Risk mitigation approach to contractual claims of civil infrastructure projects in South Africa

by

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DECLARATION

I, **Awad Saad Abdulla Saad**, declare that the contents of this thesis represent my own unaided work, and that the thesis has not been previously submitted for academic examination towards any qualification. Furthermore, it represents my own opinion and not necessarily those of the Cape Peninsula University of Technology.

Signed

08 August 2025

Date

ABSTRACT

Risk mitigation approaches on contractual claims in civil infrastructure projects are according to the reviewed literature not adequately determined and evaluated. No proper mitigation model for reducing the occurrence of contractual claims risk delaying the delivery of civil infrastructure projects within the budgeted cost and time could be found. The aim of this study was to develop an effective risk mitigation model to address contractual claims risk and to enhance the delivery of civil infrastructure projects in South Africa. A risk mitigation model was conceptually developed through a review of the literature and an understanding of the research by determining the factors causing contractual claims risk in project delivery; impacts of risk occurrence; and essential strategies to mitigate risk in civil infrastructure projects. Applicable theories were evaluated to validate the feasibility of the model by integrating design concepts to establish the principles of the research constructs. The model development demonstrates the application of a mixed method technique through a procedural analysis of quantitative and qualitative data, thus both descriptive and inferential statistical approaches were used for data analysis. The quantitative data were collected through a questionnaire administered to civil engineering contractors registered on the Construction Industry Development Board grades 3–9, as grade levels 1-2 contractors are mostly not the main contractors. The results derived from the quantitative data were used to structure face-to-face interview data collection, which involved the participation of seven purposively selected stakeholders with adequate experience in civil infrastructure project execution. The findings obtained from the quantitative data analysis were further analysed using partial least square-structural equation modelling (PLS-SEM) to develop a risk mitigation model. The findings confirmed that the relationship between the factors causing contractual claims risk, and the impacts of risk occurrence, have acceptable predictive potential to influence the essential strategies to mitigate risks that occur during contracting and construction activities of civil infrastructure project execution. This study established that risk management procedures for adequate project performance are not sustainably applied to assess risk occurrence during construction projects. Therefore, the study provides applicable risk indicators to construction organisations, construction professionals, risk managers, and government agencies. The model can offer solutions to issues relating to contractual claims risks based on the good relationship established between the causes, impacts, and strategies.

Keywords: Civil infrastructure; contractual claims risk; construction delay; cost overrun; projects; risk management; South Africa.

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DEFINITION OF KEY TERMS

Term	Definition	Source
Construction contracts	A legal agreement signed between contractual parties to define contractual relationships and obligations to maintain the completion of a project according to an agreed time frame and standards.	Yih Chong *et al.* (2011)
Contractual claims risk	A potential threat that impedes progress of a civil infrastructure project as a result of unfulfilled legal agreements between contracting parties	Apte and Pathak (2016); Bashettiyavar (2018)
Contractual relationships	A cooperative mutual understanding between participating parties in the construction of the project as specified in the contract	Zaghloul and Hartman (2003)
Contractual parties	Parties who have entered into a contract agreement with one another that includes clauses, obligations, benefits and roles that define the parties direct and indirect responsibilities in the project's success.	The researcher's definition
Delay	Overrun time after the contract's stipulated date or beyond the period extension's grant date.	Fugar *et al.* (2010)
Dispute	A disagreement between contractual parties regarding the project.	Younis *et al.* (2008)
Project management	A management process governing the project to reduce negative impacts and ensure that there are no obstacles to achieving the project activities on the specified time.	Schwalbe (2015)
Stakeholders	Individuals and/or organisations that participate in project implementation, both having direct and indirect roles in project activities and an influence on the project.	Yih Chong *et al.* (2011)
Risk mitigation	Controlling the risks correlating with constant contractual claims during the implementation phases of the project.	Ahmad *et al.* (2018)

CHAPTER ONE

1. THE PROBLEM AND ITS SETTINGS

1.1 BACKGROUND

The construction industry is a crucial sector for economies worldwide, contributing significantly to national development (Okanlawon *et al.,* 2024). The sector is also considered economically vital for many countries (Osei-Kyei and Chan, 2017; Krystallis *et al.,* 2020:127; Demissie, 2020:1). Investment in civil infrastructure serves as the primary means of providing essential services and plays a significant role in the development of African countries (Fon *et al.*, 2021; Nhlengethwa *et al.,* 2021:49).

In South Africa, the construction industry serves as a fundamental pillar of the National Development Plan, playing a crucial role in delivering civil infrastructure projects that drive economic growth (Aghimien *et al.,* 2019). Given its significance, investment in these projects facilitate the provision of essential services and promotes sustainable economic development (Eja and Ramegowda, 2020; Fon *et al.*, 2021 Nhlengethwa *et al*., 2021). Consequently, the government allocates substantial budgets to infrastructure development (Alamu *et al.,* 2024).

The implementation of civil infrastructure projects involves several stages, including initial planning, detailed design, construction, and ongoing maintenance. Each of these phases contributes to the creation of sustainable and resilient infrastructure that meets societal needs (Eja and Ramegowda, 2020). However, such projects are inherently complex and multifaceted, making them vulnerable to various risks that can impede project delivery (Zainal Abidin and Ingirige, 2018).

Research indicates that certain risk management practices are not widely applied in assessing and mitigating risks in construction projects (Ikuabe *et al.,* 2023; Al-Mhdawi *et al.,* 2023; Nguyen and Macchion, 2023; Liu-Lastres and Cahyanto, 2023). Leung (2024) highlight the ongoing lack of consensus among researchers and construction industry practitioners in South Africa regarding key risk assessment factors and the selection of appropriate techniques for risk management models that could enhance project performance. Furthermore, Ansary and Renault (2018:53) emphasised the need to identify and evaluate the causes of risks affecting project performance in the construction industry. In this regard, Safapour *et al.* (2020:126) underscored the importance of mitigating risks related to cost overruns during project delivery to prevent the misallocation of public funds derived from tax revenues used to finance civil infrastructure projects.

Civil infrastructure projects are particularly vulnerable to risks associated with contractual claims, which often arise due to tensions, disputes, and confrontations between contractual parties (Deacon and Kajimo-Shakantu, 2024:331). Consequently, these claims pose a significant challenge to the effective delivery of these projects during the construction process (Söderlund, 2018:11). Mukuka (2015:1693) argued that such issues persistently recur, making them a major concern for the construction industry. To address this, El-Adaway *et al.* (2018) suggested that enhancing the efficiency of risk mitigation approaches for contractual claims could improve productivity and reduce disputes and conflicts between contractual parties throughout project performance process.

Risk mitigation in infrastructure construction projects is essential due to their complexity. The implementation phase faces various risks, with temporary project teams made up of multiple companies being a major source. Additionally, the failure of construction managers' management techniques to control political, social, and economic risks during execution further complicates the project and increases risks (Zwikael and Sadeh, 2007: 755; Zavadskas *et al.,* 2010:33). According to Schoonwinkel *et al.* (2016:21), civil infrastructural project management has issues that have high risks that hinder efficient civil project delivery. These issues are considered as an obstacle to project success. They further explained that time and cost overruns caused risk leading to disputes among construction operators.

Numerous studies have been conducted on the modalities to reduce the constant increases in the occurrence of disputable contractual claims that causes risk in civil infrastructure project delivery. El-Sayegh *et al.* (2020:1) opine that constant claims in such projects cause high construction cost and create disputes among stakeholders. Shi *et al.* (2001:60) and Babaeian Jelodar *et al.* (2021) stated that delayed action from contractors during the construction phases leads to cost overruns, which creates sources of risks associated with claims, conflicts, and disputes in the projects.

In South Africa, contractual claims of civil infrastructure projects occur as a result of unsustainable practices by construction managers (Sibande and Agumba, 2018: 323; Bikitsha and Amoah, 2020:1). Alshihri *et al.* (2022:2) noted that material cost during production contributes to cost overruns in civil projects, which forms a basis for risk incidents. For most projects, factors that cause risks to civil project delivery are time overrun, late payments, and design-related issues. El-Sayegh *et al.* (2020:1) suggested that negotiating disputable contractual claims by the contractual parties could assist in ratifying a contractor's claim and avoid disputes and risks associated with project delivery.

To support the above, Kikwasi (2013:53) report that the risk mitigation measures against disputes in most civil projects include management and coordination, time performance monitored through the design and construction stages. Ceric (2014:931) claimed that strained contractual relationships and conflict of interests lead to time delays and cost overruns as a source of risk issues. Other factors that contribute to contractual claims risk issues on construction sites and disputes are insufficient contractors' experience, insufficient funding, delayed payments by default, unskilled labour, and poor planning (Jaffar *et al.,* 2011:193). Kikwasi (2013:53) confirmed that the highlighted issues contribute to construction cost increases and delays in civil infrastructure projects. This results in risk challenges during the construction process.

Dixit and Tiwari (2020:9) conducted studies on risk management of financial portfolios for civil projects. The two studies demonstrated related outcomes by developing a multi-standard mechanism of decision-making to optimise the overall value of a construction company's finances. Koshe *et al.* (2016:18) and Sanni-Anibire *et al.* (2022:1395) categorised the main factors causing risk through delays in civil infrastructure projects as untimely release of progress payments, changes in design, inaccurate evaluation of tenders by contractors, lack of labour, poor performance, financial problems, as well as impaired planning and coordination.

According to Gbahabo and Ajuwon (2017:20,46), and Sanni-Anibire *et al.* (2022:1395), delays originate from risks arising from time and cost overruns, disputes, litigation, arbitration, litigation, and abandoned projects. Similarly, Shaikh *et al.* (2010:11) explained that client, contractor, resource, and general issues are the four causes of delay responsible for civil project risks that result in time and cost increases, as well as emergence of claims. Due to this, a need for effective management of contracts and projects is needed, including well-organised records for project success to achieve a reduction in risk management on the construction site (Yusuwan and Adnan, 2013:54).

The challenges associated with risk of contractual claims in the delivery of civil infrastructure projects have increased in recent years due to the increasing range and complexities of projects, inadequate inquiry into the frequent causes of contractual claims, poor bidding strategies, insufficient contractor experience and strained contractual relationships. These determinable problems pose many hazards in the delivery of civil infrastructure projects due to ineffective risk management, inadequate cost estimate at the planning stage, as well as lack of control of construction cost within budget during the project implementation (Mishmish and El-Sayegh, 2018:26). Okoh *et al.* (2024) also noted that the burden of debt accumulated, and lack of construction operators' evaluation systems impede the delivery of civil infrastructure projects.

Khoshnava *et al.* (2020:116759) explained that the development of civil infrastructure plays an important role in limiting the effects of economic decline of a country. Koirala (2017) added that construction of infrastructure projects suffers risks associated with contractual claims and long-term contractual conditions for financing. This effect causes higher cost of construction projects due to the lack of an applicable framework for the mitigation of claims risk. Consequently, there is a need for mitigation of risks relating to cost increment in the civil infrastructure project delivery in developing nations, since public funds and tax revenues are the main means of financing infrastructure projects. In construction, project risks are divided in different ways. Szymanski (2017:176) classified construction risks into five groups including preliminary design, tender, detailed design, construction works and financing the investment.

According to Asiedu (2017:363), the inefficient assessment of risk impact on stakeholders' interests and project costs, including lack of claim reduction modalities and inadequate mitigation of contractual claims, remains a challenge in civil infrastructure projects. These issues occur because of increased costs of construction that may exceed the budgeted cost during implementation. Hardjomuljadi and Sulistio (2021:80) specified that effective management techniques for the mitigation of claims and associated risks in civil infrastructure project were not explored. This necessitates the need for the development of a risk management tool to improve construction as well as minimising litigation, disputes, and abandonment of projects

1.2 CONTEXT OF THE RESEARCH

Infrastructure construction projects are typically large, uncertain, and complex, which causes them to be more at risk of impeding project delivery (Roumboutsos and Pantelias, 2015:183). In recent years, civil infrastructure projects have faced many challenges of contractual claims risk that impede the progress of a project because of unfulfilled legal agreements between contracting parties (Bashettiyavar, 2018; Antoniou and Tsioulpa, 2024:333). Since there are situations where project deliveries suffer cost overruns, delays, and failure to achieve client and user requirements, higher construction costs, litigation, quarrelling, disputes between contractual parties, and abandonment of projects, all of which negatively impact project delivery (El-Sayegh *et al.,* 2020; Dlamini and Cumberlege, 2021). These challenges are related to technical complexities, financial constraints, regulatory barriers, and socio-political factors that require urgent interventions (Maseko, 2018; Chang *et al.,* 2018; Karami and Olatunji, 2020; Bikitsha and Amoah, 2022). The literature further highlights that risk management methods and procedures designed to improve project performance are often insufficient (Bracci *et al.,* 2021:205; Alvand *et al.,* 2023:392; Pham *et al.,* 2023:1945). Senses and Kumral (2023:1) examined the trade-off analysis and potential risk by identifying risk planning uncertainties, differences in implementation, and influences of some types of risk management methods and practices on project performance aspects.

Many previous studies have demonstrated technical solutions to risks that are affiliated with claims occurring in the construction of civil construction projects (Dlamini and Cumberleg, 2021). Nonetheless, contractual claims still prevail, which frequently leads to disputes between contractual parties (El-Sayegh *et al.,* 2020:1). This problem results in time overruns against the stipulated time in the contract and costs for all contractual parties (Shehu *et al.,* 2014:1471; Watermeyer and Phillips, 2020:1). Some researchers emphasised that the risks encountered by civil construction projects are typically due to poor procurement arrangements, lack of resources, design contradictions, poor project management, changed orders, scarcity of communication systems, and poor procurement management skill (Watermeyer and Phillips, 2020:1).

Studies conducted on common risks in attaining time efficiency on a project noted routine delays due to contractual claims that seem more crucial. These studies have not adequately identified the most significant causes of delays that need to be monitored carefully to avoid contractual claims during construction. Sibande and Agumba (2018:323) suggested risk mitigation strategies for improvement during implementation of the project by adhering to construction standards and delivering high-quality work. Banaitiene and Banaitis (2012:429) also conducted a study on the strategies for risk management in civil projects, with the intention of improving project quality and costs. However, the highlighted studies did not address contractual claims occurrence in civil infrastructure project. Taroun (2014:101) noted various approaches to evaluating the risks opposing civil projects due to low monitoring of damages and claims during construction. Despite the large number of studies conducted in this area, the influence of risk mitigation on the occurrence of contractual claims in the construction of civil infrastructure was seldom discussed.

Therefore, it is important to identify and scrutinise the risk factors that cause contractual claims, to improve project performance in terms of time and cost overruns, poor quality, and to ensure clients' and other project parties' satisfaction. This study will aid the understanding of the sources and the influence of claims in construction projects. The identification of these factors will enhance the deployment of strategies, approaches, and appropriate tools for the improvement of construction project management.

1.3 PROBLEM STATEMENT

Due to the lack of sustainable use of risk management practices in the South African construction industry, contractual claims challenges persist across all engaged production departments. The extent of these challenges increases the cost of construction and time of project delivery and affects the interests of the stakeholders. This indicates the need for a mitigation model to reduce the continual occurrence of contractual claims risk impeding the delivery of civil infrastructure projects within a budgeted cost and time. The development of an applicable risk mitigation model will support existing risk management techniques. Four sub-problems were formulated to simplify the understanding of the main problem:

1. Contractual claims risk mitigation is a challenge for civil infrastructure project delivery,
2. Risks during the construction of civil infrastructure projects have an impact on stakeholders,
3. Construction managers are not provided with adequate strategies for risk mitigation in civil infrastructure projects, and
4. There is no effective model to mitigate contractual claims risk in civil infrastructure project delivery.

1.4 RESEARCH QUESTION

What factors need to be considered by civil infrastructure stakeholders to mitigate contractual claims risk and ehnace the delivery of civil infrastructure projects in South Africa? The research question stated above was simplified into sub-questions itemised below:

1. What are the factors causing contractual claims risks in civil infrastructure project delivery?
2. How does the occurrence of risks impact civil infrastructure projects in South Africa?
3. What strategies are required for construction managers to manage risks in civil infrastructure projects?
4. What model should be developed to mitigate contractual claims risks in civil infrastructure projects?

1.5 AIM OF THE RESEARCH

This study aimed to develop an effective risk mitigation model to address contractual claims risk and to enhance the delivery of civil infrastructure projects in South Africa. The research aim is simplified into a set of research objectives as follows:

1. To identify the factors causing contractual claims risk in civil infrastructure project delivery,
2. To ascertain the impacts of risks occurrence in civil infrastructure projects,
3. To determine essential strategies to mitigate risks in civil infrastructure projects; and
4. To develop and validate a risk mitigation model to address contractual claims risk and enhance the delivery of civil infrastructure projects in South Africa.

1.6 RESEARCH BELIEFS

1. The factors causing contractual claims risk in civil infrastructure project delivery are not identified,
2. The impacts of risk occurring in civil infrastructure projects have not been properly determined,
3. Applicable strategies for stakeholders to mitigate risk in civil infrastructure projects are inadequate, and
4. An effective model for risk mitigation of contractual claims in civil infrastructure projects has not been developed.

1.7 SIGNIFICANCE OF THE RESEARCH

Civil infrastructure construction processes in developing nations, such as South Africa, are facing challenges due to associated risks and constant delays, which often lead to disputable contractual claims (Oshungade and Kruger, 2017:13; Dlamini and Cumberleg, 2021). Several studies have explored methods to reduce the increasing risks associated with contractual claims for civil projects. However, previous research lacks applicable solutions to issues such as higher costs, litigation, disputes, and project abandonment (Dlamini and Cumberleg, 2021). Given the persistent recurrence of these challenges, there is a pressing need for a model to address claims, mitigate risks, and control construction costs (Mukuka *et al.,* 2015:1693).

The main focus of this research was the constant contractual claims resulting from delays caused by cost and time overruns, which hinder construction operators from meeting client objectives and satisfying expectations in terms of cost, time, and quality (Ceric, 2014:931). Akogbe et al. (2013) identified key delay factors affecting civil project completion, including insufficient financial capacity from contractors and owners, poor procurement strategies, frequent design changes, poor consultant supervision, and lack of proper equipment and technician expertise.

Hence the typical statements of facts are:

- Reducing contractual disputes seems to be the main aim of many researchers in recent years (Ebgelakin *et al.,* 2015:395). However, there has been no significant solution to construction risk mitigation to prevent the occurrence of contractual claims.
- Creating an operational risk management plan is not an easy task. Many construction companies suffer risks during project performances. These risks have negative impacts on civil projects (Iqbal *et al.,* 2015:65).
- The type of common risks depends largely on the type and location of construction, where the infrastructure projects are taking place (Siraj and Fayek, 2019:12).

Based on evidence regarding claims and their challenges in the literature, this research aimed to promote best practice risk-mitigating strategies. Thus, this study contributes to the body of knowledge by establishing an effective risk mitigation model to address contractual claims risk and to enhance the delivery of civil infrastructure projects. Proactive techniques were also developed to alleviate persistent disputable contractual claims and associated risks, thereby facilitating resource utilisation and cost control in achieving quality civil infrastructure project delivery. Public funds, revenue, and taxes remain the key means of financing infrastructure projects. Therefore, the model was expected to achieve the following results:

- Establish risk mitigation mechanisms for stakeholders to control recurring claims in civil infrastructure projects and maintain project costs within budget.
- Implement operational techniques that improve efficient cost control during the production stage and ensure client requirements are met within the stipulated timeline.

1.8 LIMITATIONS

The study focused on the risk mitigation approach in claims reduction to achieving cost efficiency in the delivery of civil infrastructure projects within the constraints of the budgeted cost:

- Data were collected from construction and consulting firms registered on the Construction Industry Development Board (CIDB) register, and consulting quantity surveying firms registered with the South African Council for the Quantity Surveying Profession (SACQSP) from grades 3–9, including experts in civil infrastructure project delivery in South Africa.
- A quantitative survey was conducted through the administration of a closed-ended questionnaire survey to all participants (e.g., construction contractors, consulting firms,

etc.), who are professionals registered on the SACQSP register and working with construction companies that are registered on the CIDB register.

- The qualitative research method was conducted through interviews among selected construction stakeholders working with the construction companies and consulting quantity surveying firms on grades 5–9 in the Western Cape, as one of the largest provinces in South Africa. Relevant information on contractual claims in civil infrastructure projects was obtained from directors who worked under Western Cape Transport and Public Works.

The reason for choosing construction companies registered on the CIDB on grades 3–9 is based on financial and work capability. The upper limit of the tender value of grade level 3–9 ranges from R3,000,000 to no limit, signifying that the contractors handle large projects. Therefore, the claims and risk involved in projects would be high, and therefore worth being investigated. Hence, they were able to reflect on their experiences on the implementation of projects by providing relevant information about contractual claims and associated risks. The construction companies from grade levels 1-2 were not included because most of these contractors within these grades are new entrants in the construction field and, in most cases, they work as subcontractors of higher-grade contractors.

1.9 ETHICAL STATEMENT

The study observed the four pillars of research ethics as enumerated below:

- **Integrity and quality of data:** This research study was designed to ensure that accurate and quality data was collected to enhance the effectiveness of the research findings. All sources of information used in this study were appropriately cited and acknowledged in the reference list. Quality assurance was observed in ensuring accurate data capturing. The data was collated and assembled using Excel. Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), followed by the PLS-SEM analysis conducted using SmartPLS4.
- **Voluntary participation:** The study participants were chosen using appropriate selection criteria, and voluntary participation ensured.
- **No harm to participants:** No information that might constitute a threat or cause harm to the participants was used in this study.
- **Confidentiality:** Confidentiality and anonymity of information supplied by the research subjects would not be made known to any third party under any circumstances.

1.10 CHAPTER OUTLINE

This study is structured as follows:

- **Chapter One–the problem and its setting:** This chapter covers the background to the problem, context of the research, problem statement, research question, aim and objectives, research beliefs, significance of the research, limitations, ethical statement, and chapter outline.
- **Chapter Two–literature review:** This chapter contains a review of the literature to build a theoretical underpinning for the research. Information collected from the literature focused on issues related to civil infrastructure projects. The chapter provides an overview of the risk mitigation approach, coordinated and clear information on contractual claims risk hindering project delivery was discussed, and a chapter summary was provided.
- **Chapter Three–theoretical and conceptual frameworks:** This chapter includes the theoretical and conceptual frameworks upon which the research intends to achieve its overall objectives. Theories on contractual claims were discussed and evaluated to appropriately justify the originality of this study.
- **Chapter Four–research methodology:** This chapter comprises the research methodology under three sections, which are research philosophy, research methodology, and research design.
- **Chapter Five–research methods:** This chapter discusses the research methods upon which the research is established, and justifications for the chosen techniques for data collection.
- **Chapter Six–quantitative research data collection, analysis and discussion:** This chapter includes the quantitative data analysis, discussion of the results, and benchmarks them against previous studies.
- **Chapter Seven–qualitative research data collection, analysis and discussion:** The chapter includes qualitative interviews towards validation of the findings obtained in chapter six; content analysis is also presented.
- **Chapter Eight–the establishment of a model:** This chapter contains a discussion on the establishment of a risk mitigation model in civil infrastructure projects.
- **Chapter Nine– summary of findings, conclusions, and recommendations:** This chapter contains the summary of findings, conclusions, and recommendations for the application of the conceptual approach in civil infrastructure projects.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 INTRODUCTION

A literature review is presented in this chapter, related to contractual claims risk and aspects of the influences hindering the delivery of civil infrastructure projects within budgeted cost. This provides theoretical support for this study. The chapter presents an overview of the factors that could be influencing the civil infrastructure projects.

2.2 OVERVIEW OF CIVIL INFRASTRUCTURE PROJECTS IN SOUTH AFRICA

2.2.1 Benefit of civil infrastructure projects to the construction industry

The South African construction industry plays an important part in the growth and economic development of the nation and enhances the lives of the people over a broad spectrum, through the performance of civil infrastructure projects that create employment and wealth (Windapo and Cattell, 2013: 65; Watermeyer and Phillips, 2020: 1). At all levels of the industry are the distinguished stakeholders of the private and public sectors.

The Construction Industry Development Board (2004:6), Adenipekun (2013:254), Siyan and Adegoriola (2017:65) considered civil infrastructure investment as a major operation for the growth of sustainable economies. Large budgets are always disbursed for infrastructure development by governments to ensure their progress to increase economic growth and reduce housing problem amongst the people. Civil construction projects increase business, attract investment, reduce housing shortages, and create jobs on a large scale. Thus, the construction process of civil infrastructure projects propels the construction industry towards achieving efficient facilities and service delivery.

