not properly communicate construction project risks.</td>
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<tr>
<td>12</td>
<td>Department of Labour does not define risk ownership properly for the workplace.</td>
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<tr>
<td>13</td>
<td>Risk should be built-in at a higher percentage than current, during tender stages of each project or sub-project. This should be made standard.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Risk can be quantified in currency or time and its impact can also be measured accurately.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Operational efficiency of a business is independent of risk management strategies of that business.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>My organisation thrives under application of structured risk management methods.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>17</td>
<td>I am an active participant and contributor in risk management in our organisation.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>18</td>
<td>Organisational or project risk management model should define levels of accountability to suit each employee level in an organisation.</td>
<td></td>
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<tr>
<td>19</td>
<td>Risk ownership can be delegated.</td>
<td></td>
<td></td>
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<tr>
<td>20</td>
<td>Rapid business growth requires rapid risk response and emergency planning to be outsourced for better efficiency and impact.</td>
<td></td>
<td></td>
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<td>21</td>
<td>Rapid business growth requires a pre-emptive risk management model in place.</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>22</td>
<td>ISO31000 international risk management standard should be made statutory to all high risk bearing construction activities.</td>
<td></td>
<td></td>
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THANK YOU FOR YOUR PARTICIPATION
YOUR INPUT IS HIGHLY APPRECIATED
ANNEXURE 2C – SURVEY QUESTIONNAIRE
RISK ANALYSIS

UNIVERSITY
JOHANNESBURG

This survey questionnaire has been developed to collect data that will be used to contribute in determination of the need for an alternative risk management model to be applied in construction business.

INSTRUCTION FOR USING THIS QUESTIONNAIRE:

1) The table contains a characteristic of a certain risk bearing entity and 3 choices relating to that characteristic. Only one choice selection per question is allowed.
2) Mark the appropriate choice with an X in the provided check box.
3) The questions are based on your knowledge and experience in your application and participation in risk management within your business organisation.
4) As far as reasonable practicable, please avoid leaving options void of any selection.
5) Please remember to fill in your details in the spaces provided below in this page before submitting the questionnaire.
6) The estimated time to complete this questionnaire is 12 minutes.

Company: 
Project Name: 
Project Site: 
Date: ________________ SIGN: __________________

<table>
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<th>ID.</th>
<th>Characteristics</th>
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<th>Option 2</th>
<th>Tick</th>
<th>Option 3</th>
<th>Tick</th>
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<td></td>
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<tr>
<td>Project Scope</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>1</td>
<td>The scope of the project is:</td>
<td>Well-defined and understood</td>
<td></td>
<td>Somewhat defined, but subject to change</td>
<td></td>
<td>Poorly defined and/or likely to change</td>
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</tr>
<tr>
<td>2</td>
<td>All stakeholders (vendors; subcontractors; partners) are:</td>
<td>Identified and Committed</td>
<td></td>
<td>Identified and not Committed</td>
<td></td>
<td>Unknown</td>
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</tr>
<tr>
<td>3</td>
<td>Historical information is (e.g. as-built drawings, Data Books; etc.)</td>
<td>Available</td>
<td></td>
<td>Partially Available</td>
<td></td>
<td>Not Available</td>
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<td>4</td>
<td>Environmental Constraints</td>
<td>Categorical Exclusion</td>
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<td>Environmental Assessment</td>
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<td>Environmental Impact Statement</td>
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<td>Project Schedule</td>
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<tr>
<td>5</td>
<td>Are the project’s major milestones:</td>
<td>Flexible - may be established by the project team</td>
<td></td>
<td>Firm - pre-established</td>
<td></td>
<td>Fixed - pre-established by a specific commitment or legal requirement and beyond the team’s control</td>
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<td>6</td>
<td>The total estimated effort hours are:</td>
<td>Less than 2,000 per month</td>
<td></td>
<td>Between 2,000 and 5,000 per month</td>
<td></td>
<td>Greater than 5,000 per month</td>
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<td>7</td>
<td>Project duration (baseline) is estimated at:</td>
<td>Less than 2 years</td>
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<td>2 to 4 years</td>
<td></td>
<td>Greater than 4 years</td>
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<td></td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>The project budget (Preliminary Engineering) is based upon</td>
<td>Public Infrastructure Development Projects Work Breakdown Structure Spreadsheet</td>
<td>Project specific WBS</td>
<td>Other methods or techniques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>--------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-----------------------</td>
<td>----------------------------</td>
<td></td>
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<tr>
<td>9</td>
<td>The Preliminary Construction Cost Estimate is based upon:</td>
<td>Public Infrastructure Development Projects Cost Based Spreadsheet</td>
<td>Project specific WBS</td>
<td>Other methods or techniques</td>
<td></td>
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<td></td>
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<tr>
<td>10</td>
<td>Program amount matches or exceeds the estimated cost and is stable.</td>
<td>Funding is greater than estimated construction cost and/or is expected to be stable.</td>
<td>Funding is less than estimated construction cost and/or its stability is highly uncertain.</td>
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</tr>
</tbody>
</table>