Mokoena and Mathibe (2019) stated that the South African construction industry contributed approximately 40% to the total gross fixed investment and accounted for roughly 4% of the country's nominal GDP, while also generating employment for 1,395,000 individuals across both the formal and informal sectors in recent years. According to the Construction Industry Development Board (2021:3), investment in infrastructure plays a crucial role in gross fixed capital formation and fosters significant employment opportunities in both sectors. The construction industry has the potential to significant increase the nation’s economic development and productivity and have a positive impact on employment. Therefore the need for governments of developing nations to develop the construction industry to effectively complete projects to combat the problem of unemployment and poverty, as well as training citizens for skills development and productivity, and creating more job opportunities through the development of civil infrastructure (Dang and Sui Pheng, 2015:237). The construction project involves planning for project design as well as transforming this planning into infrastructure development, which includes control of construction resources within the agreed cost and time at the briefing stage of civil project delivery to provide long-term benefits to the economy, as a nation's economic growth is tied to infrastructure development (Blom and Guthrie, 2016:56). Civil infrastructure projects have the potential to create significant social benefits and employment, boost public and private sector activities, and increase government revenues (Buvik and Rolfsen, 2015: 1484; Wu *et al.*, 2017: 1466; Rezvani *et al.*, 2018: 1043).

2.3 CAUSES OF CONTRACTUAL CLAIMS RISKS THAT HINDER CIVIL INFRASTRUCTURE PROJECT DELIVERY

2.3.1 Related challenges facing contractual claims risk mitigation

The South African construction industry has challenges in the civil infrastructure projects sector pertaining to several obligations, responsibilities and operational processes (Windapo and Cattel, 2013:65; George *et al.,* 2016:24). Some of these challenges were identified by Emuze and Smallwood (2011:929) as inadequate time management efficiency, client dissatisfaction, reworks and defects. Windapo and Cattell (2013:65) clarified that industry stakeholders have various impacts on civil projects, including increased costs of construction materials, higher prices and mortgages, high failure rates of company performances, and contractual obligations. According to Pillay and Mafini (2017:1), risk management strategies in the construction industry involve five key challenges: technical expertise, scientific efficiency, skills, procurement methods, and supply relationship with construction management. Despite the impact of immense responsibilities and obstacles affecting the South African construction industry, the sector still has the potential to play a significant part in the population's socioeconomic empowerment. This could be achieved by strengthening the industry's capabilities in the areas of execution and delivery of construction projects without hindrance or related risk.

A survey conducted with construction engineers, quantity surveyors, and contractors demonstrated that most experts in the field of construction tend to mitigate risks, but projects suffer problems due to unfairness in bidding practices (Barman and Charoenngam 2017). These problems result in over-claiming by contractual parties, withholding payment for service delivery, negligence in the preservation of documents, and poor workmanship. These challenges are critical to project delivery; thus, it is important to establish a mechanism to control the impact of budget on project delivery (Barman and Charoenngam 2017).

2.3.2 Causes of contractual claims

Claims in civil construction projects arise because of a wide range of reasons, causes, and factors (Shen *et al*., 2017:727). Distinct approaches have been developed to deal with causes of contractual claims, including alternative solutions to disputes, determination of types of construction claims, and approaches to avoidance of the claims risk (Kalogeraki and Antoniou, 2024:11; Matarneh, 2024:141). Moreover, the avoidance of claims risk requires a clear understanding of the contractual conditions and claims-related causes (Alghamdi, 2022:83; Apte and Pathak, 2016:45). According to Stanley *et al.* (2015:34), based on a study performed on claims in Nigeria civil projects, the cost of claims included in a project and the total claims package (amount) were calculated as percentages of the original value of the contract.

Related to the above, the standardisations used were the comparison between the relative amounts of claims collected in a given category; this was achieved by determining the contract and absolute values that may not indicate the relative effects of a project. Shaikh *et al*. (2020:1) identified the common types and causes of claims that typically occur in large civil projects, namely delay claims, extra work claims, claims arising from ambiguities in contractual conditions, extension of time claims, and suspension of work claims. Studies have asserted that delays in payment are the most common type of claim, followed by incomplete design, variation orders, change orders initiated by the owner, lack of communication, and poor project management (Shaikh *et al*., 2020:1).

2.3.3 Stakeholder-associated delays in project delivery

According to Doloi *et al.* (2012:267), the key stakeholders in civil infrastructure delivery are clients, consultants, and contractors. The function of stakeholders in managing construction claims during implementation remains unclear, as deficiencies in planning and scheduling have the greatest impact on cost performance for clients, consultants, and contractors. Delays are a highly common source of construction claims, occurring when one party's activity is affected by the inactivity, inability, or constraints of another party (Surahyo, 2018:189). Delays lead to a chain of claims, and their admissibility depends on their sources, the attitude of the stakeholders, and the complexities of projects. Claims emerge from the delays due to labour and equipment idleness and overhead charges (Iyer *et al.,* 2008:178). The following are delays identified as instigators of contractual claims and their sources of occurrence (Iyer *et al.,* 2008:178):

- Delay due to handing over of the construction site,
- Delay due to release of mobilisation advance,
- Delay due to late receipt of checking of drawings,
- Delay due to accidents,
- Delay due to temporary stoppage,
- Delay due to rework, and
- Delay due to extra work.

Surahyo (2018:189) mentioned the following common causes of delay that lead to claims in projects:

- Delay in handing over construction site to the contractor,
- Delay in approvals and decisions,
- Delay due to owner's nominated subcontractors or by the general contractor's subcontractors,
- Delay or defects in items supplied by the owner,
- Delay in delivery and supply of materials,
- Delay in the progress of work by the contractor,
- Failure to adequately schedule and coordinate the work, and
- Strikes, adverse weather, contractor errors, variations and owner-directed suspension.

Aiyetan *et al.* (2011:25) and cited high-ranked factors influencing project performance as poor construction planning, poor control techniques, poor management style, lack of construction site preparation, poor site management and supervision, unforeseen ground conditions, unmotivated workers client-initiated variations, necessary variations of works, slow decision making by stakeholders, and lack of customers' experience. These factors have significantly caused delay in the delivery of civil projects. Kim *et al.* (2009:39) revealed that the delay in civil projects in developing countries incurred financial losses for all stakeholders. This influences project scheduling because of the financial difficulties experienced by the contractors, insufficient contractor experience, and lack of supply of materials (Sweis *et al.,* 2008:665).

In addition, Assaf and Al-Hejji (2006:349) considered planning and inadequate implementationof requirements as prominent sources of delay. Misinterpretation of the requirements could cultivate conflict among construction representatives and cause delay, cost and time overruns, litigation, and claims (Aibinu and Jagboro; 2002:593; Valentin and Vorster 2012:19). Al-Momani (2000:51) added late delivery, project design, user changes, and increase in quantity as further causes of delay. Also, Sambasivan and Soon (2007:517) noted that contractual claims have strongly become endemic in developing nations by aiding lack of communication between parties, errors in construction stages, problems with subcontractors, shortages of material, labour supply, equipment availability and failure. They further advocated the importance of creating awareness on the extent to which delays can adversely affect project delivery (Sambasivan and Soon, 2007:517). Sepasgozar *et al.* (2015:15) discussed the causes of delays related to construction technology, emphasizing its potential to improve productivity and reduce project duration. The authors' study revealed that the use of older technology caused delays, which in turn led to claims in civil infrastructure projects. Kaliba *et al.* (2009:552) highlighted the significant impact of claims on civil projects in developing countries, noting that road construction is a major component of the industry. They recommended implementing an effective claims management system to control construction costs. Kikwasi (2013:57) ranked the main causes and effects of delays and disruptions during the performance of projects as presented in Table 2.1 and Table 2.2.

Table 2.1: Ranking of causes of delays and disruptions

Causes of delays and disruptions	**Rank**
Design changes	1
Delays in payment to contractors	2
Information delays	3
Poor project management	4
Compensation issues	5
Disagreement on the valuation of work done	6
Conflicts among the involved parties	7
Project schedule changes	8
Supply/procurement problems	9
Incompetent contractors	10
Bureaucracy	11
Multiple projects by contractors	12
Incompetent contractors	13
Contractual claims	14
Unexpected ground conditions	15
Government interference	16
Poor understanding of the project	17
Shortage/lack of equipment	18
Shortage of materials	19
Skills shortage / unavailability	20
Acts of God	21

Adapted from Kikwas (2013:57)

Table 2.2: Ranking of effects of delays and disruptions

Effects of delays and disruptions	Rank
Time overrun	1
Cost overrun	2
Negative social impact	3
Idling resources	4
Disputes	5
Arbitration	6
Delays by the client in returning loans	7
Poor quality of work due to hurry	8
Delaying in achieving profitability by clients	9
Bankruptcy	10
Litigation	11
Stress on contractors	12
Total abandonment	13
Acceleration losses	14

Adapted from Kikwasi (2013:58)

Delays and disruptions are used spontaneously when claims are made for cost overruns on complex projects. The author further stated that frequent delays on construction site causes construction cost increases and considerable difficulty in justifying and quantifying such claims for project delivery in developing nations. The relation between the causes and effects of delays and disruptions as they present the delivery of civil infrastructure projects is diagramatically presented Figure 2.1.

Aibinu and Jagboro (2002:593) and Sambasivan and Soon (2007:517) highlighted six effects of delay on project delivery in the Nigerian construction industry, which are time overrun, cost overrun, dispute, arbitration, total abandonment and litigation. Other researchers have done similar work in different continental areas. Sambasivan and Soon (2007:517) researched the effect of delays in the Malaysian construction industry and Haseeb *et al.* (2011:41) presented the effects of delays in the Pakistani construction industry as clashes, claims, total desertion, and slow growth of the construction sector.

Shen *et al*. (2017:727) identified causes of construction claims in civil construction projects by illustrating claims associating with the changes made by the client. They further noted that if the changes lead to disparity between the stakeholders or the changes occurred because of uncontrollable events or external influences, then there is a probability that disputes will occur and contract claims might be initiated (Shen *et al*., 2017:727). Another researcher, Abdul-Malak *et al.* (2002:85) noted that the desire of the client or owner to modify the drawings to suit his/her interests, including specification issues, typically lead to claims. Rowlinson and Yates (2003:854) found that an incomplete construction contract can lead to tensions pertaining to the client’s specification problems and construction delays, which paves the way for such claims as extensions of time and additional payment for project completion. In effect, this tension caused by client is considered excessive, unreasonable, and abets conflicts and disputes between contractual parties (Rowlinson and Yates, 2003:854).

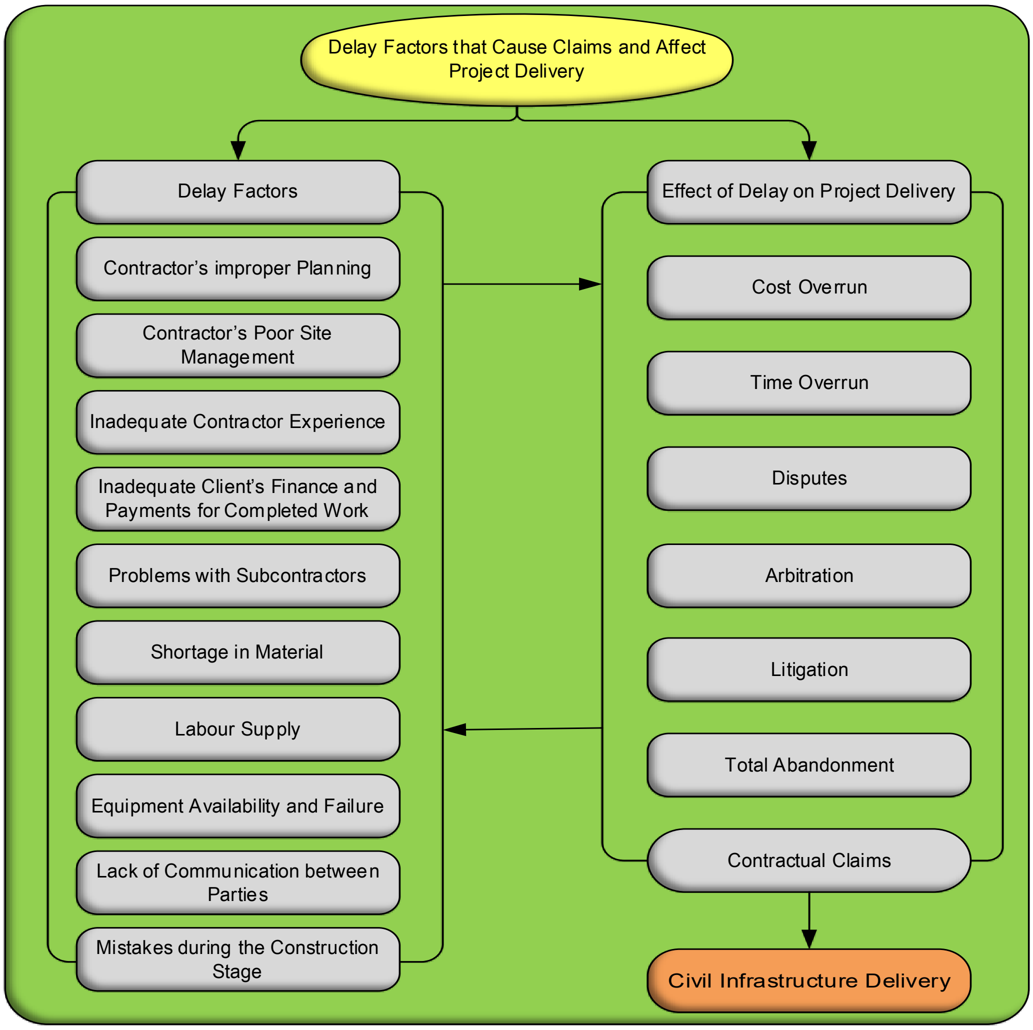

Figure 2.1: Factors related to delay causing contractual claims that prevent project delivery

Similarly, causes relating to contractor-associated contractual claims are also identified in this section. Arditi and Pulket (2005:387) highlighted common causes that could provoke claims in civil infrastructure projects and also result in disputes or conflicts, particularly in large projects. These common causes are identified as lack of communication, insufficient planning, poor specifications, clumsy contracts, poor conditions of the construction site, late payment, including manpower restrictions, poor quality materials and equipment, lack of supervision, acceleration in measures, delays, lack of notice requirement, and changes in construction design by the owner (Arditi and Pulket, 2005:387). All the aforesaid causes could instigate litigation amongst the stakeholders, especially between the client and the contractor. Therefore, project managers, principal owners, consultants, contractors, and professionals are advised to adequately quantify the principal causes of claims and identify applicable practices to resolve these claims (Lahdenperä, 2012:57).

Related to the above citations, many other researchers in various countries have reported similar causes of claims in civil infrastructure projects (Shen *et al*., 2017:727). Some claimed that project delivery exceeding budgeted time and cost, as well as specification disagreement between stakeholders, caused claims due to occurrence of unexpected events (Sweis *et al.,* 2008:665). The possibility of having unresolved claim issues leading to conflicts and disputes is considered very high (Mitkus and Mitkus, 2014:777).

Gashahun (2020:41) highlighted that the causes and effects of delays in construction projects related to consultants included delays in approvals, design changes, insufficient investigation of designs concerning the site, and inadequate involvement of stakeholders during the planning stage. Mpofu *et al.* (2017:346) further explained that consultant's shoulder much of the responsibility for unrealistic contract durations, which ultimately lead to contractual claim risks. Kazaz *et al.* (2012:428) identified incomplete or inaccurate designs, as well as delays in the readiness of designs by consultants, as key factors contributing to construction delays. Shebob *et al.* (2011:1005) and Alfakhri *et al.* (2018:766) stated that frequent design changes and poor-quality control by consultants were significant contributors to delays. Khalifa and Mahamid (2019:4956) noted that delays by consultants in issuing instructions and drawings, failure to address design modifications and change orders, and insufficient coordination by consultants with on-site contractors lead to cost increases in projects. Famiyeh *et al.* (2017:181) and Coleman *et al.* (2020:41) highlighted that poor inspection by consultants during the implementation of civil projects was a primary cause of cost overruns. Additionally, Ntiyakunze (2011:85) pointed out that conflicts could arise from delays in the consultants' evaluation process of contractors' claims.

2.3.4 Performance-associated claims

Civil infrastructure projects require adequate work performed on the design and construction engineering of structures and buildings, particularly focusing on building operation to ensure the satisfaction of stakeholder demands (Bagthariya and Shah, 2022:4). However, many previous studies have endeavoured to explain the complexity of the performance issue on the construction sites. These studies discussed project performance in large-scale infrastructure projects, where the sizes are significant and schedules are impeded due to the impact of several factors on project performance (Bosch-Rekveldt *et al.*, 2011:728; Xia and Chan, 2012:7). Some studies identified stakeholders' or project managers' viewpoints as one of the impediments affecting project performance on construction sites (Wu *et al.,* 2017:1469).

Further studies considered schedule and budget overruns, poor project quality, low productivity, production technical problems, client dissatisfaction, and poor safety systems as basic problems causing performance issue in civil infrastructure projects (Arashpour *et al.,* 2017:647; Arashpour *et al.,* 2018:46).

On the other hand, some groups of researchers critically determined the effects of the performance issue on civil infrastructure projects (Ogunde *et al.,* 2017:1234). The authors reported such signficiant attributes as financial stability, work progress, quality criteria, standby safety systems, stakeholders' relationship and reputation, availability of resources, management capacity, dispute management, and contractual claims management (Ogunde *et al.,* 2017:1234). Molenaar and Songer (1998:467), as cited in Ochieng *et al.* (2013:1), reported the impact of quality issues on the overall performance of a civil project, while Olawale and Sun (2010:509) reported the impact of lack of monitoring techniques on the time and cost of executing a civil project. In addition, other factors influencing project performance are price volatility, inadequate materials, stormy weather, and accidents (Zaini *et al.,* 2010:330). Therefore, project performance is estimated by quantifying performance implementation as related to the success of the project through time, cost, and quality (Bonham *et al.,* 2017).

2.3.5 Cost, time implication of claims

Okada *et al.* (2017:592) stated that changes requested in the design and construction phases by the owner can induce cost and time overruns, as well as unreliable decisions by the project team. Anees *et al.* (2013:77) supported this view, stating that frequent changes requested by the owner could lead to contractual claims if not properly managed through an appropriate mechanism for monitoring construction operations. According to a study performed by Konkoon and Chovichien (2014:66), construction claims occurring during a civil project performance influence the cost, time and space available for a contractor to effect claim management. The study described the approaches that a contractor can observe in effecting claim management across various units during construction production. Thus, it is considered essential for a contractor to understand and identify changes requested, including the understanding of the effect of the time and cost analyses on the changes to be implemented. These approaches are expected to enhance economical delivery of the civil infrastructure project. Other factors identified are claims and dispute mishandling, payment delays, errors and omissions in drawings, misinterpreting contractual clauses, and non-adversarial communication (Hendrickson, 2005:102). Other identified factors are political influence, corruption across departments, upsurge price of construction materials due market inflation, financial challenges for project execution, and security issues (Odeyinka and Yusif, 1997:31). In spite of the identified challenges, successful completion of a project is arbitrated through delivery within budgeted cost and time based on various parameters (Niazi and Painting, 2017:510). This is considered a significant challenge in the developing countries as many civil projects are abandoned as result of one circumstance or another.

2.3.6 Resource-associated claims

In recent times, the unique, dynamic, and complex nature of the construction industry has been experiencing increased claims, liability exposure and disputes, and unreasonable settlements and poor management of resources (Bajere *et al.,* 2017:14). Resources management is a crucial part of the construction industry that ensures ultimate delivery of completed civil projects. Shortage of resources has been one of the challenges slowing down construction performance in developing countries, such as South Africa. The impact of this particular challenge on the delivery of a civil project in developing countries is compounded by the presence of socioeconomic stress, institutional weaknesses, and other influential issues (Raja and Murali, 2020: 253).

Additionally, allocation of resources for construction project execution requires efficient construction planning, which includes cost-efficiency, value adding, time-efficiency, labour-efficiency, and adequate site preparation (Raja and Murali, 2020:253). It is understood that adequate resource allocations encourage better project performance, provided that efficient planning structure is implemented to initiate production. More so, well-planned construction activities could foster better economic and social development than contributing to the depletion of natural resources of a nation (Tafesse *et al.,* 2022:5).

2.3.7 Human resources-associated claims

Issues pertaining to human resources are another crucial aspect instigating contractual claims in the construction industry. Workers in the construction industry are responsible for the overall delivery of the construction projects from the planning to execution aspects of the construction development. These workers are responsible for ensuring that the project is properly executed and delivered within the appropriate management of the cost, time, quality, and safety stipulations. These responsibilities cut across different operational areas such as consultancy, architecture, engineering, and management. This responsibiliy, if not appropriately discharged, could have a significant influence on the occurrence of contractual claims in civil projects. In the process of discharging these responsibilities, adequate skills and knowledge acquired through training and experience are considered critical to deter any occurrence of incompetence during production activities, which could incur contractual claims in civil infrastructure projects (Crawford, 2005:7).

2.3.8 Contract-associated conditions on construction sites

Some previous studies discussed the essence of managing the conditions of a contractual claim in civil projects. Al-Zwainy *et al.* (2018:624) clarified the importance of understanding the contractual claim conditions as a basis for avoidance of disputes and delays. Further study showed that effective claim reduction can be achieved by developing an appropriate economic structure that could strengthen the financial capability of the owner. In some ways, an owner or a client is relieved of facing serious financial obligations arising from unforeseen conditions of the construction site and their consequential effects, provided that there is always a regular disclaimer and limited inspection of the site. However, queries persist as a result of the unforeseen conditions of the construction site.

Early agreement on a contractual term will deter constant construction claims, disputes, and non-adversarial communication. Also, a clear understanding of the causes of claims will help in reducing claims that provoke costs of construction. Apte and Pathak. (2016: 45) reported that major causes of claims on the construction site are delays, demolition, errors and omission in drawings, and frequent changes in design. The above listed causes of claims encourage delays in construction project delivery and thereby provide room for extension of time (EoT), postponement, litigation, withholding of payment, and many others (Rowlinson and Yates, 2003:854; Zaneldin, 2006:453). According to Zaneldin (2006:453), construction claims are considered by many project participants as among the disruptive and unpleasant events that occur during a civil project execution.

2.3.9 Dispute-associated causes of contractual claims

Mashwama *et al.* (2016:196) highlighted the main factors of disputes in civil projects in Swaziland as follows:

- Deterioration of respect and the contractual relationship between parties,
- Cost of rework, relocation of workers, equipment and materials,
- Cash flow concerning insurance coverage and risks,
- Breakdown of cooperation between contracted parties,
- Additional expenses in managerial and administrative areas,
- Professional reputation loss for companies,
- Extended or complex awards process,

- Time and cost overruns due to delay,
- Possibility of litigation,
- Loss of business viability,
- Height tender prices,
- Productivity loss, and
- Profitability loss.

Assah-Kissiedu *et al.* (2010:24) identified ten factors causing conflicts in Ghanaian civil projects, including their importance as regards the clients, consultants and contractors. They are:

- Government policies that encourage poor evaluation tenders, which leads to claims,
- Poor financial arrangements by client leading to delayed payments,
- Lack of effective communication between the contractual parties,
- Unclear and incomplete description of items in quantity invoices,
- A disorder that causes a delay in the work schedule,
- The contractor misunderstanding the terms of a contract,
- Contractor failing to evaluate construction work,
- Client failing to pay instalments when due,
- Poor design and control specifications, and
- Lack of skilled subcontractors.

Cakmak and Cakmak (2014:183), Aryal and Dahal (2018:2), and Naji *et al.* (2021: 45646) showed the most common causes and categories for disputes in civil projects as presented in Table 2.3.

Table 2.3: The most common causes and categories for disputes

Dispute category	Causes of dispute
Owner-related	Owner-initiated modifications
	Modification of the scope
	Possession given late
	The process of accelerating
	Expectations that are unrealistic
	Payment issues
Contractor-related	Work progress delays
	Extensions of time
	Contractor's financial failure
	Contractor's technical deficiency
	Tendering procedure
	Work of low quality
Design-related	Errors in design
	Specifications that are insufficient or incomplete
	Design quality
	Information accessibility
Contract-related	Inconsistencies in contract documents
	Various interpretations of contract provisions
	Allocation of risk
	Other contractual issues
Behaviour-related	Culture of adversity/controversy
	Communication breakdown
	Absence of team spirit
Project-related	Site circumstances
	Unanticipated changes
External factors	Weather conditions
	Legal and economic factors
	The sector's fragmented structure

Adapted from Cakmak and Cakmak (2014:184); Aryal and Dahal (2018:2), and Naji *et al.* (2020: 45646)

2.4 IMPACTS OF RISK ON CIVIL INFRASTRUCTURE PROJECTS

2.4.1 Risk impact classification in civil infrastructure project delivery

According to Perera *et al.* (2009:87), risk is known as an inescapable phenomenon in civil project delivery. The classification of project risk allocation in a construction contract has a direct impact on risk handling decisions. Risk must be identified and allocated in a well-defined method for risk management. This can only be accomplished if contractual parties are aware of the obligations and responsibilities related to the occurrence of risks and the ability to deal with it. Perera *et al.* (2009:87) explained that every endeavour in civil project delivery involves risk. Thus, the success or failure of any venture depends crucially on how to deal with it. In the construction industry sector, there has been a poor track record in dealing with these risks. Project managers are responsible for a variety of failures, including failure to meet quality and operational standards, cost overruns, and unexpected delays in the delivery of civil projects. The track record of coping with these risks has not been reliable in the construction industry. Project managers have to take responsibility for most of this. Consequently, effective risk assessment and management for civil infrastructure project delivery remains a challenging task for the professionals (Ehsan *et al.,* 2010:16).

The construction contract may be characterised as the formulation of risk allocation among the contractual parties. These risks are related to unforeseen ground conditions at the construction site, changed orders, time extensions, final cost increases, poor quality work, implementation or design errors, claims, and disputes (Al-Qershi and Kishore, 2017:196).

2.4.2 Impact of stakeholder management on project delivery

Stakeholder management is one of the key success factors for construction firms in the construction industry, although managing the stakeholders' environment has always been a complex situation (De Schepper *et al.,* 2014:1210). Categorically, the complex and uncertain nature of construction projects, as a result of their different sizes and scope, is one of the main problems affecting the success of project delivery within the estimated cost and time. This is perceived as a result of insufficient management as it impacts stakeholder interests. The effective implementation of a project requires an effective stakeholder management strategy to meet the interests of stakeholders (Mok *et al.,* 2015:446). On the other hand, Di Maddaloni and Davis (2017:1537) explained those stakeholders have a major and wide-ranging role in the construction industry. Understandably, stakeholders' perceptions about project uncertainty, dynamics and complexity lack proper configuration of their needs and interests in stages of project implementation.

2.4.3 Impact of risk on project performance

Issues occurring over the course of project performance are related to risks that cannot be handled between contractual parties. In most cases, these problems include demands from the contractor to extend the time or repayment for an additional cost or both, as a result of insufficient allocation to the project (Apte and Pathak 2016:44). The inappropriate allocation of risk overruns in the construction industry leads to time and cost overruns, conflicts, claims, disputes, and results as well in a reversal of the level of trust in contractual relationships and a lack of quality (Tembo-Silungwe and Khatleli, 2020:1). Civil infrastructure projects regularly experience time and/or cost overruns, delays, and disputes over contractual claims during the execution phase because of contractual parties' inability to identify or mitigate major risks in the planning stages (Antoniou and Tsioulpa, 2024:1). Kikwasi (2013:56) identified five high-ranking effects, namely time and cost overruns, negative social effects, deceleration in supply, and disputes.

Many civil projects encounter extensive issues and delays in project performance assessment criteria, which affects the ability to achieve effective performance in time and cost (Memon *et* *al.,* 2012:45). The parameters measuring construction performance differ from one project to another. Despite several studies on this issue, no framework has been established to assess success in the large and complex projects (Ogunlana, 2010:228). Based on this, many construction projects are affected due to time and cost overruns, which promote uncertainty among contractual parties (Rowlinson and Yates, 2003:854; Gangolells *et al.,* 2011:1023). Sibande and Agumba (2018:523) identified delay in the supply of construction equipment and materials, including the attitudes and morale of the workers as most prevalent factors affecting the performance progress during project execution. Likewise, Ramabodu and Verster (2013:48) noted change in scope of work by the client, incomplete design at the bidding period, contractual claims about an extension of time and cost, estimated delays and incremental variations as the main factors influencing cost and schedule overruns in a civil project in South Africa. Muhammad *et al.* (2015:91) also indicated that impact of variations on labour productivity could encourage disputes, time and cost overruns, as well as slow down project performance rate.

Sibande and Agumba (2018:523), emphasised that poor performance in civil projects also has an influence on the quality of production. In the South African construction industry, proper quantifying of project performance is perceived as a concern among client representatives, consultants, contractors, and subcontractors due to the uncertainty and risk encountered (Hugo *et al.,* 2018:116). All these challenges influence project delivery in South Africa. The authors suggested that these challenges could be minimised or mitigated by measuring actual project performance, which involves enhancement of the traditional design and construction processes. In addition, they further claimed that expediting the project, pressures on the client, losses, inexperience of the contractors or contracting parties, ongoing contractual claims, and delays in obtaining profit by the client influence project scheduling due to contract issues (Hugo *et al.,* 2018:116). Kikwasi (2013:52) noted that delays and disruptions are also a source of potential risk encountered in civil infrastructure projects. Chidambaram *et al.* (2012:37) pointed out that time risks associated with cost impact on project delivery as a result of poor planning and time scheduling. This aids design variations, excessive approval – in government administrative procedures, inconclusive approval – by the client occurrence during project execution.

In support of this, El-Sawalhi (2015:95) and Doloi *et al.* (2013:267) noted in their studies that political obstacles, mismanagement, poor coordination and design have significant influence on time project delivery performance, availability of resources, shortage of materials and equipment – due to delays, procurement of unqualified and inexperience personnel, poor equipment and raw materials. Other researchers cited that measuring the extent of production quality measurement could assist in underscoring the roles, mission, and responsibilities of the project team (Mbachu, 2008:471). Anumba *et al.* (2002:264); Abdul-Rahman *et al.* (2006:23), and Gharouni *et al.* (2021:04021131) proposed a study concept-based mitigation model that manages various delays emerging from inexperienced personnel and operational mismanagement faced during project execution.

Gamil and Rahman (2018:239) identified lack of technical skills and effective communication between contractual parties as one of the paramount causes of time and cost overruns in civil infrastructure projects. Some studies claimed that lack of awareness and poor communication among the contractual parties are significant to the occurrence of time and cost overruns as it concerns the utilisation of resources, procedures, regulations, and systems available for project execution (Khekale and Futane, 2015:849; Apte and Pathak, 2016:44; Niazi and Painting, 2017:510; Aryal and Dahal, 2018:2; Hugo *et al.,* 2018:05018001). The impact of this effect yielded chain risk, conflicts, claims and disputes continuum as illustrated in Figure 2.2.

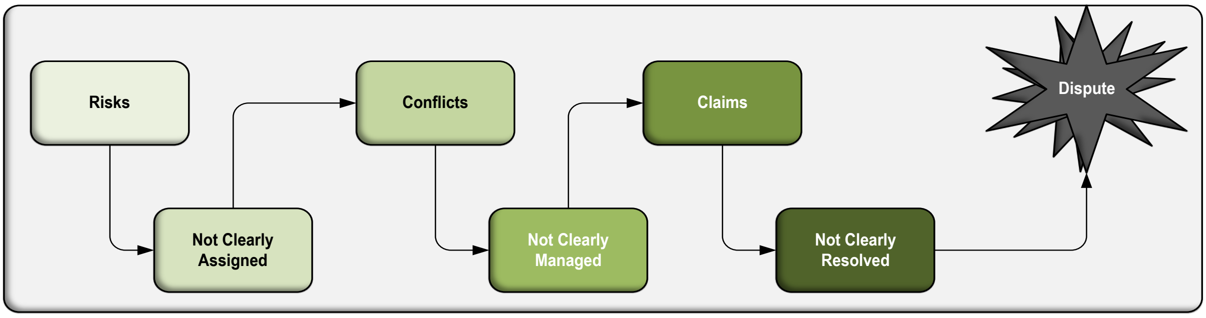

Figure 2.2: The risk, conflict, claim and dispute continuum

Adapted from Khekale and Futane (2015:849); Apte and Pathak (2016:44); Aryal and Dahal (2018:2)

2.4.4 Impact of time overrun risk

The influence of time overrun risk on delivery projects was described by Lo *et al.* (2006:636), Adekunle and Ajibola (2015:1) and Koshe and Jha (2016:18) as a factor that slows down work progress without impeding the entire construction processes. However, this could also cause project abandonment because of the variations in project execution (Morakinyo *et al.,* 2015:629). Pinto (2013:643) added that in construction industry project delivery, failure can be attributed to decision error, inadequate operational planning, and poor design phase. Liu *et al.* (2016:1) noted that those variations in project design have a big influence on project delivery due to occurrence of errors developing from the different views of owners, architects, and contractors.

As part of the discussion, Ahmed *et al.* (2002:5) and Gajare *et al.* (2015:89) classified types of time delay into four cases: commensurable delay, incommensurable delay, non-reversible delay, and synchronous delay. The researchers described commensurable delay as the suspension of work temporary, wholly, or partially. It can also be described as the act of owner's inability, or violation of contractual conditions in the construction contract. Incommensurable delays are caused by unexpected factors, or lack of control, or negligence of work by the contractor (Yao *et al.,* 2020). Non-reversible delay is described as a delay preventing the execution plan due to the risk observed by the contractor while, synchronous delay, is described as a delay occurring as a result of the owner and contractor contributing to the delay. Doloi *et al.* (2012:479) described lack of committal, ineffective site management, poor site coordination, improper planning, ineffective communication, substandard contract, and lack of clarity in the scope of the project as factors influencing stipulated projects time execution.

Mukuka *et al.* (2015:1690-1695) identified cost overruns, loss of profit, disputes, poor quality of work, and negative image of the contractor as predominant contributors to the time-related problems occurring during construction work in the Gauteng province of South Africa. A study conducted by Kusakci *et al.* (2017:274) on the effects of delay on the schedule of civil projects in Libya revealed that poor performance of risk management, poor planning, poor quality, disputes, abandonment of projects, time and cost overruns, and lack of resources and equipment significantly influenced scheduling in construction industry. Similar studies identified poor planning of the supply chain, inadequate regulation, poor communication amongst stakeholders, slow workflow, poor financial status of the contractors, delay in payment by the owner, political situation, poor communication between contractual parties, equipment inefficiency, and high competition in biddings as factors causing delays in work scheduling (Mahamid, 2013:45; Luo *et al.,* 2020).

Ramli *et al.* (2018) identified factors that caused time delay during construction in Malaysia as improper construction methods by the contractor, bad weather conditions, difficulties in handing over the site, failure or delay of site equipment, competency level of the technical personnel, and labourers' lack of adequate experience and skills. A similar study conducted by Haseeb *et al.* (2011:41) identified external factors such as frequent earthquakes and floods as the main factors causing time delay in Pakistan. Studies performed in Pakistan showed that time overrun is principally instigated through constant contractual claims (Gardezi, Manarvi and Gardezi, 2014:196).

2.4.5 Impact of cost overrun risk

Cost increases in civil infrastructure projects are understood to cause major risk impacts on project performance (Little, 2011:240). Several studies have been conducted to investigate the cause of cost overruns in civil projects (Abdel-Hafeez *et al.,* 2016:71); a report by Durdyev (2019:1241) on causes of cost overrun risk in civil infrastructure projects revealed that design errors, incomplete design, inaccurate estimation, poor planning, frequent bad weather, poor communication, inadequate skills, financial problem, price fluctuations, contract management issues, inexperience, incompetence, contract management issues, and physical conditions of soil and land were predominant contributors of cost overruns. A study conducted in Russia by Kuzmina *et al.* (2021: 09004) showed that duplication of work and errors could result from wrong decisions made without necessary consultation which would lead to an increase in costs.

In Nigeria, an extensive study was conducted by Ogunde *et al.* (2017:233) to identify prevalent contributors of cost overruns during civil projects. They found delay in executing additional works, poor performance, political influence, construction site conditions, inaccurate estimates, contractors' financial difficulties, and hiking costs of materials as the main contributors of cost overruns (Ogunde *et al.,* 2017:233). Adeyemi and Masalila (2016:88) established that poor design services, frequent change in design, lack of skilled contractors, lack of experienced project managers, and owners' financial difficulties instigated the occurrence of cost overruns in the Vietnamese construction industry. Also, a study by van Thuyet *et al.* (2007:187) presented similar findings, wherein conflicts between contractual parties, social and economic circumstances, decision-making delay, intense competition in tender stages, weather fluctuations, and short periods for tender bidding were identified as factors with adverse influence on the cost of construction in civil projects.

Ramabodu and Verster (2013:131) identified the underlying factors causing cost overruns in civil project delivery in South Africa. They found that contractual claims include extension of time with cost, inconsistent changes in design, inaccurate financial estimates in project planning, delays in cost variations, and additional works. Research performed in Swaziland indicated that hidden costs, indirect costs, and direct costs largely influenced the occurrence of cost overruns because of disputes (Mashwama *et al.,* 2016:196). In this case, the hidden costs can be described as the cost of a strained contractual relationship between contractual parties and loss of quality. The direct costs can be described as fees, expenses paid to lawyers, and claims consultants, while the indirect costs are described as salaries, costs due to low productivity and managers' incompetency.

2.4.6 Impact of risk on contractual relationship

Contractual relations in civil projects are based on situations that reflect the level of trust or distrust of contract documents. The underlying concept of contractual relationships is collaboration between an owner and a contractor in the performance of the project (Meng, 2011; Young and Poon, 2013:943; Suprapto *et al.,* 2015:1347). Contractual relationships depend on reciprocal attitudes, which consequently lead to minimum claims risk and prevention of risk challenges (Meng, 2011; Young and Poon, 2013:943; Suprapto *et al.,* 2015:1347). In terms of project team level, contractual relationship requires teamwork trust, mutual behaviours, project performance quality as related to transfer of relevant information, regular coordination of project activities, knowledge and experience contribution, and team support on/during the occurrence of events (Suprapto *et al.,* 2015:1347). The cooperative relationship arrangements in project performance are linked to the behavioural interaction, work method, and individual and organisational conditions relating to the enhancement of perceptions of the construction (Hartmann and Bresnen, 2011:41).

As construction projects are becoming larger and more complex, it is important that the selection of a construction contract must depend on its association with project product, process uncertainty, risk allocation, owner's internal capacity, and market conditions (Klakegg *et al.,* 2021: 289; Hu *et al.,* 2021:366). Ideally, the contract type should be based on a contractual relationship with a common set of objectives, interlinked norms of trust, complementarity, respect, and clear procedures for risk management, and resolution of disputes to facilitate cooperation between contractual parties (Wang *et al.,* 2021:799). Occurrence of conflict in contractual relationship influences the association between the contractual parties and project stakeholders, which has adverse effect on the project success and results in poor communication during project implementation (Wu *et al.,* 2017:1466). Other challenges affecting contractual relationships are continuous complexity, scope, size and time-consuming projects, resulting in possibly high costs (Drexler and Larson, 2000:293; Zaghloul and Hartman, 2003:419; Sanderson, 2012:432).

2.4.7 Impact of conflict risk

In recent years, some authors have focused on perceptions on the causes of conflicts in construction projects, with the intention of identifying the significant causes of conflicts as well engineering conflict mitigation processes (Ntiyakunze, 2011:65; Ejohwomu *et al.,* 2016:270; Koc and Pelin Gurgun, 2021). Conflict occurrence is considered a severe risk to project execution in the construction industry, as claimed by Jaffar *et al*. (2011:193). It is also believed that contractual problems such as increased cost, delay, poor productivity, loss of profit, and damage in contractual relationships contribute to the occurrence of conflict (Jaffar *et al*., 2011:193). Other researchers identified interdependence and insufficient communication, lack of cooperation among project parties, dissatisfaction with quality of performance, delays in payments, poorly written contracts, inaccurate cost estimates, inefficient planning and scheduling, delays in project approval, frequent changes to scope of work, and lack of skilled labour as other causes of conflicts (Wu *et al.,* 2017:14662017; Chaturvedi *et al*., 2021:1). It is essential to mitigate these conflict issues because unresolved conflicts among contractual parties could escalate into contractual claims and excessive delays (; Liu *et al.,* 2014:547; Cakmak and Cakmak, 2014:187; Gad and Shane, 2014; Naji *et al.,* 2020).

In Asia, some studies were performed on large projects to ascertain the occurrence of conflicts during execution. A report published by Xue *et al. (*2020) found that variation in stakeholders' attitudes in project development was seen as a paramount problem that cause conflicts for Hong Kong megaprojects. The report showed that governmental and non-governmental organisations, including attitudes among project participants, could an argument be a conflict. (Xue *et al.,* 2020). Charehzehi *et al.* (2017:1) described the five critical conflict factors occurring during civil projects in Malaysia as:

- Inadequate monitoring of scheduling and modernisation requirements,
- Failure to properly understand, quote, and present the business,
- Delay in paying bills,
- Inadequate management, supervision, and coordination of contractors, and
- Design and construction errors based on time, cost, quality and documentation.

Irfan *et al.* (2019:538) disclosed the negative impact of conflict factors in civil projects as production of poor-quality delivery, poor implementation of safety regulations, including lack of sufficient workforce, lack of adequate communication, incessant change orders and rework, and inadequate practice of the environmental policies. Ntiyakunze (2011:65) considered incomplete construction contracts as a major cause of conflict in the construction industry. The causes of conflicts and their relevance to the claims in civil projects are summarised in Table 2.4 (Ntiyakunze, 2011:66).

Table 2.4: Summary of causes of conflicts in civil projects

Common root causes	Self-generated causes	Common proximate cause	Claims
Unrealistic time, cost, and quality targets by the client	Clients' lack of information or decisiveness	Internal conflicts in joint ventures	Variations
Unrealistic tender pricing	Unrealistic information expectations by the contractor	Inadequate contract administration	Unforeseen ground conditions
Inappropriate contract type	Inadequate brief	Inadequate contract documents	Ambiguities in contract documents
Adversarial culture	Poor communication	Inaccurate design information	Interference with utility lines
Uncontrollable external events	Personality clashes	Incomplete tender information	Exceptionally inclement weather
Unclear risk allocation	Lack of professionalism of project participants	Inadequate design documentation	Delayed site possession
Unfair risk allocation	Lack of competence of project participants	Inappropriate contractor selection	Delayed design information
	Vested interests	Inappropriate payment modalities	Acceleration of work
	Changes by the client	Inappropriate contract forms	Suspension of work
	Slow claim response		Other disruptions by the employer or others
	Exaggerated claims		Interest on claims
	Estimating errors		Substantial increase in quantities
	work errors and others		Price fluctuations

Adapted from Ntiyakunze (2011:66)

Table 2.5: Summary of areas of conflicts and their possible causes

Areas of conflicts identified	Possible causes
Design errors	Misinterpretation of client's requirements by designers
	Inexperienced designer
	Incompetent designer
	Inadequate time for design
	Wrong design data
	Cheap design hired instead of quality
Contractual claims on the extension of time and financial claims	Incomplete tender documents
	Inadequate contract documents
	Contractor's strategy to offset the unrealistic tender price
	Inadequate contract administration
Multiple meanings of specifications	Negligence
	Inexperienced specification writer
	Cut and paste tendency
	Use of outdated specifications
Delays in payments	Lack of funds
	Poor financial projection on the client's side
	Excessive claims made by the contractor beyond the client's financial projection
	Delays originating from the evaluation process of the contractor's claim by the consultants
	Inadequate contract provisions for enforcement of timely payments
Poor communication	Lack of communication procedures
	Ineffective communication channels
	Negligence
Excessive contract variations	Change of scope of works as a result of changes in requirements ordered by the client
	Change of scope of works as a result of design errors
	Errors in bills of quantities

Adapted from Ntiyakunze (2011:85)

Table 2.5 continued.

Areas of conflicts identified	Possible causes
Excessive contract variations	Errors in drawings
	Errors in specifications
	Misinterpretation of contract information
Differences in evaluation	Unclear method of pricing the contract
	The tendency of contractors to claim high prices
	Dubious claims made by contractors
	The tendency of consultants/clients to undervalue contractor's claims
	Profit-making or loss-balancing approach of the contractors by using inferior items instead of the ones specified in the contract
Differing site conditions and limitations	Lack of money, time, experts to conduct site investigation
	Wrong interpretation of site investigation
	Ignorance of client and consultants on the importance of site investigation
	Lack of necessary building permit from a regulatory authority
Errors in project documents	Inadequate time for preparation of documents
	Incompetent personnel in preparation of project documents
	The inexperience of personnel involved in the preparation of documents
	Low consultancy fee
	Negligence
Public interruption	The project involves the displacement of people
	Unfair compensation for displaced people
	Poor public relationship between the project people and the public
	Non-adherence to public authorities' regulations, etc.
Cultural differences	Language problems
	Working norms problems
	Professional culture problems

Adapted from Ntiyakunze (2011:85)

Table 2.6: Ranking of causes of conflicts in contractual claims

Causes of conflicts in contractual claims	Rank
Incomplete tender information	1
In-adequate contract administration	2
Unclear risk allocation	3
To offset the unrealistic tender price	4
Inadequate contract documents	5
In-appropriate contract type	6

Adapted from Ntiyakunze (2011:93)

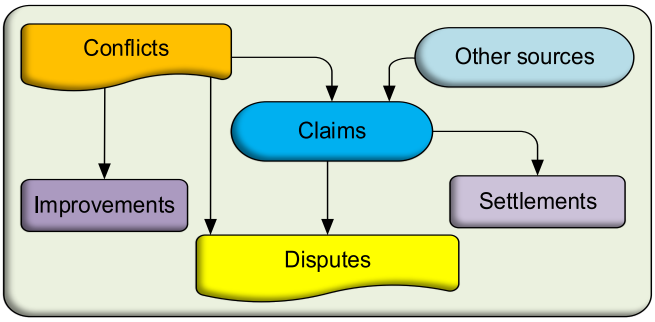

Figure 2.3: The basic relationship among claims, conflicts, disputes, and its possible outcome

Adapted from Mohamed *et al.* (2014:186)

Table 2.5 presents the conflict areas, possible causes, and their relationship to contractual claims, and Table 2.6 the rank order of the causes of conflicts in contractual claims (Ntiyakunze, 2011:85,93; Jaffar *et al.*, 2011:193; Senaratne and Udawatta 2013:158; Salooma and Khodeir, 2016:1). Figure 2.3 depicts the interaction between conflicts, claims, and disputes with the observation that there are other sources influencing claims laying by the stakeholders. From Figure 2.3 it can be seen that unresolved conflicts could lead directly to dispute or claims, while claims not settled could lead to disputes (Mohamed *et al.*, 2014:186).

2.4.8 Impact of disputes risk

Disputes are frequent risks in civil projects as a result of complications encountered in the construction process and therefore, they are termed as a major factor hindering project delivery success, which also affects cash flows for projects and the relationships among the contractual parties (Mashwama *et al.,* 2016:196; Naji *et al.,* 2020). According to Sanderson (2012:432), Winch and Maytorena (2011:345), unexpected risks that occur as a project progresses lead to potential disputes, as well as influencing the relationship among the contractual parties. It is therefore important for the contracted parties to develop a contractual relationship that could cope with the occurrence of new risks and unforeseen events. Aryal and Dahal (2018:1) claimed that disputes arise predominantly from the complexity and scale of construction work, multiple contract parties, poor contract preparation, inadequate planning, financial issues, and lack of communication issues (Lahdenperä, 2012:57). Maiketso and

Maritz (2012:65) reported that lack of knowledge on alternative resolution to disputes in civil projects influences contractual relationships in South Africa.

Conflicts stimulate high cost of resolving disputes across units during the execution of civil projects (Shin et *al.,* 2021). An increased risk of disputes is also promoted by time and cost overruns, which often results in contractual claims and contractual disagreement (Parikh *et al.,* 2019; Kisi *et al.,* 2020). Conflict and dispute investigation in the construction industry, including their impact, is considered essential to ward off unexpected occurrence of delays that could constitute major obstacles to the success of projects undergoing implementation (Cakmak and Cakmak, 2014:183; Naji *et al.*, 2020). In that case, risk of disputes is cultivated, while Leung and Hui (2020:1) advocate an approach to resolving disputes through mediation by understanding and identifying the primary causes and analysing these causes thoroughly through adequate communication amongst the involved parties.