### Management / Senior Leadership Support

<table>
<thead>
<tr>
<th></th>
<th>The project owner (IPP, Municipality, Eskom) is:</th>
<th>Identified and committed</th>
<th>Identified</th>
<th>Not identified or not committed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The Main Contractor is:</td>
<td>Identified and committed</td>
<td>Identified</td>
<td>Not identified or not committed</td>
</tr>
<tr>
<td></td>
<td>The Project Consultants / Experts are:</td>
<td>Experienced and committed</td>
<td>Experienced</td>
<td>Not experienced or not committed</td>
</tr>
<tr>
<td></td>
<td>The company-specific leadership is:</td>
<td>Committed and providing strong support</td>
<td>Committed by default but with no support</td>
<td>Not committed or does not provide support</td>
</tr>
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</table>

### Project Human Resources

<table>
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<tr>
<th></th>
<th>The Project Manager’s experience and training is:</th>
<th>Recent success in managing projects similar to this one</th>
<th>Recent success in managing a project not similar to this one or trained and no actual experience</th>
<th>No recent experience or project management training</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Describe the experience of cross functional team personnel with the tools and techniques to be used.</td>
<td>Experienced in use of tools and techniques</td>
<td>Formal training in use of tools and techniques but little or no practical experience</td>
<td>No formal training or practical experience in use of tools and techniques</td>
</tr>
<tr>
<td></td>
<td>The cross functional team is:</td>
<td>Located together at a single site</td>
<td>Located at a single site but multiple work areas</td>
<td>Dispersed at multiple sites</td>
</tr>
</tbody>
</table>

### Other Business or Organizational Impacts

<table>
<thead>
<tr>
<th></th>
<th>Eskom processes, procedures, policies require:</th>
<th>Little or no change</th>
<th>Occasional to frequent changes</th>
<th>Substantial change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The number of functional areas the project will affect are:</td>
<td>1-3</td>
<td>4-6</td>
<td>7 or more</td>
</tr>
</tbody>
</table>

### GENERAL – Technical and Performance Risks

#### Technology

<table>
<thead>
<tr>
<th></th>
<th>The technology being utilized consists of:</th>
<th>Mature (existing design software, hardware, methods, databases, and tools)</th>
<th>Emerging</th>
<th>Cutting Edge - New design software, hardware, databases, methods or tools.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The technical requirements for this project are:</td>
<td>Similar to others in Public Infrastructure Development Projects</td>
<td>New and complex</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>The overall assessment of Project Management risk</td>
<td>The project is well planned and will be carried out in a manner consistent with the Public Infrastructure Development Projects management guidelines</td>
<td>Planning for this project is inconsistent, incomplete or in other ways of poor quality AND/OR there are problems with project process that must be addressed</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Applicable Risk Model for the project is:</td>
<td>Solid. No modifications needed.</td>
<td>Revisions needed.</td>
<td>Major reconstruction needed to align it to the project requirements.</td>
</tr>
</tbody>
</table>