2.4.9 Impact of contractual claims risk

Contractual claims have been described as rights to compensation in money, property, time delay, insufficient performance, or compensation for damages which have resulted from the failure of the other party to perform a specific obligation according to the contract (Ntiyakunze, 2011:65; Abhishek *et al.,* 2014:732; Bashettiyavar, 2018:51; Mishmish and El-Sayegh, 2018:26). Alternatively, Stamatiou *et al*. (2019:382) described contractual claims as associated risks with a negative impact on civil infrastructure projects. Additionally, such claims pertaining to additional works or extension of time were perceived as conflict contributors, cost increments, and adding to project complexity (Ntiyakunze, 2011:66; Mishmish and El-Sayegh, 2018:26). Claims can be treated as a breach of contract clauses, non-compliance with clauses, or requests for compensation (Mishmish and El-Sayegh, 2018:26; Bashettiyavar, 2018:67). All these have a great effect on civil project performance in terms of risk identification and allocation (Mishmish and El-Sayegh, 2018:26; Bashettiyavar, 2018:67). These claims are considered undesirable because they require substantial time and resources, and they also stimulate unreceptive relationships among contractual parties as well as instigating risks and delays in project delivery (Abhishek *et al*., 2014:732; Zhang *et al.,* 2016; Mishmish and El-Sayegh, 2018:26; Wu *et al.,* 2018). Construction claims remain a hindrance to the progress of megaprojects in South Africa, which have the tendency to escalate into contractual misunderstandings, disputes, and lawsuits if not managed properly (Matseke and Khatleli, 2021).

In construction management, risk mitigation is considered attainable, but occurrence of claims is perceived as unavoidable in civil project execution (Wu *et al.,* 2018). and Kisi *et al. (*2020:04520001) postulated that claims sometimes remain pending for a considerable amount of time. Thus, project delivery methods (PDM) are perceived as a technique required to cultivate less adversarial relationships between contractual parties. This approach is expected to encourage fewer disputes and a reduction in claims (Cakmak and Cakmak, 2014:187; Gad *et al.,* 2014:228).

2.4.10 Types of contractual claims

There are several types of contractual claims in civil infrastructure projects, with the most prevalent ones outlined in Figure 2.4 (Abhishek *et al.,* 2014:732).

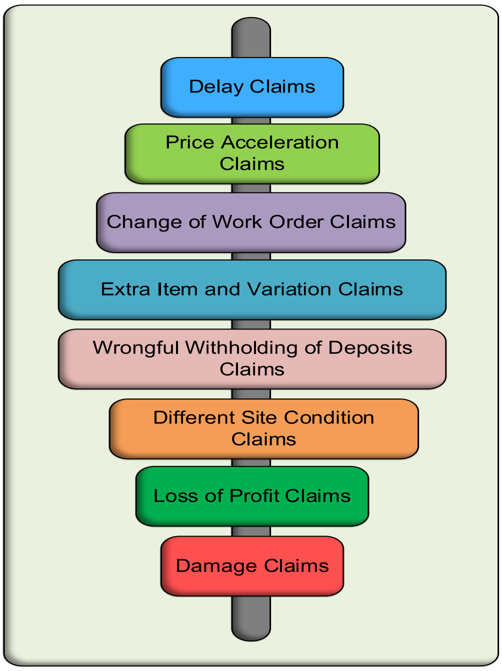

Figure 2.4: Types of contractual claims
Adapted from Abhishek *et al.* (2014:732)

2.4.11 Claims phases in the project production process

The constant occurrence of claims at various phases of the production process has a significant influence on the delivery of civil projects in South Africa. Pinto and Slevin (1989:31) noted that human conflict, budget constraints, and pressure on project delivery can affect the performance of a project manager regarding the claim challenges affecting phases of the production process. The authors further noted the importance of establishing a monitoring technique to enhance the performance of the project manager in identifying the possible occurrence of contractual claims throughout the production phases of a project (Pinto and Slevin, 1989:31). Another study by Bloch *et al.* (2012:3), highlighted four ways of improving project performance to avoid constant claims at every phase of project production. They identified a focus on strategies and stakeholder management—in preference to concentration on budget and scheduling, mastering technology and project content—by securing critical internal and external talent, building an effective team—by aligning their incentive with overall goals of the project, and excellence at core projects management practices—together with short delivery circles and rigorous quality checks.

Risk management processes are applied to perform claims reduction at every phase of project production. According to Tummala and Burchett (1999:223), risk management is a consistent and well-structured approach in identifying and understanding potential risk factors, as well assessing the consequences and uncertainties associating with them. Based on the multifaceted and challenging attributes of a civil project, project managers are advised to be conversant with a wide variety of construction resources and have the skills necessary to manage projects efficiently (Sleyin and Pinto, 1987:33).

Contractors are advised to follow steps required to establish clauses in a contract that include provision for estimated cost and time, presentation of sufficient documentation to aid tracking and managing of contractual claims, while it was also noted that adequate co-operation between contractors, owners, and consultants could ward off possible occurrence of conflicted opinions (Abdul-Malak *et al.,* 2002:84).

2.4.12 Claims hindrance in project delivery

Azhar *et al. (*2014) explained the factors influencing the implementation of integrated project delivery in civil infrastructure construction projects. These factors are broadly classified under organisational, technological and legal categories affecting efficient project production processes. Nowadays construction developers have started implementing green building techniques to effect claims reduction by considering and integrating sustainable design into the construction process. According to Nawi (2014), Zeitlow (2004), as cited in Sultana *et al.* (2013:279) traditional construction techniques has been criticised for its fragmented approach to project delivery, including its failure to establish effective design for cost reduction as result of challenges emerging from reworks, costs, wastage, and lack of effective communication during construction operations (refer to Figure 2.5). Nawi, (2014) further stated that constant occurrence of contractual claims during project execution affects a wide range of construction activities, such as civil and structural engineering, construction projects, building work, dams, bridges, airports, hydraulic systems, sewage treatment facilities, and demolition activities.

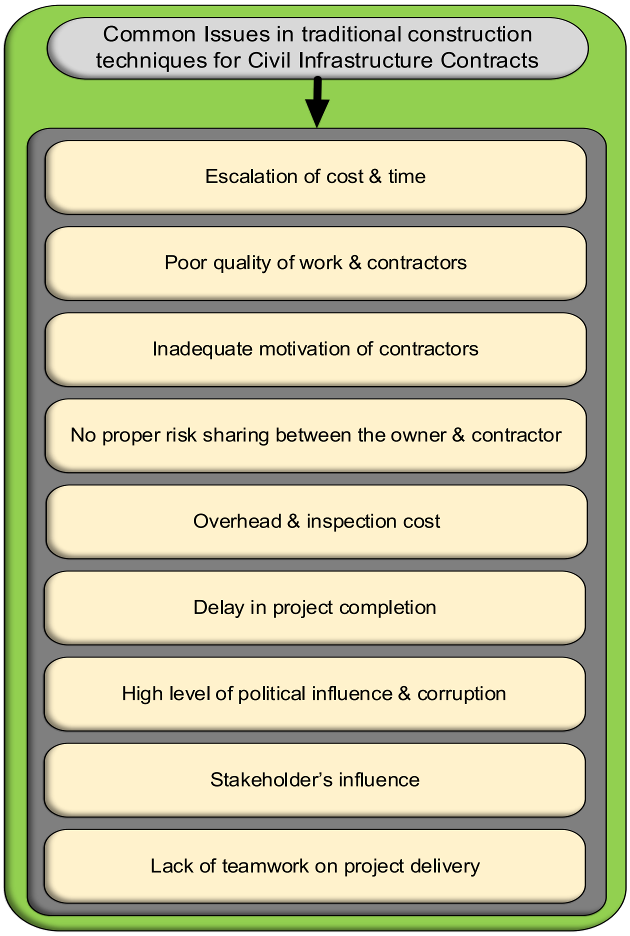

Figure 2.5: Common Issues in traditional construction techniques for Civil Infrastructure Contracts
Adapted from Sultana *et al.* (2013:279)

2.4.13 Impact of materials management

Materials management is another aspect of construction production that could discourage contractual claims if adequately implemented. Appropriate handling of construction materials has a significant influence on the cost of construction production, and it can also promote site productivity and contractual claim-free activities. A study by Patel and Vyas (2011:1) has shown that construction materials and equipment constitute more than 70% of the total cost for a civil project. Therefore, proper planning and handling of the construction materials is significant in ensuring that productivity, cost-efficiency, and time stipulated for a civil project are attained to avoid construction claims occurrence (Patel and Vyas, 2011:1). Kasim *et al.* (2005:793) supported the above statement by observing that improper handling of construction materials in civil infrastructure projects instigates delays and occurrence of contractual claims. However, materials management is particularly problematic in fast-track projects where design and procurement decisions are made concurrently with construction activities.

Patel and Vyas (2011:2) described materials management as a process for planning, executing, and controlling administrative and construction site activities. The materials management process is aimed at safeguarding construction materials for appropriate use in the construction industry. In other words, the process ensures that the right quality and quantity of materials are specified, purchased, delivered, and managed to deter delay and cost overruns.

2.4.14 Equipment management impact on claims and risk reduction

Equipment management is another factor that influences claims and risk reduction through downtime (DT). Prasad *et al.* (2004:199) elucidate that DT is a non-trivial issue affecting equipment usage on the construction site. DT causes unavailability of equipment as a result of sudden breakdown. This effect influences performance and operating cost of the construction site, which could induce a contractual claims risk between the client, consultant, and contractor. Prasad *et al.* (2004:200) stressed the importance of equipment in construction, particularly during civil infrastructure projects, by stating that appropriate handling of the construction equipment will ward off increased operating cost of the construction site and unnecessary delay that may be due to equipment under-supply or breakdown.

Based on the above research, construction companies are advised to adopt proactive maintenance plans and an efficient supply structure of equipment in order to minimise the impact of DT and avoid delays. According to Edward and Holt (2009:186), construction plant and equipment management are vital in the execution and delivery process of civil infrastructure projects. Eight factors were identified in achieving efficient management of equipment in construction, such as plant maintenance, downtime and productivity, health and safety, operator competence, machine handling, and miscellaneous. These factors are expected to enhance plant reliability, safe modes of work, and optimal production process.

2.5 RISK MITIGATION STRATEGIES IN CIVIL INFRASTRUCTURE PROJECTS

2.5.1 Overview of risk mitigation approaches in civil infrastructure projects

The construction process is frequently seen as being fraught with the traditionally adversarial relationship between employers and contractors. This is due to a lack of risk mitigation, which leads to contractual claims since project participants feel obligated to focus on the success of their businesses rather than the entire project (Chan *et al.,* 2012:7). Due to lack of a suitable mechanism or reliable method of providing feedback and ensuing the resolution of concerns, the risks and gaps were not properly documented by the project parties, including inconsistent tracking of problem root cause. Chan *et al.* (2012:6) grouped the mitigating factors into 7 categories as follows:

- Agreements of the contractual relationship and mutual trust,
- Correct selection by the project team,
- Participation of contractors in the decision-making process,
- Third-party review of the project design at the tender stage,
- Clear contractual terms and scope of work,
- Fair treatment of contractors, and
- Standard contractual terms in a target cost contract and guaranteed maximum price contract (TCC/GMP) manner.

2.5.2 Project Management Approach

According to Kerzner (2017:3) and Zid *et al. (*2020:149) the project management approach is described as an approach used in directing the managerial activities of line managers in planning systems, scheduling, controlling, and using existing resources to complete the project. Papke-Shields and Boyer-Wright (2017:1689) defined the project management process as the use of a set of tools and strategies to coordinate the utilisation of different resources for the completion of work within schedule, cost, and quality limitations. Each project production process needs a unique combination of mechanisms and procedures at each stage of a project to reduce the risk of cost overruns. Pinto (2013:643) noted that project management requires effective skills and requirements to provide a means of improving both the efficiency and effectiveness of corporate performance. Unfortunately, the track record of developing project management is considered unreliable. Also, Hardjomuljadi and Sulistio (2021:82) emphasised the significance of project management in identifying and coordinating all resources needed for a specific project such as schedule, cost, tasks, staff, follow-up plan, including other basics of construction techniques as project planning.

Attaining acceptable levels of quality and cost-efficiency in civil projects requires a significant disbursement of money, time, and resources, wherein both human machinery and materials are consumed by the project due to management procedures (Lu *et al.,* 2019:855). Hence, the resource wastage in construction projects leads to risks that could be avoided if handled properly through effective integration of project management methods and procedures; thus, there would be no need for claims (Fapohunda, 2014:22; Ershadi, *et al.,* 2019:1093). Carbonari *et al. (*2011:47) explained that project management is a very tough task. Implementation of construction projects has always involved complexity, fragility, and availability of materials, changes in design plan, human resources and facilities, cost and time of construction as most significant factors that required proper management.

On the other hand, Baiden and Price (2011:129) indicated that project management can only be effective if teamwork is allowed on the construction site. Teamwork involves the process of collaboration between construction operators, as a work team practices methods, behaviours and information exchanges that enhance the project environment. Fapohunda (2014:22) clarified that project management is the responsibility of all operators and workers on the construction site for the efficient use of construction resources to achieve the project objectives. Project management usually consists of various phases of the project in the process of planning, implementation, evaluation, and maintenance to achieve project delivery.

2.5.3 Importance of project management approaches

Civil infrastructure projects are exceptionally complex in the construction and design stages, which has led to the increasing development of contract arrangement and management techniques to avoid some disruptions that may occur during implementation (Kemmer, 2018:2). Civil projects development relies on planning techniques to achieve project requirements, which include defining requirements, developing technical specifications and managing project processes and procedures (Dvir and Shenhar, 2003:89). Fleming and Koppelman (2016:1) stated that establishing a valuable method of project planning alerts the project manager on time about possible occurrence of contractual claim issues during construction projects. This approach serves as a claim's reduction indicator.

Majid *et al.* (2012:11) and Faraji *et al.* (2022: 210) explained that monitoring the performance progress and controlling the delivery plan for infrastructure projects are among the most important tasks of project management. Sözüer and Spang (2014:609), and Kaiser *et al.* (2015:126) noted that adequate establishment and effectiveness of project requirements are very vital to construction operators in mitigating risk and reducing claims for effective implementation in terms of cost, time, quality planning and control.

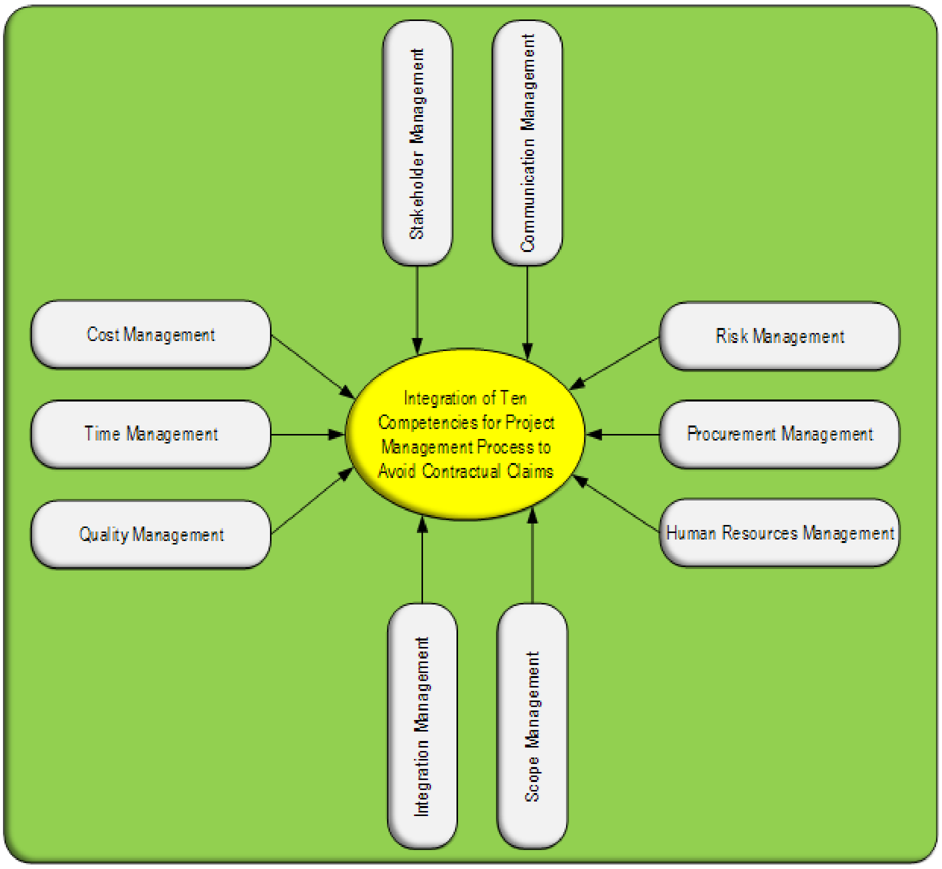

Figure 2.6: Framework of the ten competencies required for management in reducing risk of contractual claims and cost overrun of civil infrastructure project delivery
(Baiden and Price (2011:129); Pinto (2013:643)

Baiden and Price (2011:129), and Pinto (2013:643) suggested that construction operators have to programme their production activities across ten techniques to avoid delay, cost increases, and claims during the delivery projects in developing nations (refer to Figure 2.6). The ten techniques are as follows:

1. Stakeholder management,
2. Communication management,
3. Risk management,
4. Procurement management,
5. Human resources management,
6. Integration management,
7. Scope management,
8. Cost management,
9. Time management, and
10. Quality management.

2.5.4 Importance of project requirements to claim reduction

Adequate establishment of project requirements for claims reduction and a risk mitigation approach is vital in civil infrastructure projects. However, based on the literature reviewed, the importance of project management techniques in civil projects implementation has been extensively established for many construction aspects, such as cost, time, and quality planning and management, including variation in work orders and materials (Al-Momani, 2000:51). Dvir and Shenhar (2003:89) argued that project execution hinges on three planning techniques that must be implemented in the planning phase of construction. These techniques include the definition of requirements, the development of technical specification, and project management processes and procedures.

It is expected that the techniques will offer a real-time approach to the execution of a project by relaying a warning signal that could disrupt the progress of the project. The signal prompts the project manager to forecast the additional costs required to complete the project as one of the prerequisites for claim reduction (Fleming and Koppelman, 2016:1). Majid *et al*. (2012:11) explained that the principal tasks of a project management team are to monitor and control the output of a construction work, track the progress of work on the construction site, and ascertain if established requirements are achieved.

2.5.5 Risk management in project delivery

Risk management is a critical technique in construction projects in ensuring that project objectives are effectively achieved (Perrenoud *et al.,* 2017:04017019). Okudan et al. *(*2021:137) described risk management as a tool that assists in controlling, identifying, and evaluating proactive risk mitigation at all project stages. Some researchers explained that the use of an effective risk management technique is essential to the administrative organisation and quality management procedures along the planning phases and implementation of projects in the construction industry (Mogos *et al.,* 2019:103). The implementation of this technique will raise productivity. Kikwasi (2013:53) referred to risk management as a determinant tool used in demonstrating effective project management for developing the strategies of dealing with risks, planning, identifying, analysing, controlling, supervising, and maintaining an adequate approach to reducing time and cost risks and improving the likelihood of project success. However, Adeleke *et al.* (2019:392) noted that planning alone is not sufficient unless accompanied by thorough monitoring of potential risks by project teams to mitigate losses during the occurrence of delay and contractual claims.

Therefore, an effective risk management tool has an important role to play in managing construction cost within the budgeted cost in achieving project objectives by improved time, cost, quality, profit, and risk mitigation to ensure project delivery (Akintoye and Macleod 1997:31). Another researcher pointed out that most risk management techniques only apply to some part of the project management process (Breysse *et al.,* 2013:173; Nisar, 2013:638). This calls for the development of a risk management tool to improve the construction of civil projects.

2.5.6 Cost management in project delivery

Cost management offers better handling of construction costs and formulating of construction strategies to aid development and implementation of controls that could facilitate the attainment of project objectives (Petrova and Zarudnev, 2013:1009). This primarily depends on the importance of the resources required for the project implementation protocol. In some cases, construction professionals have made decisions that have direct consequences on project progress (Love and Iran, 2003:650). One of the affected areas is cost, which results from the inability to manage construction cost within the estimated period (Akintoye and Macleod, 1997:31). In addition, high construction cost is said to be caused by non-functional discipline, which affects the performance of the project against achieving project delivery (Love and Iran, 2003:650).

However, cost estimation for civil projects traditionally begins with quantification and a time-consuming process, which includes quantity surveyors, use of a variety of tools, and cost applications required to produce a project cost estimate. The ineffective handling of this approach makes cost estimation a challenging problem in civil infrastructure projects (Doloi, *et al*., 2011:622; Elmousalami, 2020).

2.5.7 Quality management in project delivery

The construction industry is a major component of the economic wealth of any nation. Its economic impact is experienced through the development and implementation of civil infrastructure projects (Muya *et al.,* 2013:53). However, infrastructure projects suffer from an escalation in construction costs, claims and contractual disputes, and schedule delays, which pose challenges to high quality delivery of projects in developing countries (Gbahabo and Ajuwon, 2017:46). With a view to obtaining high quality, construction industry professionals must engage in training requirements and quality improvement standards, prepare partnership agreements between parties involved in the construction process, understand project scope, understand specifications, and understand designs (Muya *et al*., 2013:53; Waters and Ahmed, 2020:16).

Quality improvement in the construction process is essential: this is the reason why construction operators must commit to perpetual quality improvement as one of the catalysts in risk reduction pertaining to time and cost overruns (Waters and Ahmed, 2020:16). Muya *et al.* (2013:53) explained that the major causes of high construction costs in civil infrastructure projects are a result of schedule delays, bad weather conditionss, changes of scope, lack of technical expertise, financial difficulties among contractors and clients, local strikes, economic issues, poor quality of materials, modification designs, lack of equipment, poor supervision and coordination in construction site, errors during construction, contract modification, disputes, and claims. Also, Rwelamila (2018:3) indicated that the boom in recent years in the construction industry requires the use of effective steps and strategies to achieve a project's objectives in terms of time, quality and cost to ensure that projects are successfully delivered within the budgeted cost.

2.5.8 Scope management in project delivery

Scope management is a very important element in improving project delivery in terms of controlling the project implementation phases (Gangapatnam, 2020:7). According to Little (2011:240) and Lenferink *et al*. (2013:615), civil infrastructure projects have grown in scale and scope, which has increased the costs of a project. Thus, there is a need to improve project performance through better contract integration, allocation integration, and management integration. Lukhele *et al.* (2021:18) stated that the implementation of infrastructure projects is undergoing changes in scope due to risks associated with uncertainty in the activities and processes of project performance. Ranasinghe *et al.* (2021:89) explained that uncertainty in civil projects is a recurring feature considered as a challenge in the implementation phases because the uncertainties in projects have not been envisaged.

2.5.9 Procurement management in project delivery

Procurement management is always seen as an essential impact on the performance of civil projects in developing nations (Abdullah *et al.,* 2010:123; Sayyed *et al.,* 2021:1). Poor procurement management hinders the progress of a strategic planning implemented to avoid delays (Abdullah *et al.,* 2010:123; Sayyed *et al.,* 2021:1). Abdullah *et al*. (2010:123) indicated that the delay factors that hindered the progress of the strategic planning process for civil projects were identified in irregular cash flow phases, financial difficulties by contractors, poor construction site management by contractors, and ineffective performance and limited experience of contractors. However, the success of procurement management in construction projects depends on the level of improving innovation in the process of organising the procurement plan and project performance (Sayyed *et al.,* 2021:1).

2.5.10 Communication management in project delivery

Construction stakeholders' management involves great awareness in project management, with the intention of improving stakeholders' participation across all ramifications of project planning and implementation towards achieving laydown objectives. Stakeholders are individuals with stakes in a project who may influence or be influenced by the achievement of project objectives (Oppong *et al.,* 2017:1037). Studies have asserted that stakeholders have a variety of influences on a project based on their diverse experiences, professions, cultures, and educational levels. Stakeholders frequently present a wide range of interests and influences that must be met through effective communication, planning, and implementation of project objectives (Oppong *et al.,* 2017:1037).