**LEGISLATION**

**Labour Relations**

| 24 | Skill level of labour force is: | High – No need for intervention | Medium – Intervention and training needed | Low – Expatriation and outsourcing needed. |
| 25 | If outsourcing and expatriation is essential for the project success, the expatriates will add the most value on this: | Management Level (Project directors; Construction managers; etc.) | Professional Level (Engineers, Technicians, Specialists) | Skilled labour |
| 26 | Company can deploy enough skilled labour to meet the project scope: | Readily from within the organisation | From Labour Brokers | Cant. Secondment or recruitment required. |
| 27 | The collective bargaining structures are: | Specific and accommodative | Vague | Non-existent |

**PROCUREMENT**

**Purchasing – Material; Consumables; Tools and Plant**

| 28 | Construction material for the project is: | Free-issue from the project owner / client | Purchased by the individual company | Part – issued and part purchased. |
| 29 | Vendor list for material purchase is approved by: | Client | Individual Company | No approval needed. |
| 30 | BBEEE contributor level: | 4 and above is accepted for vendors | 3-4 is accepted for vendors | 1-2 is accepted for vendors |

**EXTERNAL – Vendor / Labour Broking**

**Subcontracting**

| 31 | If project is outsourced | Subcontractor is familiar in this market | Subcontractor is new to this market |
| 32 | Are subcontractor firms required and committed to the project? | Yes – Some subcontractor firms are required (less than 50%) and are expected to be signed before start of project | Yes – Project will be staffed by subcontractors and/or labour brokers. Commitment is not expected to be complete prior to start of project | No – subcontractor firms are not required |

THANK YOU FOR YOUR PARTICIPATION

YOUR INPUT IS HIGHLY APPRECIATED
### Annexure 3A – Analysis Results (Tables)

#### Frequency Table

<table>
<thead>
<tr>
<th>Designation</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
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<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Director / Project Lead</td>
<td>2</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Senior Manager</td>
<td>11</td>
<td>12.8</td>
<td>12.8</td>
<td>15.1</td>
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<tr>
<td>Senior Professional (Engineer, Discipline Lead, etc)</td>
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<td>23.3</td>
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<tr>
<td>Discipline Officer (GC, Safety, HR, etc)</td>
<td>27</td>
<td>31.4</td>
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<td>Technical Staff (Engineering, Logistics, Finance, Projects, Contracts, Welding, etc)</td>
<td>14</td>
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<td>16.3</td>
<td>86.0</td>
</tr>
<tr>
<td>Construction Staff (Supervisor, Artisan, Semi-skilled, Assistant)</td>
<td>12</td>
<td>14.0</td>
<td>14.0</td>
<td>100.0</td>
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<tr>
<td>Total</td>
<td>86</td>
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#### Gender

<table>
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#### Race

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#### Age

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#### Qualification

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#### Company

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<td>Consultant / Expert</td>
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Figure A.1 Demographic frequency results
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## Figure A.2 Descriptive statistics results

## Figure A.3 section of the frequency tables – Alternative determination
ANNEXURE 3B – ANALYSIS RESULTS (GRAPHS)

Figure A.4 Race distribution demographics

Figure A.5 Company type distribution demographics
Figure A.6 Need for a risk-management tool

Figure A.7 A full-on risk analysis exercise should be carried out by organisations prior to project execution and/or tendering
Figure A.8 Construction risk management models should be mathematical like those in the banking industry such as Basel III.

Figure A.9 Historical information
Figure A.10 Skill level of labour force demographics

Figure A.11 The Project Consultants / Experts
Figure A.12 The experience of cross-functional team personnel with the tools and techniques

Figure A.13 Eskom processes, procedures, policies requirements
Figure A.14 The technology being utilized consists of:

- Mature (existing design software, hardware, methods, databases, and tools)
- Emerging
- Cutting Edge - New design software, hardware, databases, methods or tools.

Figure A.15 Whether the project is being outsourced:

- Subcontractor is familiar in this market
- Subcontractor is new to this market