Nevertheless, inadequate communication among the stakeholders and construction operators has made the involvement of construction stakeholders ineffective since their influences and interests are not considered (Rose, 2013:1). Therefore, this causes high construction costs because the stakeholders have negative involvement in the project production process (Rose, 2013:1). Effective communication enhances motivation and teamwork among the construction team to achieving their objectives and interests on project delivery (Aapaoja *et al.,* 2013:708).

Kwofie *et al.* (2017:826) stated that effective communication technology practices in the construction industry are critical. However, communication problems remain one of the crucial challenges that affect delivery of civil projects. Although many efforts are made to achieve effective communication between the contracting parties to deliver the project on time, poor communication still frequently occurs. Safapour (2020) noted that poor internal interactions amongst the project teams have a significant impact on the quality of performance rendering by the stakeholders, owners, designers and contractors during project implementation phases. Moreover, Kwofie *et al.* (2017:826) explained that developing strategies and behavioural communication skills for communication management propel the planning success in the infrastructure project delivery. Therefore, Olaniran (2015:48) clarified that the implementation of construction projects required effective communication between construction operators at all phases of project construction.

2.5.11 Strategies for stakeholder impact

Stakeholders are classified into two groups, internal and external, and have capabilities that enable them to deal with problems that arise during project implementation phases (Lin, 2017:318; Loosemore and Lim, 2017:90; Xia *et al.,* 2018:707). The internal stakeholders are the official associates with other involved parties in the project (Xia *et al.,* 2017). They also have key roles in achieving an effective outcome of the project (Xia *et al.,* 2017). In contrast, external stakeholders operate externally, with no official authority over project activities but are negatively affected by the outcomes of the project (Aaltonen, 2011:165). Construction projects affected by claims and disputes often result in complex problems between owners and stakeholders (Lehtiranta, 2014:640; Hwang and Ng, 2016:631). Governments should enjoin construction stakeholders to effect educative strategies that could stimulate dispute avoidance towards generating high profits through increased productivity (Mashwama *et al.,* 2016:196).

According to Waters and Ahmed (2020:17), educative strategies include focusing on establishing clearly stated roles and responsibilities, ensuring strong leadership, oversight and support, leadership of works, and creating methods and actions for documenting risks and capturing and resolving issues. Others deploy an enterprise change management plan, evaluating the efficiency of project managers, and ensuring the accountabilities of all project parties.

However, stakeholders' involvement in the project production process is very significant, starting from the inception to the completion of the project because their involvement has a great impact on project claims. Nevertheless, along the line of the project production process, some of the stakeholders are side-tracked by the construction operators. The stakeholder's influences are very vital, and they can be positive or negative. In addition, the three discretionary attributes of stakeholders are authority, legitimacy and interest, while the activities of the stakeholders and the progressive attitudes of the managers have a major influence on the final decision as well on the implementation of the project (Álvarez-Gil *et al.,* 2007:463; Nastran, 2014:1359). Constant negative attitude of stakeholders towards a project can impede the effective production of the project through demolition, modification and reworks, thus attracting claims (Lehtiranta, 2014:640).

Figure 2.7 supports this by illustrating that the two measurement levels (tactical and strategic) could identify positive and negative influences of stakeholders' interests during project delivery. According to Zidane *et al.* (2015:844), the project production process is based on five levels of measurement, which are tactical, strategic, relevance, impact and sustainability. These measurement levels have serious implications on claims. In terms of efficiency, amongst the aforesaid five measurement levels, project success is measured primarily on both tactical and strategic levels. Figure 2.7 supports this by illustrating that the two measurement levels could pinpoint both positive and/or negative influence of stakeholders' interests during project delivery.

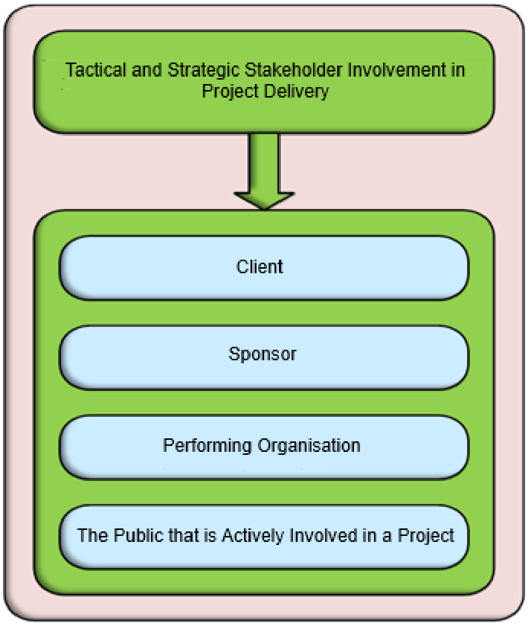

Figure 2.7: Tactical and strategic stakeholder involvement in project delivery
Adapted from Zidane *et al.* (2015:845)

2.5.12 Considering stakeholders' interests in project delivery

According to Yang *et al.* (2009:337), the enhancement of stakeholders' interests in project delivery should focus on fifteen critical success factors in project implementation phases as illustrated in Figure 2.8.

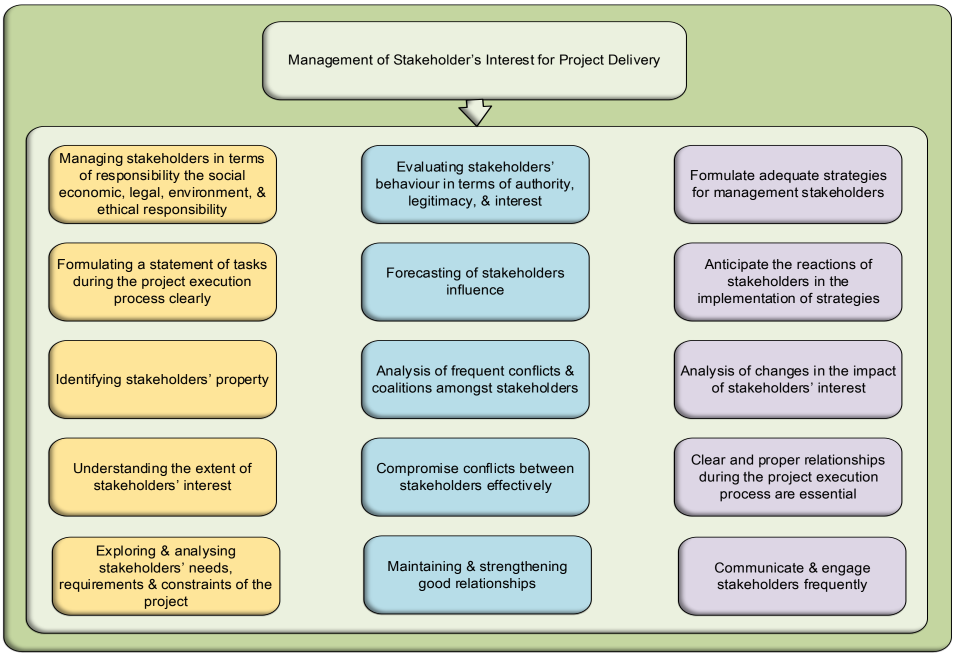

Figure 2.8: Management of stakeholder's interests in project delivery
Adapted from Yang *et al.* (2009:341)

2.5.13 Claims management in project delivery

Claims management is one of the important factors in attaining successful completion of a project. It institutes fair dealing between a client and a contractor, enhances construction cash flow, and deters project abandonment and disputes, provided the claims are resolved accordingly (Oyegoke, 2006:96). According to some authors, claims management has encountered various obstacles due to lack of proper notification procedures in contracts, poor documentation management, change of orders, poor documentation, and lack of contract awareness among the contractual parties (Hassanein and El Nemr, 2008:246; Shahhosseini and Hajarolasvadi, 2021:208). Noting this, Oyegoke (2006:96) proposed expertise engagements and knowledge transfer through joint venture partners as suggested solutions to claims management, while Zaneldin (2006:453) noted the essentiality of understanding the objectives of a project and stakeholders' influences on a project during construction production. These effects will reduce constant demolition, reworks, and claims as a result of complaints from involved stakeholders (Zaneldin, 2006:453).

Hassanein and El Nemr (2008:246) however noted that the design of a standard contract with applicable clauses and availability of methodological approach for change orders in developing countries can be considered to reduce claims. Enshassi *et al.* (2009:79) declared that awarding a bid to the lowest bidder and interference during projection execution are among the main causes of claims.

2.5.14 Project delivery quality in claims reduction

Above all the production aspects in the construction industry, quality is considered a principal determinant of claim reduction. This aspect hinges on the project delivery process involving traditional methods (design-bid-build) and design build delivery methods. However, no project delivery option is perfect, because it all depends on the quality requirements of a particular project to determine best design option (Zid *et al.,* 2020:149). The quality of a project hinges on cost and time, whereby the success of a project delivery depends on the design method applied (Prostejovska and Tomankova, 2017:1). In that case, the degree of quality of a project delivered demonstrates the extent to which risk has been mitigated regarding contractual claims. In some cases, traditional methods (design-bid-build) have caused cost overruns, delays, and poor quality as a result of a poor project delivery approach. This specifies that the project implementation approach has greater influence on the project delivery approach (Chen, 2011:5456; Noorzai, 2020).

2.6 CHAPTER SUMMARY

This chapter clarifies risk mitigation approaches, causes of frequent contractual claims, and their impacts on the delivery of civil infrastructure projects. The impacts of contractual claims were evaluated through cost, time and quality to demonstrate their importance in ascertaining the production performance of particular civil projects on construction sites. In addition, the most significant factors that influence frequent contractual claims were established based on the literature reviewed, such as time overrun, cost overrun, stakeholders' interest, conflict, dispute, claims, etc. The significance of these factors was aligned with the aim and objectives to motivate the need to establish a risk mitigation model. An adequate understanding of the influence of poor risk mitigation approaches is presented and extended towards challenges pertaining to risk mitigation in civil infrastructure projects.

Factors that caused cost and time contingencies during construction production process were indentified. The unexpected cost increases and project delays ascribed to the project owners, construction processes, and environmental factors, from which several types of risk factors usually occur were also discussed. Causes of contractual claims risk were identified, including clear discussions of the types of contractual claims, contractual claims difficulties, contractual claims conditions, resource issues, and equipment handling by enabling a standpoint on the considerable factors that cause contractual claims risk in civil infrastructure projects.

The following gap in the literature was identified; previous studies have overlooked the role of the risk mitigation approach of contractual claims within construction projects (Abd El-Karim *et al.,* 2017; Rasheed *et al.,* 2022; Alvand *et al.,* 2023), which are significant sources of cost overruns and delays in infrastructure project delivery. This challenge has not been sufficiently explored, emphasizing the need for further investigation into bidding processes, cost overruns, and contractual relationships during project execution.

From the literature reviewed the key impact of the stakeholders and risk overruns were identified and the significant impact of stakeholders' interests, inadequate communication, time overrun risk, cost overrun risk, conflict risk, and dispute risk were stressed as well as the key threats that emanated from the internal and external environment of stakeholders' organisations during the construction projects. The gap identified related to the impact of contractual claims risk indicates that some previous studies overlooked the converse of risk mitigation and inadequate assessment on the impact of risk connected with contractual claims on the stakeholders (Khodeir and Nabawy, 2019; Srinivasan *et al.,* 2022; Mekonen *et al.,* 2023; Genc, 2023; Shankarrao *et al.,* 2023). The lack of effective claims reduction modalities, and the inadequate mitigation of contractual claims remains a challenge during the construction of civil infrastructure projects because construction costs exceed budgeted costs.

Based on the literature reviewed relevant strategies that could be implemented to mitigate the occurrence of contractual claims risk and the importance of project management strategy to reduce contractual claims risk through adequate utilisation of construction resources were highlighted. Other strategies considered were cost management, quality management, work scope management, communication management, procurement management, stakeholders' interests, and claims management. Previous studies identified various risks without a thorough study on risk mitigation management pertaining to contractual claims (Szymański, 2017; Azeem *et al.,* 2020; Kamal *et al.,* 2022; Nguyen and Macchion, 2023). Lastly it was established that management techniques on risk mitigation for construction operators to manage contractual claims reduction in civil infrastructure projects haver not been adequately explored. Chapter 3 will discuss the theoretical and conceptual aspects of the framework development.

CHAPTER THREE

3. THEORETICAL AND CONCEPTUAL FRAMEWORKS

3.1 INTRODUCTION

In Chapter 2 a review of the literature was conducted, focusing on the first three objectives. This chapter sets out to expose the fourth objective, providing a theoretical perspective of the theories, enabling the development of a conceptual framework upon which an effective risk mitigation model to address contractual claims risk, to enhance the delivery of civil infrastructure projects in South Africa could be achieved.

3.2 THEORETICAL VIEWPOINT OF CONTRACTUAL CLAIMS OF CIVIL INFRASTRUCTURE PROJECTS

The theoretical understanding of the study framework is presented in this Chapter. The idea is based on the evidence obtained from the literature studied on contractual claims risk mitigation in civil infrastructure projects. The theoretical aspect of the framework demonstrates the design concept of the research construct, while the conceptual aspect showcases the knowledge behind constructing the contractual claims risk mitigation model. In addition, the theoretical development of the framework will incorporate the understanding of the aim and objectives of the study (Kavaratzis, 2004:58). The construct establishes the relationship between the factors causing contractual claims risk, impacts of risks occurrence, and essential strategies to mitigate risk in civil infrastructure projects. For the purpose of this study, the following theories namely: theory of construction site contractual claims and related risk, theory of contractor interests, theory of necessity for claims, theory of stakeholders' interests, theory of frequency of a contractual claim, theory of impact contractual claims on the stakeholder, theory of claims reduction modalities, theory of late payment risk, theory of risk mitigation process efficiency, theory of influence of stakeholders in risk mitigation, and theory of dispute contractual claims will be examined; one of the mentioned theories will be utilised to support the conceptual framework and the achievement of the research aim.

3.2.1 Theory of construction site contractual claims and related risk

The frequent occurrence of contract claims has been a critical issue impeding the delivery of civil infrastructure projects. This has a significant impact on the cost, time and quality of executing a project, which effects all parties involved and subjects them to disputes and conflicts. The impact of this may consequently cause litigation between the stakeholders due to unsolved issues. Common factors such as frequent variations in design, payment delays, cost and time overruns, and stakeholder interests hinder the initial plans to achieve the set goals (Tuner and Simister, 2001:457; Sambasivan and Soon, 2007:517). Amongst these factors, cost overrun is considered the most serious factor that has been receiving considerable attention within the academic and construction environments (Love *et al.,* 2016:184).

Despite various related studies conducted on preventing the occurrence of contractual claims risks in South Africa, it is understood that cost overruns remain a pervasive problem that requires attention to ease the problems experienced by construction operators. Love *et al.* (2016:184) noted that a reduction strategy for regular occurrence of contractual claims is essential to civil infrastructure investments, roads, bridges, multi-storey building, ports, and railways to enable the population growth in Africa to sustain a competitive advantage in the global market. The authors suggested the importance of establishing a probabilistic theory that could offer governments a general understanding of the uncertainties and risks that could impede delivery and promote cost overruns in civil infrastructure projects (Love *et al.,* 2016:184). They also proposed the design of effective risk mitigation and control strategies to aid project cost and time management (Love *et al.,* 2016:184).

3.2.2 Theory of contractor interests

The theory of contractor interests demonstrates the importance of a contractor in ensuring all allocated responsibilities are duly discharged without any prejudices or delays. A contractor's inability to perform his/her duties could incur disputes and conflicts, which escalate to delays, cost, time overruns (EoT), and material wastage. Khanzadi *et al.* (2016:1066) supported this by stating that delay is an issue occurring due to activities transpiring between a contractor and an owner. Variations occurring during project execution can be quantified by applying project control methods, continuous assessment of the schedule, computing progress percentages, and earned value parameters. The decision to restore an abandoned project will require additional budgets in terms of cost, time and quality of delivering the project. In the case of an abandoned project, the owner is mostly at loss due to damaged materials, increased cost, EoT, and outdated quality and design.

Kadefors (1999:231) explained client-contractor interaction in a building project, and that 'fairness constraint' sets the rules for interaction. In a situation where a contractor's contract proposal is not adequately double-checked for probable risk existence, then a client may experience project delay along the execution line. Otherwise, the client must have a convincing proposal, with adequate arguments and justifications that could be accepted by the contractor. The author also identified the principal driving forces and dispositions that affect the client, design teams, and variation negotiations by the contractor (Kadefors, 1999:231).

Frequent occurrence of claims in civil infrastructure projects has been a problem in many constructions works (Bhangwar *et al.,* 2022:41; Kikwasi*,* 2023:1710).

3.2.3 Theory of necessity for claims

The theory of necessity for claims shows simplified procedures or techniques that could be used to curtail the occurrence of claims risk in civil infrastructure projects. Efforts have been geared to mitigating claims and risk occurrence through management procedures. The necessity of curbing contractual claims risk in such projects is to consolidate the work output of the workers to a complex task. The uncertainty of measuring workers' performance at the planning stage of production is perceived to be responsible for frequent occurrence of contractual claims risk (Kuchta *et al.,* 2023:2). According to Ren *et al.* (2001:185), claims not handled properly could promote a high level of disputes that may run out of control. A construction project contract that encourages adequate trust and communication and values partnershipa will lessen contractual claims risk mitigation and improve performance (Cheung *et al.,* 2006:48).

3.2.4 Theory of stakeholders' interests

In this section stakeholders' interests are identified and presented. It is understood that various stakeholders are involved in a civil construction project, each having different interests in the project (Freeman and MCVea, 2001:189; Bryson, 2004:21; Ackermann and Eden, 2011:197). Ackerman and Eden (2011:197) added that stakeholders operating at segregated levels require adequate efforts in handling the challenges. Some of these challenges are experienced consequently due to controlling stakeholders' interests in the organisation strategies, to lessen their impact on the outcome of the strategies (Ackermann and Eden, 2011:197).

It is understood that formal and informal association amongst the stakeholders demonstrate a significant aspect of their power. However, some stakeholders possess combinations of these two forms of relationship that are considered more influential. The formal relationship is usually well understood while the informal relationship is subtle and pervasive, and it could also be the most critical (Ackermann and Eden, 2011:197).

Stakeholder theory is said to have become a fundamental component of business ethics, aimed at improving stakeholders' influence on project delivery (Harrison *et al.*, 2015:859). There are several problems with stakeholder theory as currently understood, for example, lack of a coherent justification framework, the issue of adjudicating between stakeholders, and the issue of stakeholder identification. Friedman and Miles (2002:1) argued that most previous studies demonstrated a lack of appreciation of the range of organisation, and the extent to which such relations change over time, including how and why such changes occur. Specifically, highly conflicting relations between organisations and stakeholders are usually ignored. Considering the lack of appreciation, observation reveals that merging of the separate components of stakeholder theory will be a significant attainment.

3.2.5 Theory of frequency of a contractual claim

The theory of frequency of a contractual claim towards the delivery of the civil infrastructure projects is presented. Two main approaches were identified that influence such projects around the globe. These two approaches are competence and contractual perspectives. The competence perspective of the stakeholders has a significant impact on the cost of construction issues, design errors, and influential factors (Figure 3.1), while it is noted that construction firms, as a repository of knowledge, are ignored in the contractual perspective; it occupies centre phase from the proficiency perception. Lehtiranta (2014:643) claimed that the proficiency perception can be applied to interpret a firm's competitive advantage, including the subsistence and boundary of a firm. This implies that an individual theory of a firm is developed based on the evolutionary theory. In contrast, the contractual claim theory of the company is in absolute disparity with the legal concept of the company as an entity created by the state (Osifo *et al.,* 2025).

The entity theory of a construction company supports state intervention in the form of either direct regulation or the facilitation of shareholders litigation in the company on the ground that the state created the corporation by granting it a charter. A state charter merely recognises the existence of the 'nexus of contract' called a company. Each contract in the 'nexus of contract' warrants the same legal and constitutional protection as another legally enforceable contract. Moreover, freedom of contract requires that parties to the 'nexus of contract' must be allowed to structure their relations as they desire, through effective communication among stakeholders to address issues of interest.

3.2.6 Theory of impact of contractual claims on the stakeholder

A firm's claimants go beyond stockholders and bondholders to include customers, suppliers, providers of complementary services and products, distributors and employees. It is viewed as a contractual coalition, consisting of both investor and non-investor stakeholders, corporate finance has traditionally focused on investors, as they play a crucial role in linking corporate strategy with operations. Enshaasi *et al.* (2009:61) clarified that late payment, performance and management issues contribute to the impact of contractual claims risk on the stakeholders (Figure 3.1). Halpen (2001:42) argued that in selling a product or services or purchasing inputs, companies issue both explicit and implicit claims. Among the two, the explicit claims refer to the contractual basis on which goods and services are sold or purchased by companies, whereas implicit claims only relate to the company's promises to stakeholders, e.g., employees, customers, and services, etc. Implicit claims also reflect the promise of quality, good working conditions, and service levels which are inexplicitly stated in a contract, but which, when present, permit a company to sell a product at higher prices, and to purchase goods and services from suppliers at lower prices than competitors.

3.2.7 Theory of claim reduction modalities

Ho and Liu (2004:94), described a contractual claim as a request by a construction contractor for compensation over and above the agreed-upon contract amount for additional work or damages, which supposedly resulted from an event that was not included in the initial contract. Ho and Liu (2004:94) state that the existence of a right is very subjective because of the complexity of the construction contract and process. In addition, the amount of money involved in a construction project is usually so large that a small discrepancy in the contract interpretation will cause a significant impact on the project profit. Thus, this induces argument and litigation consequently due to extensive delay, wherein claims and risk reduction becomes difficult to control. In this multidisciplinary environment, claims appear to hinder the completion of a construction project because of constant claims on each phase of production.

Zaneldin (2006:453) suggested a solution for claims reduction namely that a stakeholder should allow a reasonable time for the design team to produce clear and complete construction contract documents with no or minimum errors and discrepancies. The team should also be given ample time to establish efficient quality control techniques and mechanisms that can be used during the design process to minimise errors, mismatches, and discrepancies in the contract documents (Figure 3.1). A stakeholder is advised to apply special contracting provision and practices that have been used successfully in past projects and develop a cooperative and problem-solving attitude during the project through a risk-sharing philosophy and by establishing trust among partners.

3.2.8 Theory of late payment risk

According to Sweis *et al. (*2008:665) the construction industry is a major player in the economy, creating both, employment and wealth. Projects experience extensive delays, which exceed initial time and cost estimates as a result of late payment by the client. Enshaasi *et al.* (2009:61) explained that many projects have been delayed for reasons believed to be outside the control of both the contractor and owners. The associated problems are delay in payment, lack of site staff's proactiveness to detect claims, inaccessibility or unavailability of relevant documents, and conflicts arising during owner/contractor negotiations, which are all critical problems tackled through claim management process.

Mpofu *et al. (*2017:346) clarified that ample studies have been conducted on project delays. The persistence of the problem demands that a quest for solutions continuous. It can be argued that the problem is likely to be more pronounced in an area where development pressure is at its peak. Mpofu *et al.* (2017:346) further explained that causes of construction delays range from unrealistic contract durations to poor labour productivity, with consultants and clients seemingly shouldering the bulk of the blame game. There is however evidence that all the three main stakeholders in a construction project (clients, consultants and contractors) need to change their existing practices to ensure timely payment of contractors and delivery of the project to discourage regular occurrence of the risk of contractual claims.

3.2.9 Theory of risk mitigation process efficiency

Talluri *et al. (*2013:253) explained that comprehensive assessment of the efficiencies of alternative risk mitigation strategies has not been adequately addressed in the literature relating to successful project production processes. Such assessment will assist managers to select the appropriate mitigation strategy for a given decision-making.

3.2.10 Theory of influence of stakeholders in risk mitigation

Stakeholders play a significant role in risk mitigation; however, many remain unwilling to adopt adequate risk mitigation measures in their projects, despite the availability of various technical design solutions and the enactment of the intervening legislative framework necessary to facilitate successful project delivery (Egbelakin *et al*., 2015:395).

3.2.11 Theory of disputable contractual claims

Egbelakin *et al. (*2015:395) explained that reducing construction disputes appears to be the main goal for many researchers in the last 10 years. Many of them have attempted to identify the expected causes of disputes as construction claims can be considered as the main source of disputes. The major factors posing challenges to the risk mitigation approach are stakeholder’s practices for disputable contractual claims and lack of a risk assessment information system.

An in-depth understanding of these challenges highlights the need for a holistic approach that should incorporate market-based incentive necessary for successful project delivery (Ebgelakin *et al*., 2015:395).

3.2 SELECTION OF THE THEORY UNDERPINNING THE CONCEPTUAL FRAMEWORK AND RESEARCH AIM

Based on the theories reviewed, all eleven theories are linked to the contractual claims risk occurrence in civil infrastructure projects. Among these theories,'theory of stakeholders' interests' is considered appropriate for the purpose of this study because it provides comprehensive information that can be related to all stakeholders involved in civil infrastructure projects and addressing the causes, impacts, and strategies pertaining to contractual claims. This theory also helps in understanding the varying interests, power dynamics, and interactions among stakeholders, such as contractors, clients, designers, and suppliers that are crucial in identifying the root causes of claims and associated risks (Ackermann and Eden, 2011; Dmytriyev *et al.,* 2021).

By utilising stakeholder theory, this research emphasises the need for a collaborative approach to managing claims, mitigating risks, and fostering effective communication among stakeholders by ensuring that all parties work towards common goals in project delivery. An addiional reason for the adoption of this particular theory is because it provides insights into risk mitigation of contractual claims in civil infrastructure projects. The importance of its adoption will help the development of a robust model that will encompass required elements that are essential for improving project delivery and minimising disruptions to time, cost, and quality. By using this stakeholder-focused approach, the study seeks to enhance the understanding of how to manage causes and control contractual claims risk to promote successful and sustainable project outcomes.

3.3 CONCEPTUAL FRAMEWORK

A conceptual framework in most studies conducted is referred to as interrelated objectives and fundamentals that help achieve study outcomes based on the identified underlying constructs. It is applied in comprehending the research position, research path, theory determination, and methodology. In other words, the conceptual framework illustrates the gaps in a research plan and fosters additional group of concepts broadly defined and systematically structured to provide focus (Leshem and Trafford, 2007:93).

3.4.1 Knowledge gaps

The conceptual framework illustrates the knowledge gaps that should be closed after computation of the variables of the study. In the context of this study, the knowledge gaps illustrated in Figure 3.1 that are justified in Section 2.6 of the literature review are the lack of evidence related to: the causes of contractual claims risks in civil infrastructure project delivery in South Africa; the impact of risks occurrence regarding civil infrastructure project delivery in South Africa; the strategies to mitigate risks in civil infrastructure project delivery in South

Africa, as well as the model that needs to be developed in order to mitigate contractual claims risks in civil infrastructure project delivery in South Africa, serving as a combination of the first three knowledge gaps identified.

3.4.2 Variables in the study

The conceptual framework of this study, illustrated in Figure 3.1, indicates the research variables, namely latent variables and measured variables that will be utilised and examined.

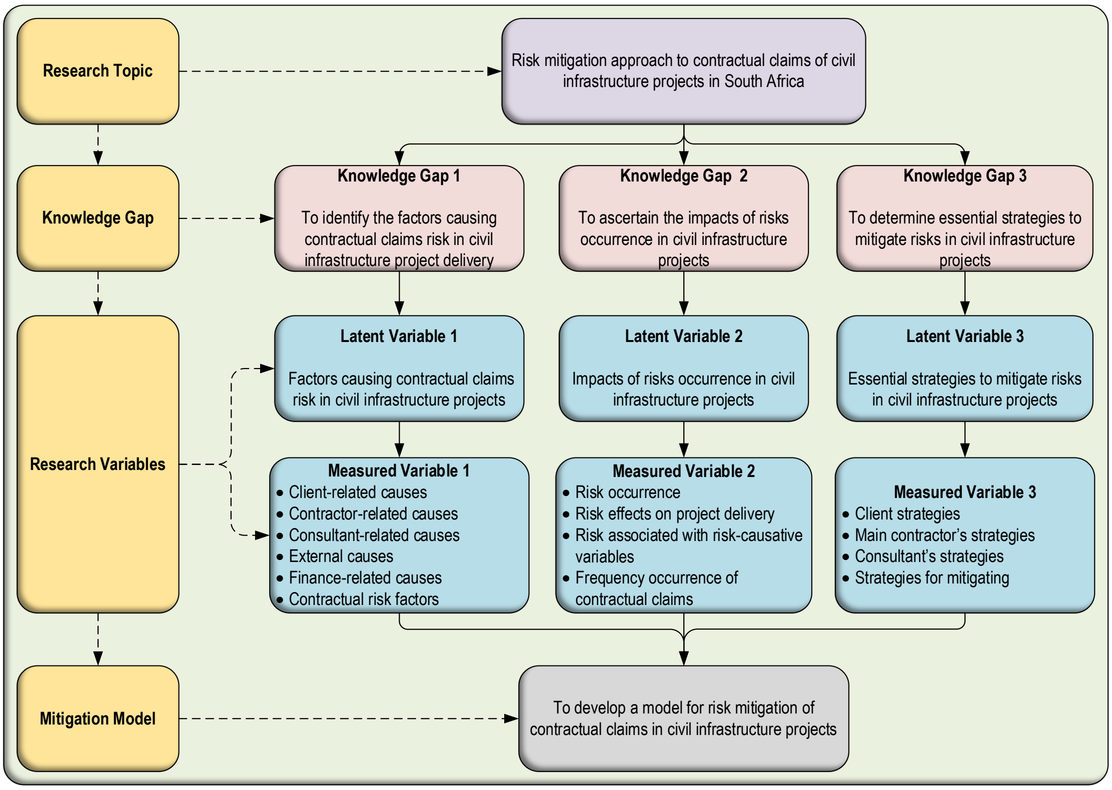

Figure 3.1: Conceptual framework for risk mitigation approach of contractual claims in civil infrastructure projects

3.4.3 Anticipated Model

A model for risk mitigation of contractual claims risk is established through a sequence of technical procedures. The model constitutes production processes, factors involved, management techniques, and required strategies to enhance decision making and production improvement (Taherdoost and Mitra Madanchian, 2023: 2). The proposed model established an operational mechanism to control constant occurrence of contractual claims risks in civil infrastructure project delivery. This concept was supported through the hypothetical development of the model based on the relationship between the underlying variables as shown in Table 3.1. Mbachu (2008:471) engaged a number of contractors and subcontractors who were registered members of Master Builders Association of South Africa (MBASA) and have been involved in more than one civil infrastructure project. The study conducted with the involvement of the contractors and subcontractors was applied to develop a framework that could be applied to quantify the performance of the subcontractors and contractors at various stages of construction. The outcome of the application showed that the performance of the subcontractors enhanced process delivery.

Table 3.1: Estimated hypothetical relationships between underlying variables

Hypotheses	Relationships	Supporting research
Hypothesis 1	A significant relationship exists between factors causing contractual claims risk in civil infrastructure project delivery and impacts of risk occurrence in civil infrastructure projects	Altoryman (2014); El-Sayegh and Mansour (2015); Kumar *et al.* (2017); Griego and Leite (2017); Santoso *et al.* (2020); Hiyassat *et al.* (2022); and Al-Mhdawi *et al.* (2023)
Hypothesis 2	A significant relationship exists between the impact of risk occurrence in civil infrastructure project delivery and essential strategies to mitigate risk in civil infrastructure projects	Kuo and Lu (2013); Guo *et al.* (2014); Burtonshaw-Gunn (2017); El-Adaway (2018); Eskander (2018); Enshassi *et al.* (2019); Van Thuyet *et al.* (2019); Rahman and Adnan (2020); and Wuni and Shen (2023)
Hypothesis 3	There is a significant relationship between factors causing contractual claims risk in civil infrastructure project delivery and essential strategies to mitigate risk in civil infrastructure projects	Ejekwu *et al.* (2022); Eybpoosh *et al.* (2011); Zailani *et al.* (2016); Kassem *et al.* (2020); Asadi *et al.* (2021); Mohandes *et al.* (2023); Shabana and Gad (2023); and Daweina and Adam (2023)

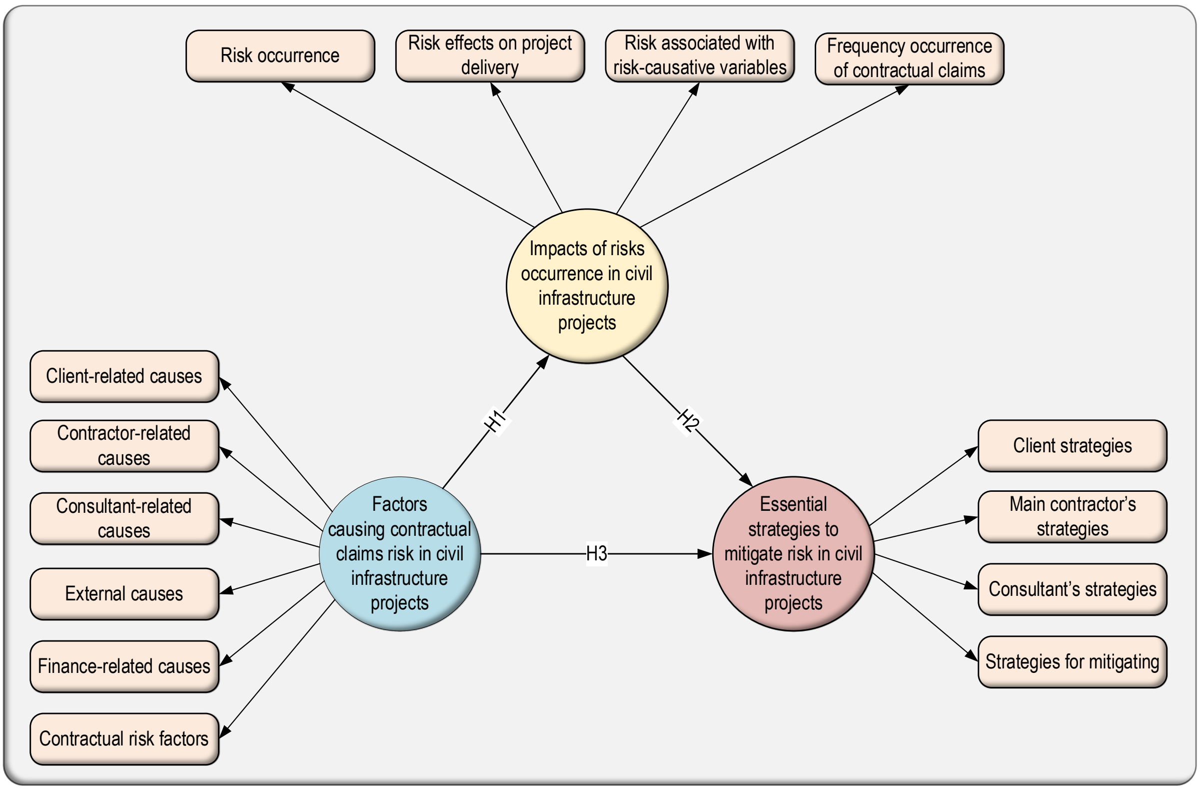

Figure 3.2: Anticipated model

Wasfy and Nassar (2021:124) noted that the methodology for analysing delay in claims is the key to obtaining a fair allocation of responsibilities for the delays and settling claims without litigation. In addition, Braimah and Ndekugri (2009:1279) stated that improvements in record-keeping would fortify the use of more reliable methodologies to process and resolve delay claims. Chan *et al.* (2004: 50) suggested the use of the Society of Construction Law's protocol for time influence analysis as a suitable procedure to assess claims for EoT, although, effective management techniques were not significantly addressed and established. In this regard, it is important for construction managements to establish an effective risk management that involves sufficient technical expertise, adequate experience, and a proper and systematic methodology. All these are expected to reflect in the development of the anticipated model (refer to Figure 3.2).

3.4 CHAPTER SUMMARY

This chapter discussed the relevance of theoretical and conceptual ideas of developing an operational framework for the mitigation of contractual claims risk. The development of the framework is established through knowledge gained from the reviewed literature.

It has been shown that the theoretical aspect of the framework development incorporates the design concept of the research construct, while the conceptual aspect of the framework development involves the knowledge of constructing the risk mitigation model. The theoretical aspect of this study presents construction site theory, contractor interest theory, necessity for claim theory, stakeholders' interest theory, frequency of a contractual claim theory, impact of contractual claims on the stakeholder theory, claim reduction modalities theory, late payment risk theory, risk mitigation process efficiency theory, stakeholders' influence in risk mitigation theory, and disputable contractual claims theory. The conceptual aspect of this study includes the design of the conceptual framework, knowledge gaps, and identification of variables. The knowledge gaps were identified and discussed, along with the selection of the study variables (dependent and independent variables). The variables were formulated from the literature and the outlined objectives of the study.

CHAPTER FOUR

4. RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter comprises literature related to the methodology applicable to this research. From the reviewed literature the most applicable methods for this study. A comprehensive framework of the principle of reasoning associated with underlying assumptions suitable to investigate the research problem is also presented.

4.2 RESEARCH ASSUMPTIONS

4.2.1 Epistemology

Epistemology is described as a branch of philosophy that studies the nature of knowledge through its basis, extent, and rationality. The epistemological paradigm involves inquiry into knowledge acceptability in a discipline, which pertains to 'how we know' as a technical approach from which knowledge is acquired (Bryman, 2012:85; Easterby-Smith et al., 2012:22). Sommer-Harrits (2011:150) researched mixed methods research and explained that it constitutes a coherent research paradigm. The study focused on two different epistemological problems pertaining to causal inference and double hermeneutics. A further review indicates that a clear interpretation of qualitative components differs from the research designs. Understanding the difference in methodological, epistemological, and ontological approach offers clarity on the reason to continue with mixed methods research as well as embracing the difference instead of imposing homogeneity. Biesta (2010:2) offered understanding of the epistemological assumption that the ideas one holds about what can be known and what it means to know something are not the same. Authors such as Love et al. (2002:295) and Addae et al. (2015:156) classified the epistemology as positivist or interpretivist.

4.2.2 Ontology

Ontology is the assumption and belief researchers hold about reality, specifically an object of research. It also centres on the questions of 'what' happens and 'why' it happens the way it happens. Greener (2011:6) described ontology as a state where the theory that drives the conclusion of research exists unconventionally from the perception of a researcher. However, with regards to social and behavioural research, one of the most important distinctions is between what researchers might refer to as a mechanistic ontology and a social ontology (Biesta, 2010:2). Mascardi et al. (2009:609) described 'ontology matching' as a process that involves the determination of the association among the entities existing in different ontologies.

Liu (2022:1), Shan (2022:1) and Baškarada and Koronios (2018: 2) discussed the extension of the ontological challenge relative to the application of the mixed method approach, emphasising the fact that there are significant philosophical and empirical differences regarding the methodology involved. Philosophical challenges associates with a pragmatic approach, while empirical challenges emerge alongside technical multiplicity characteristic to dimension distance and the mixed methods of their intended goals. A descriptive understanding of realism and relativism, as two comprehensible ontological paradigms, was presented by Fitzgerald and Howcroft (1998:323) as cited by Easterby-Smith *et al.* (2012:19).

4.2.3 Axiology

Axiology, a branch of research philosophy, examines the role of values and ethics in the research process (Saunders et al., 2016:128). According to Saunders et al. (2016:128), axiology explores the approach used by researchers to navigate their values together with that of the research participants. For example, placing greater importance on data collected through interviews rather than anonymous questionnaires demonstrates a stronger emphasis on personal interaction in research (Saunders *et al.,* 2016:128). Ultimately, axiology is concerned with the broader philosophical study of values (Saunders et al., 2016:128).

4.3 RESEARCH PHILOSOPHIES

4.3.1 Realism

Realism is a perspective that focuses on the interpretation of the social world, particularly in its natural condition. In the ontological perspective, the external world is perceived to involve hard and tangible patterns, which do not restrict the ability of an individual to acquire understanding about them. The above description is identified as a realistic position, focusing on practical, grounded understandings rather than unrealistic perceptions of life. According to Stiles (2003:265), realists provide a clear understanding of how hypothetical structures influence human behavior. Other studies have argued that there is no unified theory of realism that supports the underlying assumptions, as follows (Ponterotto, 2005:129, 130):

- Power relations primarily arbitrate thoughts – which are socially and historically established.
- Facts are considered accessible in the domain of values (ideological inscription).
- Some societal groups have advantage over others.
- Language is essential to the creation of subjectivity.
- Oppression has many facets, and focusing on one aspect could damage the interrelationship between them.

- Conventional study practices are involved in replica of oppressions of organisations of class, gender, and race.

The importance of identifying the underlying structures that cultivate natural events cannot be overlooked by a researcher because it enhances his/her ability to comprehend social realms (Stiles, 2003:265). It is also noted that a realist methodological approach tends towards semi-structured interviews (group observations) classified under mixed methods (Stiles, 2003:265). This approach aids collection of subjective data, which were assessed in this study through triangulation. This establishes a philosophical link between positivist position and phenomenologist position (Stiles, 2003:265).

4.3.2 Relativism

Relativists perceive realism as an observable fact that mutually varies in line with concepts that vary from culture to culture and situation to situation, such as right and wrong, truth and falsehood (Fitzgerald and Howcroft, 1998:321). The relativist standpoint indicates the inconsistency of the intellectual tools, which further denotes that an actual reality cannot be realised because the phenomena of life are difficult.

From the aforesaid, one can deduct the major difference between realist and relativist perceptions (Lincoln and Guba, 2000:107). According to Lincoln and Guba (2000: 107), a realist emphasises 'theory verification' while a relativist emphasises 'theory falsification'. Despite the differences, both still offer prediction and control of phenomena, as they operate actively from the nomothetic and etic perspectives. Thus, realism and relativism operate as fundamental bases for qualitative research.

4.3.3 Positivism

Positivism is described as a type of philosophical realism that is within proximity to the hypothetical deductive method (Ponterotto, 2005:128; Fellows and Liu, 2008:17). Positivists consider that an investigator could work slightly away from the social world, with the intention of assessing and determining a phenomenon by applying objective methodologies (Stiles, 2003:264). This form of philosophical realism centres on an attempt to verify prior hypotheses cited in quantitative propositions.

A positivist also operates with thorough measures and study objectives, wherein hypotheses are established to validate the realities and associations that can be fathomed into a population, such as behaviourism and empiricism. Stiles (2003:264) stated that this type of philosophical realism emerges from epistemological assumptions where external reality constitutes facts arranged similarly to law patterns. Positivism can also be viewed as a philosophical system founded on the concept of social settings that exist externally by quantifying its behaviour in preference to obtaining subjective information through feeling, thinking, or instinct (Easterby-Smith et al., 2012). However, the philosophical system stimulates a quantitative approach, which principally involves the use of questionnaires for experiments, surveys, data collection, and analytical statistical analysis (Stiles, 2003:264; Sarwono, 2019: 118).

4.3.4 Constructivism

The section describes constructivism as a proxy for positivism. Constructivism can be credited to Kant’s (1881/1966) Critique of Pure Reason. Hamilton (1994:63) conducted a study on human perceptions in accordance with Kant’s description of constructivism. The author inferred that human perception emerges from both evidence of sense and mental apparatus as approaches to organising the incoming sense impressions. Although human assertion about nature should be observed, most importantly, constructivism observes the establishment of the substantive theory as it follows a relativist position in research (Stiles, 2003:264; Ponterotto, 2005:129).

Constructivism perceives realism as internal entity in the individual as opposed to being referred to as an external entity (Hasen, 2004:133). Awareness indicates that the constructivist position promotes a hermeneutical approach. In this case, intent is concealed but participants’ involvement could be exploited to promote evidence. Life experience occurs in a social reality, which could be portrayed as reality that is unfamiliar to the cognisance of human consciousness (Ponterotto, 2005:129). This technique could, possibly, be most applicable in research or hypothetical testing (Fellows and Liu, 2008:19). This shows that constructivism establishes the centrality of relationship between the investigator and object of investigation.

4.3.5 Interpretivism

As a philosophy of research, interpretivism emphasises the significance of human behaviour and social interactions within cultural contexts (Chowdhury, 2014:433). It enables researchers to explore the underlying meanings and reasons behind individuals' actions, particularly their relationships and behaviours within society (Chowdhury, 2014:433). According to Chowdhury (2014:433), interpretivism argues that reality is socially constructed by human actors, distinguishing it from the natural sciences, which rely on objective and measurable methods.

4.3.6 Critical realism

Zachariadis et al. (2013:855) investigated technical procedures suitable to develop dynamic mixed methods for research design. The author discussed technical inferences of critical realism to substantiate the significance of mixed methods in research development (Zachariadis et al., 2013:855). The study examined the core ontological assumptions required to acquire knowledge about epistemology, e.g. validity and causation. This further explains the logic of inference behind the research process through reproduction. The study provides a clear understanding of the interaction between the quantitative and qualitative methods.

McEvoy and Richards (2006:66) cited extensive consideration of quantitative and qualitative methods in research. Ontological and epistemological challenges cultivate a considerable scope of misperception in mixed method research. Anti-conflations, methodological purist, and pragmatic are the three identified standpoints attributed to mixed methods application. Risjord *et al.* (2001; 2002) pinpointed three purposes of methodological triangulation, which are observed to be compatible with the philosophy of critical realism. Based on the above, the application of a critical realist perspective may prevent challenges associated with concept switching. This study will apply the principle of critical realism to achieve the use of a mixed methods technique.

4.3.7 Dialectic pluralism

Johnson (2017:156) noted that a great number of debates have been conducted on the role of paradigms in mixed methods research. In the past, researchers have been advised to operate within a single paradigm, whereas at present two or more paradigms offer positive features to research. Mixed methods research uses a multi-pragmatic approach within a systemic framework to engage with differences. It is advised that any individual applying a single paradigm should adopt a philosophical/theoretical framework to work in a multi-pragmatic group as well as in the dialectical pluralism. Dialectical pluralism can create teamwork among researchers to acquire the ability to work and thrive with differences and intellectual tensions. Onwuegbuzie and Frels (2013:9) expounded that critical dialectical pluralism has three axiomatic component relationships, namely ontological, epistemological, and methodological elements. Seven issues are known as nature of knowledge, knowledge accumulation, goodness or quality criteria, values, ethics, inquiries posture, and training. Critical dialectical pluralists are essentially used to promote and sustain an egalitarian society, with the intention of stimulating universal theoretical knowledge and local practical knowledge, as well as cultural progressive research. This research will consider necessary ethics to achieve quality research characterised by the concept of dialectic pluralism.

4.4 RESEARCH REASONING

4.4.1 Inductive reasoning

Inductive reasoning as a perfect, logical, and useful approach in generating solutions for theoretical problems (Okoli, 2021:1; Sauce and Matzel, 2017:1). Inductive reasoning begins with detailed observation of an occurrence. It is associated with qualitative methods of data collection and data analysis. Thomas (2006:237) affirmed that the inductive approach is usually suitable for qualitative evaluation of data. This approach is purposely utilised to reduce the raw data into a presentable format. The approach combines research findings and research objectives to establish an applicable framework as dictated by the raw data analysed. The researcher further clarified that inductive approach offers systematic procedures of analysing qualitative data that could yield reliable and valid findings (Thomas, 2006:237). Another researcher, Jebreen (2012:162) described the inductive approach as a credible and rigorous research process. It also uses a mixed method to explore the interaction strategies between analysis and client/users when required.

4.4.2 Deductive reasoning

The deductive reasoning begins with theory, formation of a hypothesis from that theory, and data collection and analysis for hypothesis testing. In addition, the emphasis of the deductive approach is generally on causality. The approach involves research questions to construct the scope of the study. In a similar way to inductive research, the deductive approach is connected with the quantitative technique of data collection. (Pear, 2014:162).

4.4.3 Abductive reasoning

Abductive reasoning combines inductive and deductive methods while primarily relying on the expertise, experience, and intuition of researchers, which makes it a distinct and valuable reasoning process in research (Wheeldon and Ahlberg, 2014:117). BJ associated with mixed methods research, as it emphasises intersubjectivity and the shared understanding among researchers, fostering a more holistic approach to knowledge generation (Wheeldon and Ahlberg, 2014:117). Additionally, abductive reasoning encourages the theoretical and empirical testing of intuitions, provides a fresh perspective on research, strengthens the robustness of association measures, and acknowledges multiple pathways to meaning, ultimately offering significant practical benefits (Wheeldon and Ahlberg, 2014:117-118).

4.5 METHODOLOGICAL APPROACH

The research approach is defined as a process of inquiry and investigation. It is systematic and methodical; and through this procedure, knowledge is increased. A research approach is an act of planning that considers a technique that includes steps of broad assumptions to detail, method of data collection and analysis, and explanation of the findings obtained (Amaratunga *et al.,* 2002:17). Malhotra *et al.* (2017:273) explained that a research approach should be comprehensive, practical, applied, managerial, and should present balanced coverage of both qualitative and quantitative materials (Figure 4.1).

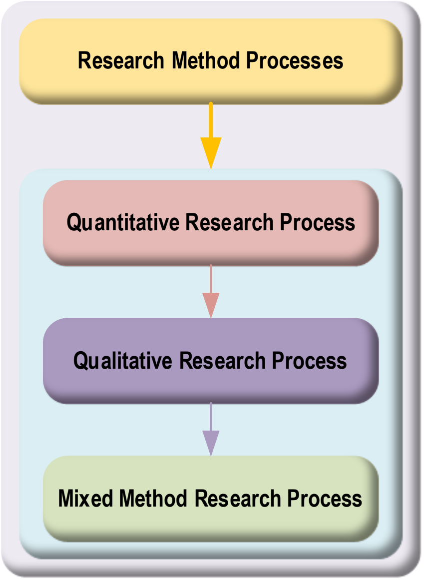

Figure 4.1: Research method processes

4.5.1 Quantitative method

Yilmaz (2013:311) defined quantitative approach as a research method that expresses phenomena concerning numerical data, which are studied using arithmetically based methods, especially statistics. The quantitative approach can also be illustrated as an empirical exploration of social phenomenon or human problems. This involves a theory containing variables statistically measured and analysed to evaluate whether the theory predicts or elucidates phenomena of interest. This type of research approach is characterised with numerical representation of phenomena explained through observations derived (Sukamolson, 2007:2). In essence, it is all about collection and analysis of numerical data to express observations pertaining to a particular phenomenon (Sukamolson, 2007:3). Creswell (2002) simply described quantitative research as collection, evaluation, and interpretation of data into a legible document (William, 2007:65). There are several types of quantitative research, namely survey research, correlational research, experimental research, and casual comparative research. Survey research, which is mostly used in built environment research, is referred to as a quantitative research type that uses scientific sampling and questionnaire design (Sukamolson 2007:4). Figure 4.2 represents different types of research techniques.

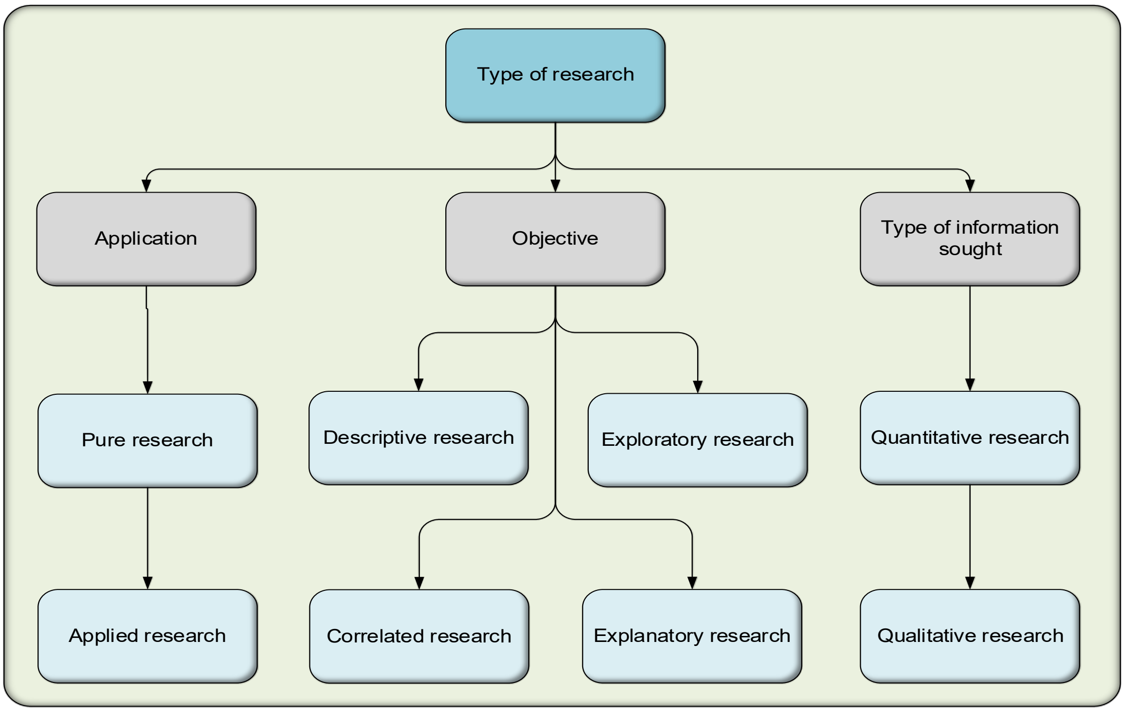

Figure 4.2: Types of research techniques

Adopted from Sukamolson (2007:2)

According to Sarwono (2019:118), the quantitative method ensures a high level of reliability of the gathered data. Nardi (2018:8) claimed that quantitative research prevents or reduces the?? occurrence of errors and biases. Related to the above, science is considered more objective, explicitly less reliant on emotion or personal preconceptions and standards. Quantitative research establishes a platform where other researchers are given the opportunity to work further on already detailed research.

4.5.2 Concept of quantitative research planning

Punch (2013:6) established a framework that explains the planning of quantitative, qualitative and mixed method research in social science. While developing the model, the author underscored the need for the development of empirical research questions, as well as describing the connection between the concepts and their empirical indicators. Research methodology is a process that involves a brief overview philosophical assumption of the quantitative research paradigm and direct-realist theory from which significant contemporary thinking in quantitative research is founded (Curtis and Drennan, 2013:12). Black (1999:1) stated that quantitative studies provide an eclectic view of research. It suggests that understanding is cyclic, and every response should be deemed exploratory. Quantitative data are crucial and can be treated as a significant part of the scientific investigation.

4.5.3 The stages of the quantitative research process

Quantitative research is known as a strategy that involves the collection of numerical data (Thomas, 2003:15). It is also identified as an objectivist conception of social reality and as preference for a natural science approach (Thomas, 2003:15). Similarly, Muijs (2010:9) described quantitative research as a process involving analysis of phenomena through numerical data using mathematically based methods. Figure 4.3 outlines the main stages of the quantitative research approach process for a study. Thus, conducting quantitative research involves devising a measure of concepts, theory, hypotheses, selected research subjects/respondents, research design, selected research site, administered research instruments/collections, processing data, analysing data, findings/conclusion and writing up findings/conclusions. Walliman (2017:9) explained that various kinds of research schemes are developed for different types of research purposes.

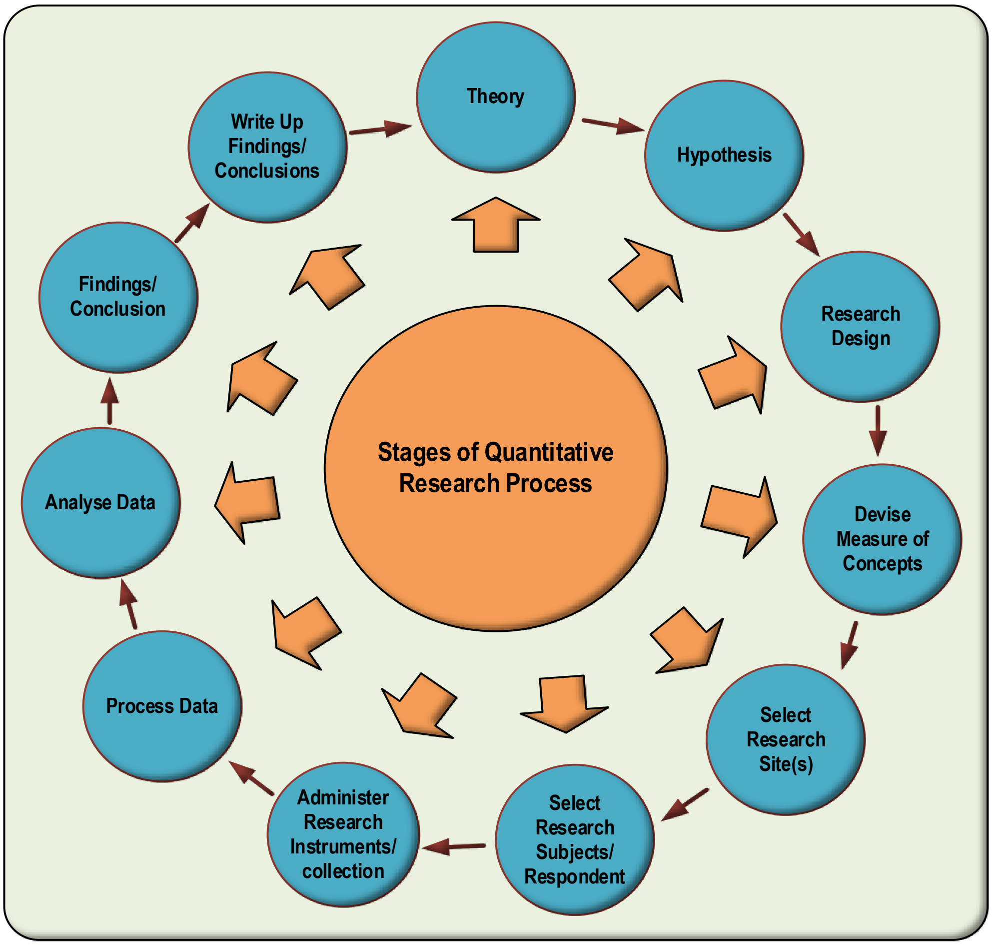

Figure 4.3: Stages of quantitative research approach process

The design approach for a quantitative research planning hinges on the type of problems to be investigated related to the objectives. However, any design approach adopted in quantitative research can use a series of research techniques that can foster efficient data collection and analysis procedures. The collective design approaches used in quantitative research are identified as follows: historical, descriptive, correlative, comparative, experimental, simulation, evaluation, action, ethnological, feminist and cultural. Dahlberg and McCaig (2010:159) stated that the quantitative research process method is considered as a technology that provides respondents with clear answerable questions.

4.5.4 Qualitative method

Patton (2005:1) described the qualitative research method as a technique used for naturalistic inquiry. The research method is also used inductively to study real-world situations in generating valuable narrative and construct case studies. Qualitative research uses an inductive analysis technique for scenarios that produce premises and patterns, wherein researchers focus more on process preferences than simple outcomes. Data generated through the qualitative approach are analysed inductively (Sarwono, 2019:118). Further, the theory comes from 'bottom-up' rather than from 'top-down) (Bogdan and Biklen, 1997:2). According to Flick *et al.* (2004:1), qualitative research describes the living world inside out, from the viewpoint of the people who participate. By so doing, it is perceived to contribute to a better understanding of social realities and draws attention to the process. The qualitative technique will be used in this study to gain more insight on the problem being investigated through an interview process. Sutrisna (2009:3) stated that qualitative research can be used to study complex problems to obtain robust results. It is also mentioned to be appropriate for human behavioural analysis. All this contributed to its rise in popularity in built environment research.

There are many benefits associated with using the qualitative technique. According to Matveen (2002:59), qualitative research allows the collection of more in-depth information on how the researcher perceives intercultural communication competence and its relationship with the performance of multicultural terms. Furthermore, the qualitative technique allows the use of focus groups because of its quick and expedient approach to simultaneous data collection from various people (Kitzinger 1995:299).

4.5.5 Concept of qualitative research planning

O'Donoghue (2006:1) noted that qualitative research has emerged to rival quantitative research over the last 30 years. The rivalry is seen as a significant change in reinforcing data collection in various social science departments. This rivalry was deemed not oppositional but rather as two parallel approaches for social research. The application of qualitative research requires planning strategies; that is, a series of guidelines for a new researcher on how to go about planning qualitative research projects. A researcher needs to adopt concept planning at the beginning of a research project to aid an easy formation of both aim and objectives of the research. Similarly, Kane and Trochim (2007:284) clarified that concept planning is accompanied by other methods exploited in determining the association existing between ideas and concepts.

Additionally, concept planning encourages complex mathematical application suitable in investigating patterns in qualitative data. The process of concept planning in research is referred to as the establishment of guidelines and methods of designing a research project for clear vision. From this statement, research vision can be described as linear or serial, wherein various components of the research project are addressed consecutively in a methodical manner (Verschuren *et al.,* 2010:5).

4.5.6 Comparison between qualitative and quantitative research approaches

Sarwono (2019:118) offered a clear understanding of the debate that the probable connection between method type and research paradigm influences the compatibility of different approaches in a quantitative research approach. The quantitative research approach communicates the hypothesis of a positivist paradigm technique. This specifies that behaviour can be clarified through objective facts.

In contrast, the qualitative research approach discloses the motive behind people's behaviour and interprets their perception about an explicit scenario. Qualitative research is exploratory; the process helps to acquire knowledge of underlying reasons, opinions and inspiration. However, the quantitative research approach measures numerical findings to compute probable findings. Thus, data generated from the two research approaches are different. From a different perspective, broad similarity does exist between the two research techniques. However, through quantitative methods, opinion, attitudes and behaviours are quantified. Almost every discussion of the reason for combining qualitative and quantitative approach begins with the recognition that different methods have different strengths (Sarwono, 2019:118). Teddlie and Tashakkori (2009:85) underscored the fundamental characteristics of qualitative research and quantitative research approaches as follows:

- A qualitative approach is used to explore a specific topic to prepare and define the outcome from a broader perspective of a study; and
- A quantitative approach is used to create a sample of respondents for a deeper exploration of data for the main issue of the study.

Amaratunga *et al.* (2002:20) provided a comparison between using quantitative and qualitative research approach as shown in Table 4.1.

Table 4.1: A comparison between the quantitative and qualitative approach processes

Term	Quantitative approach process	Qualitative approach process
Approach to Inquiry	Objective, positivist, rational, focused, functionalist, outcome oriented.	Subjective, constructivist, holistic, naturalistic-ethnographic, interpretative, process-oriented.
Hypotheses	Specific, testable, stated before a particular study.	*"Tentative, evolving, based on a particular study".*
Research Setting	Deductive, *controlled to the degree possible.*	Inductive in nature, *controlled setting not as important.*
Sampling	Randomly selected respondents, the sample size is usually "*large, representative sample to generalise results to a population."*	Purposively selected respondents, the sample size is typically *"small, not necessarily representative, sample to get an in-depth understanding."*
Measurement	Standardised, *"numerical (measurements, numbers), at the end."*	Non-standardised, "*narrative (written word), ongoing."*
Design and Method	*"Structured, inflexible, specified in detail in advance of study intervention, manipulation, and control descriptive correlation causal-comparative experimental, a few variables, a large group."*	*"Flexible, specified in general terms in advance of study non-intervention, minimal disturbance all descriptive-history, biography, ethnography, phenomenology, grounded theory, case study, many variables, small group."*
Data Collection	Observations 'non-participant '. Focus on the formal, semi-structured and structured interview. "*Administration of tests and questionnaires (close-ended),"* content analysis / statistical analysis.	Something observed 'participant and non-participant'. *"Semi and unstructured interview focus, conversation and discourse analysis, administration of questionnaires (open-ended), taking of extensive and detailed field notes."*
Data Analysis	Raw data are numbers performed at the end of the study, involves statistics in the form of tabulations to come to conclusions), findings are conclusive and usually descriptive.	Raw data are in other words, non-statistical, "*essentially ongoing, involves using the observations, comments to conclude."*
Data Interpretation	To recommend the final course of action to findings, "*conclusions and generalisations formulated at the end of the study, stated with a predetermined degree of certainty. Inferences and generalisations are the researcher's responsibility."*	Exploratory or investigative and conclusions are not conclusive, "*reviewed on an ongoing basis, conclusions are generalisations. The validity of the inferences and generalisations is the reader's responsibility."*

Amaratunga *et al.* (2002:20)

4.5.7 Mixed methods

Fellows and Liu (2008:28) and Wisdom and Creswell (2013:1) described mixed method research as a method with two or more approach techniques. Triangulation studies foster the incorporation of quantitative approach and qualitative approach in reducing or eliminating the disadvantages of each approach to resolve existing or persisting issues (Fellows and Liu, 2008; Wisdom and Creswell, 2013). McEvoy and Richards (2006:66) explained that the combination of quantitative and qualitative methods is extensively advocated. Fellows and Liu (2008:28) noted that triangulation techniques enhance the validity of internal reliability and external reliability to studies. Similarly, Johnson and Onwuegbuzie (2004:15) elucidated that mixed methods research is one of the three majors 'research triangulations' that is spoken about. The mixed methods research approach involves quantitative and qualitative techniques to inquiry about a particular problem; and is used mainly to provide a broader perspective.

The mixed methods research approach is dependent on research studies to investigate research methodologies in data collection and analytic techniques applied (Henn *et al*., 2006:3). In addition, a mixed methods researcher uses several approaches available to achieve the aim and objectives of a particular study (Creswell *et al*., 2003:209). Zohrabi (2013:254) clarified that many researchers have opted for the mixed methods research approach to both qualitative and quantitative data. However, the mixed methods research approach is very significant to this study. The identified challenges were investigated using both qualitative and quantitative techniques, with the aim of achieving results that form the foundation for establishing the main objective of this study, as outlined in Chapter 1.

According to Swanson and Holton (2005), the mixed method research approach can be classified into four types, namely: *complementary* – a combination of two results from two different methods; *development* – using results derived from a method to formulate or update different??; *initiation* –the results derived from one method are restructured into questions. Lastly, *expansion* – involves the use of a different method to increase the scope or variety of inquiry. Teddlie and Tashakkori (2009:151) classified mixed method research into five kinds, namely: parallel, sequential, conversion, multilevel, and fully integrated mixed method design. These classifications are presented in Figures 4.4, 4.5, 4.6, and 4.7.

The parallel mixed method is described as a research design with two parallel, relatively independent quantitative and qualitative data collection techniques implemented to offer adequate answers to relational questions in the research (Figure 4.4). Explanatory sequential mixed designs use the qualitative phase approach of a research project to formulate the research questions for the quantitative phase of the research chronologically (Figure 4.5).

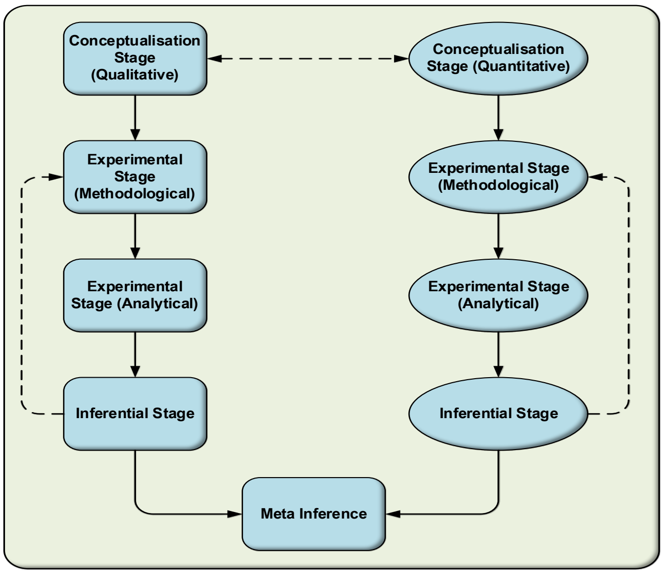

Figure 4.4: Parallel Mixed Method design

Adapted from Teddlie and Tashakkori (2009)

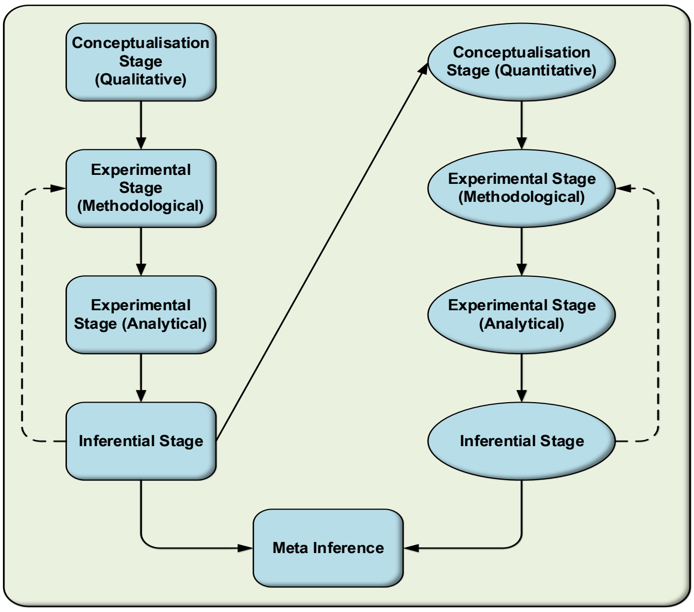

Figure 4.5: Explanatory sequential mixed method design

Adapted from Teddlie and Tashakkori (2009)

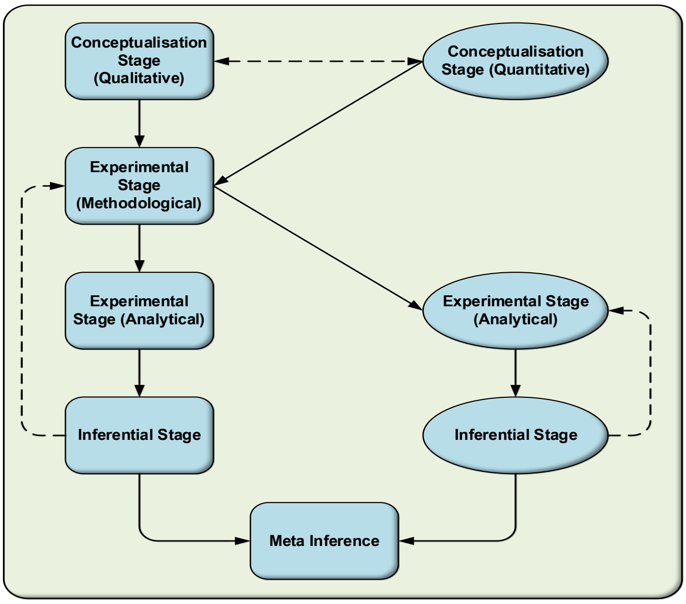

Figure 4.6: Conversion Mixed Method design

Adapted from Teddlie and Tashakkori (2009)

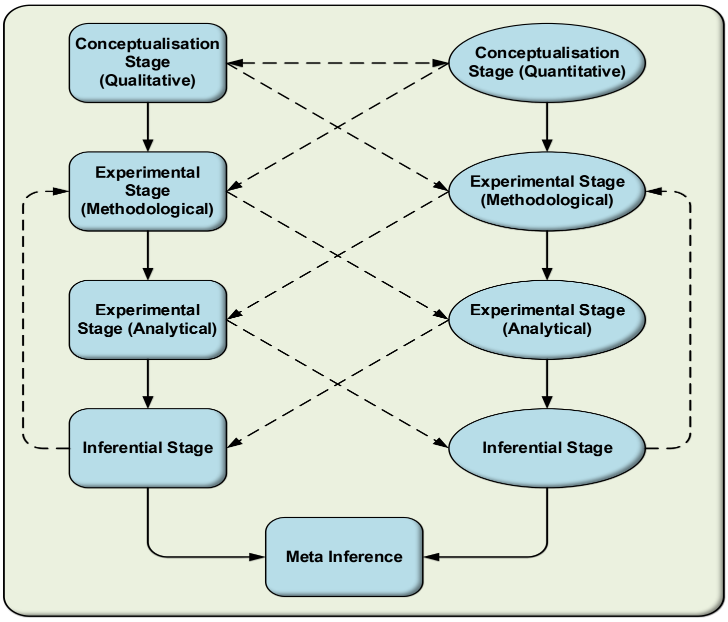

Figure 4.7: Fully integrated Mixed Method design

Adapted from Teddlie and Tashakkori (2009)

The conversion mixed designs are described as a multi-strand parallel design that involves transformation and analysis of both qualitative and quantitative data (Figure 4.6). Additionally, multilevel mixed designs are described as a multi-strand design that constitutes the collection of the qualitative data at the analysis stage as well as the collection of the quantitative data in a parallel or sequential manner. The last mixed design type is named fully integrated mixed design, which is described as a multi-strand parallel design that involves the interaction between the qualitative and quantitative approaches at every stage of the research (Figure 4.7) (Teddlie and Tashakkori, 2009:151).

4.5.8 Advantage of mixed methods approach design

The mixed methods approach design is a mixture of quantitative and qualitative processes. According to Hussain (2009:1), quantitative and qualitative are designed for an understanding of a particular subject area of interest, and both have strengths and weaknesses. Thus, when they are combined, they provide a great possibility of neutralising the flaws of one method and strengthening the advantages of the results obtained from the other research method (Neuman, 2006; Dudwick *et al*., 2006; Choy, 2014); that is, acquiring the benefits of qualitative and quantitative study, as well minimising the drawbacks of each other. These methods are highly significant to this study. Risjord *et al.* (2002:269) summarised the advantages of qualitative and quantitative methods as follows:

- Avoidance of theories with contradictory structures,
- Assist in confirming theory in similar ways,

- Progressive use of theory to a greater degree, or
- Provide completeness and confirmation to resolve issues of methodology and order dominance.

Choy (2014:99) explained that qualitative researchers usually begin with a self-assessment and reflection of themselves as used in a social-historical context. This is about a researcher's position in a society, or a highly self-aware acknowledgement within the social realm. This type of method broadly focuses on a particular question, which is considered the theoretical-philosophical paradigm in a questioning, open-ended setting as they implement a perspective. Therefore, a combination of qualitative and quantitative approaches as a technique to investigate the challenges associated with this study will establish its intended objectives and innovation.

4.6 RESEARCH TRIANGULATION

Bogdan and Biklen (1997:24) described triangulation as a process of validating data by cross-validation of more than one source. It is also applicable to quantitative and qualitative research and serving as other traditional principles such as reliability and validity (Bogdan and Biklen, 1997). Fellows and Liu (2008:158) emphasise that while questionnaires assist in understanding a general situation, the generalisation of findings requires the application of triangulation.

Cohen and Manion (1986) mentioned that triangulation enhances uniformity of results derived from different instruments. The authors further cited that triangulation improves the ability to control or assess various threats and multiple factors that may influence research outcomes. This underscores the significance of triangulation in ensuring the credibility of research findings.

Wang and Duffy (2009:2) highlighted that triangulation facilitates prompt progress from data collection and analysis to results presentation owing to adequate availability of data sources. Furthermore, this approach is particularly useful when data is either insufficient or excessive, especially when the most reliable data is unavailable, or when rapid intervention is required to improve quality. Wang and Duffy (2009:9) further stated that triangulation helps eliminate biases and deficiencies that may arise from relying on a single method of analysis.

4.7 CHAPTER SUMMARY

In this chapter a detailed explanation of the rationale behind this study, including the presentation of the advantages and disadvantages of the research techniques upon which this study is conducted was presented. Each of the techniques was discussed with emphasis on the influence of the techniques to achieve robust findings. The methodology in this chapter elucidated the prerequisite of adopting mixed methods technique for data collection, offered knowledge of the methods, and substantiated the adoption of the methods in ensuring applicable findings.

CHAPTER FIVE

5. RESEARCH METHOD

5.1 INTRODUCTION

This chapter presents different philosophies and techniques used in research. The application of these philosophies and approaches is based on the understanding of the research procedure for realising the research objectives. The methods implemented in the research, including the procedures used for collecting, collating and analysing data related to each of the research objectives and the process that constitutes the interview guide and questionnaire development, questionnaire distribution, sampling approaches and data analysis are reviewed.

5.2 THE RESEARCH PHILOSOPHICAL POSITION

As this research adopts an explanatory sequential mixed-methods approach, a pragmatic philosophical stance would typically be expected. This is most appropriate when data collection follows a concurrent methodological approach, such as in a convergent parallel design (Creswell and Plano Clark, 2011:74).

Philosophy, as defined by Ruona and Lynham (2004:151), is an intellectual process that involves questioning, interpreting, experimenting with ideas, evaluating arguments, and exploring conceptual relationships. It provides a framework for critical thinking, enhances the alignment between thought and action, and strengthens the ability to draw meaningful conclusions that improve practical knowledge and skills (Kumar, 2019:4). Three key aspects of interpreting philosophical issues in research (Easterby-Smith *et al.,* 2012:19) are identified as:

1. Clarifying research designs.
2. Distinguishing between appropriate and inappropriate methodological choices.
3. Developing research designs beyond the researcher's prior experience.

In line with this, the study adopted a methodology that facilitates the effective collection and interpretation of data to achieve its research objectives by incorporating a combination of two philosophical paradigms:

- Postpositivism — specifying quantitative aspects of data assembled in Phase 1.
- Constructivism — specifying qualitative aspects of data assembled in Phase 2.

The philosophical positioning of any research is influenced by multiple factors, as diverse perspectives exist within different paradigms. The academic community continues to debate the most appropriate philosophical stance for research design and methodological choices. Easterby-Smith *et al.* (2012:17) suggested that research philosophy can guide the selection of design approaches by considering subject-specific constraints and knowledge structures.

In this study, a mixed-methods approach was implemented using an explanatory sequential design, which justifies the adoption of both postpositivism and constructivism in separate phases of data collection. Postpositivism was the principal philosophical paradigm used with a strong impact on the quantitative data grouping in Phase 1.

5.3 JUSTIFICATION OF THE MIXED METHOD APPROACH SELECTED FOR THIS STUDY

The justification for selecting the explanatory sequential mixed method approach stems from the need for a large set of quantitative data in phase 1 and a smaller set of qualitative data in phase 2 (Creswell, 2009; Zohrabi, 2013; Haq, 2015; Creswell and Poth, 2016; Creswell and Clark, 2018). An explanatory sequential mixed-methods approach was specifically selected, as shown in Figure 4.6. The small amount of qualitative data collected in phase 2 was used to put together appropriate case studies to supplement the quantitative data to develop an effective risk mitigation model. The formation of the structured interviews followed the complete collection and analysis of the quantitative data in the first phase of data collection process. The quantitative aspect is considered the more significant, as it allowed for a comparative analysis of construction practitioners' perceptions across organisations and supports the empirical examination of the research objectives, as outlined below:

- To identify the factors causing contractual claims risk in civil infrastructure project delivery,
- To ascertain the impacts of risks occurrence in civil infrastructure projects,
- To determine essential strategies to mitigate risks in civil infrastructure projects; and
- To develop and validate a risk mitigation model to address contractual claims risk and enhance the delivery of civil infrastructure projects in South Africa.

The selection of this approach follows Brannen’s (2008:53) recommendation on three key issues: personal issues, relating to research background and factors influencing mixed methods use; professional issues, addressing opportunities and risks; and project issues, ensuring methodological suitability. Mixed method research is valued for leveraging both quantitative and qualitative methods while minimising research risks and costs (Grafton *et al.,* 2011:11). Johnson *et al.* (2007:112) identify mixed-method research as the third research paradigm with quantitative and qualitative approaches. In this study, mixed methods enhanced the data collection, questionnaire management, and survey documentation (Henn *et al.,* 2006:3).

5.4 RESEARCH DESIGN PROCESS

Khanday and Khanam (2019: 367) explained that a typical design process in all areas of research design exploits different types of methods. It is understood that different types of methods are associated with different stages of the process, while a relatively unstructured and ambiguous method occurs earlier in the process. Research design is also employed to provide applicable solutions to any existing problems. The process involves groundwork research to acquire various standpoints about a particular research challenge, group of various probable separate solutions, and a reiteration procedure of cultivating concepts of reflection and reliability (Zimmerman *et al*., 2007:493). Gray and Malins (2016:1) considered the research design process as a collective act because it involves other practitioners, participants and professionals from different disciplines or external bodies e.g. industry, commerce, and other voluntary sectors. A diagrammatic illustration of the research process is presented in Figure 5.1 to demonstrate the link existing between initial tasks, data collection and processing, and output.

Maxiwell (2012:2) stated that a good design, one in which the components work harmoniously together, promotes efficient and successful functioning. The researcher further stated that a flawed design leads to poor operation or failure. This highlights that research or operations involving design utilise various design concepts, defined as a plan or protocol for executing or achieving a specific goal, such as a scientific experiment. Kazdin (2003:3) identified six steps that a researcher should consider for a research design:

i. Produce a feasible research concept that can cultivate possible investigation outcomes for a specific research problem,
ii. Critically evaluate published research results for fact findings,
iii. Evaluate basic challenges affecting research methodologies and define appropriate techniques for resolving them,
iv. Assess the influence that culture, ethnicity, class, and gender may have in affecting the research process,
v. Examine the ethical use of outcome and process measures in a research study, and
vi. Identify a variety of research methods used in the investigation of problems, so that aim, and research objectives will be established.

As part of the research design process, Creswell and Poth (2017:2) identified five different approaches to the qualitative design approach as:

i. narrative,
ii. phenomenology,
iii. grounded theory,
iv. ethnography and case studies, and
v. discussion of procedures for conducting a qualitative technique.

This study involves all techniques to design the research procedure required to achieve the aim and objectives.

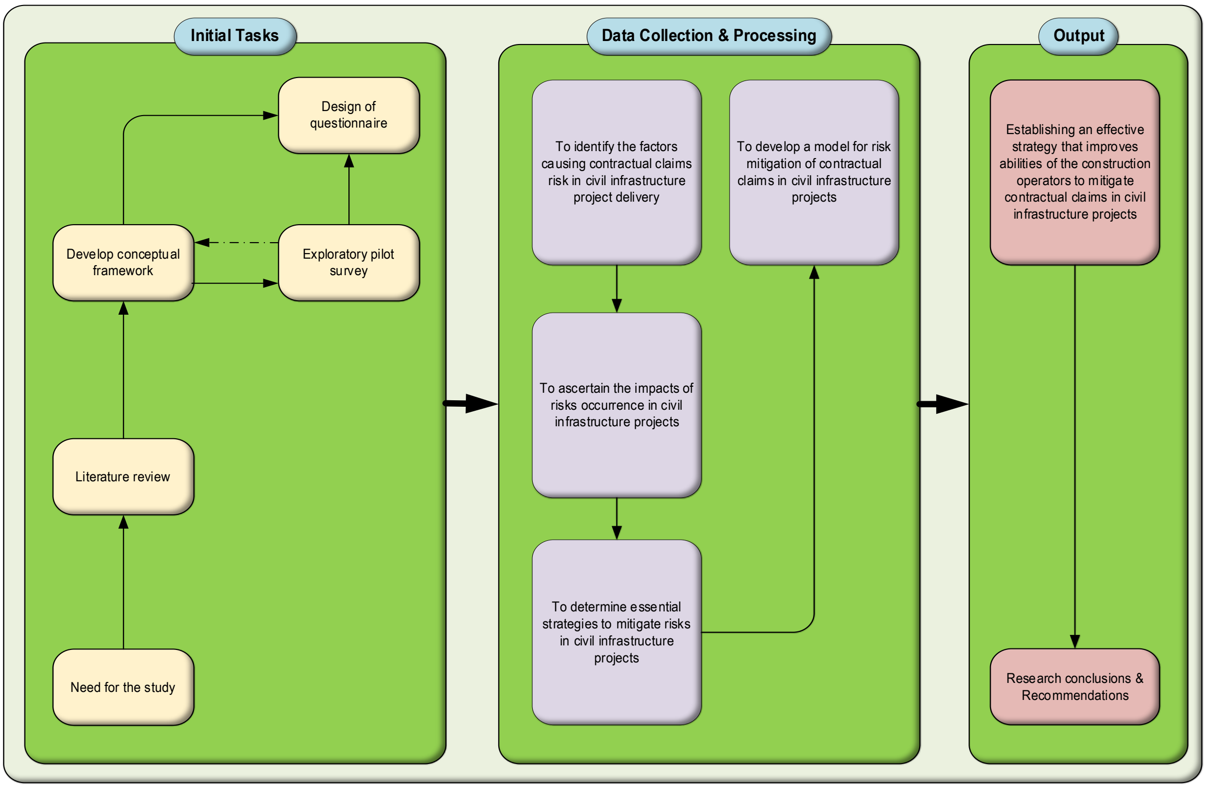

Figure 5.1: The research process

5.4.1 Data collection procedures

Having noted the applicable research methodology earlier in Chapter 4, it is important to understand the best approach to data acquisition and interpretation for resolving the highlighted problems in section 1.3. The approach will aid technical knowhow in addressing the ethical implications of the research relating to validity and reliability. Leedy and Ormrod (2005:104) highlighted four basic questions to pave the way for the realisation of the research. These questions are highlighted below:

i. What data is needed?
ii. Where is the data located?
iii. How will the data be secured?
iv. How will the data be interpreted?

This study captures all the research questions highlighted above by considering the use of the mixed methods approach as the procedural technique for data collection and the basis for the implementation of quantitative and qualitative approaches. The objective behind the sourcing of quantitative and qualitative datasets is to raise the credibility, validity and generalisability of the findings obtained (Easterby-Smith *et al.,* 2012:61). As related to the application of the mixed methods, the research questions (section 1.4) formulated for this study required more than one dataset. In addition, the interpretation of these questions demanded that the right research design process to derive applicable answers for different types of problems was applied.

The procedures for securing the right data for each objective of this study are tabulated in Tables 5.1, 5.2, 5.3 and 5.4 respectively, while the data collection phases are diagrammatically illustrated in Figure 5.2. These illustrations simplify the effective ways to work through the study objectives by ensuring that the four fundamental questions suggested by Leedy and Ormrod (2005:104) are duly applied in the study.

The data treatment of Objective 1 involved the identification of the data location, data securement and data interpretation, and were classified as quantitative data.

Table 5.1: Objective 1 – Treatment of data

Required data	**Quantitative data to identify the factors causing contractual claims risk in civil infrastructure project delivery**
Location of data	Construction professionals in all the nine provinces of South Africa, who have been involved in construction and consultation in civil infrastructure projects from the pool of construction companies in the CIDB; and consulting quantity surveying firms were from the SACQSP list of those registered on grade 3–9.
Securing data	Respondents were contacted by SurveyMonkey, email, hand delivery, and follow-up were initiated through telephone calls.
Interpretation of data	Descriptive Statistical Analysis on SPSS Statistics 23.

The data treatment of Objective 2 followed a similar approach than for Objective 1, which were also classified as quantitative data.

Table 5.2: Objective 2 – Treatment of data

Required data	**Quantitative data to ascertain the impacts of risks occurrence in civil infrastructure projects**
Location of data	Construction professionals in all the nine provinces of South Africa, who have been involved in construction and consultation in civil infrastructure projects from the pool of construction companies in the CIDB; and consulting quantity surveying firms were from the SACQSP list of those registered on grade 3–9.
Securing data	Respondents will be contacted by SurveyMonkey, email, hand delivery, and follow-up will be initiated through telephone calls.
Interpretation of data	Descriptive Statistical Analysis on SPSS Statistics 23.

The data treatment of Objective 3 followed a similar approach as employed for Objective 1 and Objective 2 but classified as quantitative and qualitative data.

Table 5.3: Objective 3 – Treatment of data

Required data	**Quantitative and qualitative data to determine essential strategies to mitigate risks in civil infrastructure projects**
Location of data	Quantitative data through a questionnaire survey to the construction professionals from the pool of construction companies in the CIDB list of registered on grade 3–9, who perform as construction and consultation experts in civil infrastructure projects in the Western Cape, Gauteng, and KwaZulu Natal Provinces.
	Qualitative data through a structured interviewing of seven construction stakeholders from the pool of construction companies (CIDB) on grade 3 – 9, who execute as construction and consultation experts in civil infrastructure projects in Western Cape, Gauteng, and KwaZulu Natal Provinces.
Securing data	Respondents were contacted by SurveyMonkey, email, hand delivery and follow-up were initiated through a telephone call and direct interview.
Interpretation of data	Descriptive statistical analysis.

Data treatment of Objective 4 involved location of data through triangulations of data, securing data through factor analysis (FA) and interpreting data using a structural equation modelling (SEM) technique as the product of the results from the combination of objectives 1, 2 and 3 in developing an operational framework for risk mitigation of contractual claims in civil infrastructure projects.

Table 5.4: Objective 4 – Treatment of data

Required data	**The combination of the results from objectives 1, 2 and 3**
Location of data	Triangulations of data sourced from objectives 1, 2 and 3.
Securing data	Factor analysis.
Interpretation of data	Structural equation modelling (SEM) technique.

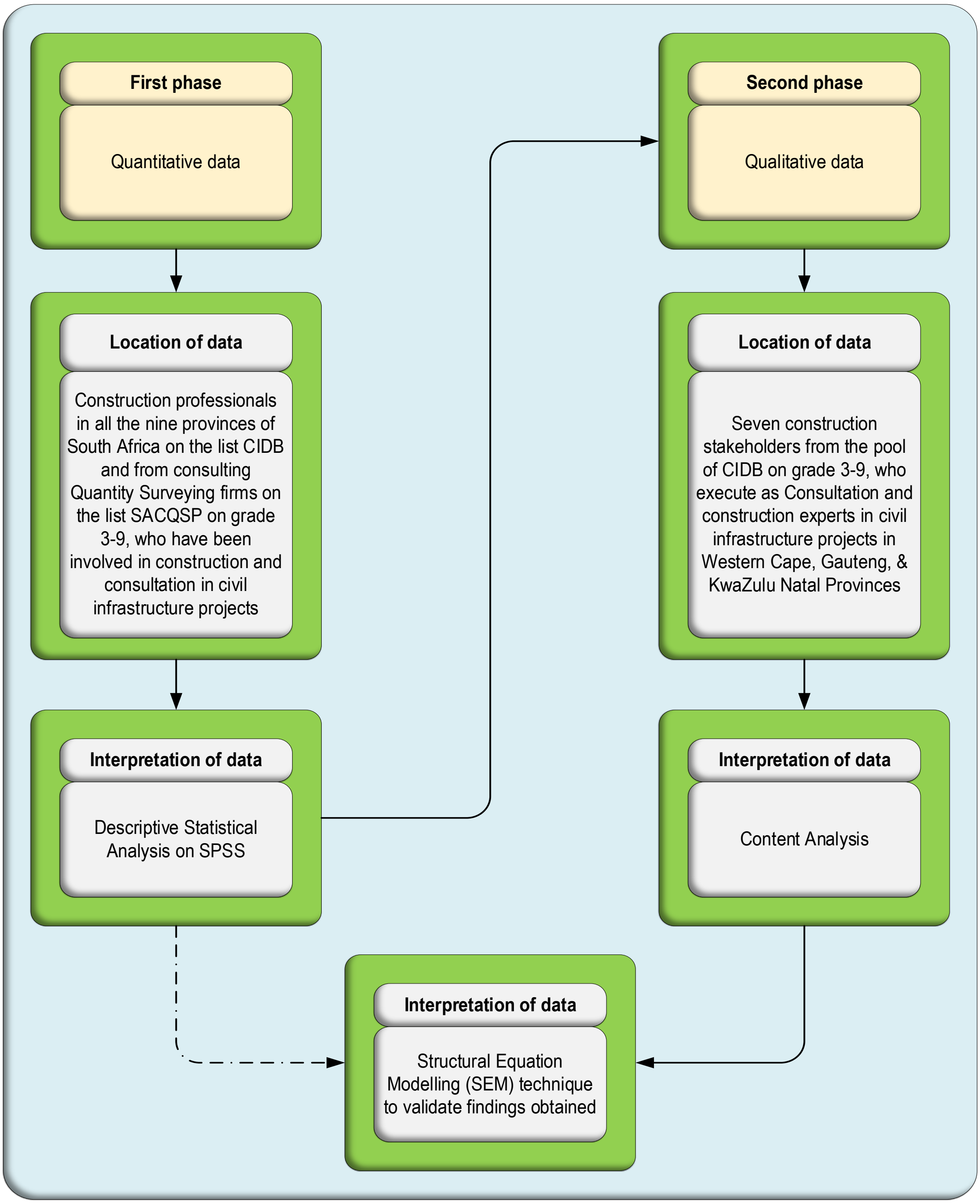

Figure 5.2: The research data collection phases

5.4.1.1 Quantitative data collection phase

Quantitative data collection is a process initiated in social and construction management studies through the implementation of a survey approach. Saunders *et al.* (2009) state that survey research provides a better knowledge on the quantitative depiction of trends, attitudes, or opinions of a sample obtained from a population. Well-structured survey material was adopted for quantitative data collection from a substantial population sampling. They emphasised that a strategic approach should use to structure the interviews and observations in quantitative data collection phase. With the purpose of having a clear understanding about contractual claims risk and its mitigation in civil infrastructure projects, a series of questions were developed to solicit opinions on the contractual claims risk impact on the civil infrastructure projects from the construction practitioners in contracting and consulting firms. The questionnaire provided a quantitative dataset through the opinions or responses given by the selected respondents (refer to Appendix B).

One can also describe questionnaire surveys as an effective way of collecting adequate amounts of data from a certain number of selected participants to attain reliable findings (McQueen and Knussen, 2002). A questionnaire is also described as a self-administered measuring tool that comprises both open-ended questions – where respondents present their views in full) and closed-ended questions – where the respondents are allowed to choose from answers given in questionnaire). A detailed content and response format, including proper structuring of the survey will help to yield reliable results. In that case, certain precautions must be followed in designing questionnaires, wherein the questions must be comprehensible and robust to motivate the respondents. The transfer of data gathered with the questionnaires should be made easy to code and edit on statistical analysis software. In this study, literature reviewed in Chapter 2 aided the design of the questionnaire used.

The distribution of the questionnaire was based on three approaches, which were online distribution, through SurveyMonkey, email, and hand distribution. SurveyMonkey is an internet-based platform for data collection, which provides a platform for a researcher to form the survey questions, while the email distribution of the questionnaires fostered free response to the questions. On the other hand, hand distribution provided unconditional responses to the questions as the respondents began to mark the options provided in the questionnaire. Blaxter et al. *(*2006) and Creswell (2009:149) supported the use of SurveyMonkey for quantitative data collection, since it permits a larger population of dataset. The selection of the participants was conducted using a stratified random sampling technique for a set of diverse professionals involved in the civil infrastructure projects overseeing (13), project management (71), supervision (49), consulting (9), and contracting (24). They were selected from the construction firms registered on the Construction Industry Development Boards (CIDB) classes of work occupying General Building (GB) and Civil Engineering (CE) from grade 3–9, with experience in contractual claims risk in civil infrastructure projects in South Africa. This sampling technique was selected to facilitate easy elimination of selection bias of participants as well to ensure that the sample was representative of the larger population (Acharya, *et al.,* 2013).

5.4.1.2 Qualitative data collection phase

In qualitative data collection, as related to construction management, conduction of qualitative interviews is frustrating due to the unpreparedness and unavailability of construction industry professionals that were involved in the research survey (Easterby-Smith et al., 2012:126). This study considered seven participants, who are project manager (3), risk manager (2), and quantity surveyor (2). The selection of participants was based on participants' level of experience and position occupied in the construction firms situated within the surveyed provinces. These participants were contacted by phone and via emails to ascertain their availability for easy collection of qualitative data (Easterby-Smith et al., 2012:126). Dates for approximately 30-minute interviews were scheduled based on the availability of individual interviewees. The selection of these seven (n =7) participants was based on random sampling to disregard selection bias and ensuring that the sample was a representative of the larger population (Acharya, et al., 2013).

Due to the importance of investigating the risk mitigation approach in South Africa, it was crucial to perform a preliminary study to establish the relevance of the findings obtained from the literature reviewed to uncover the challenges in civil infrastructure projects. After interviewees were contacted, it was necessary to follow up by letter, email or telephone call (Easterby-Smith et al., 2012:126) to ensure prompt readiness. It fosters reliability and establishes future collaboration and opportunity to share additional information about the research (Easterby-Smith *et al.,* 2012:126).

The research interviews were semi-structured to allow open-ended responses from the interviewees (see Appendix D). This practice encourages qualitative researchers to have beliefs about the subject of discussions, with the opportunity to generate reliable descriptions of research phenomena by exercising openness during the interview (Turner, 2010:754). Necessary instructions were prepared for the interview based on the preliminary outcomes derived from related research findings. The qualitative questionnaire was classified into five related questions, with seven respondents involved: Question 1 contained information on the influence of cost and time on the project delivery. Question 2 probed procurement effects on civil infrastructure projects. Question 3 included the significance of contractual risk on the delivery of civil infrastructure. Question 4 encompassed the impact of stakeholders' interests on the implementation of civil infrastructure projects, and the final question (question 5) contained the appropriate operational framework for risk mitigation of contractual claims on the civil infrastructure projects.

As part of the interview process, consent was obtained from the interviewees to allow the use of a digital voice recorder for the interview, and a research assistant was present to assist in ensuring no loss of (essential) information during the interview.

5.4.1.3 Quantitative and qualitative data

The quantitative and qualitative data were obtained from experienced civil infrastructure workers, who were registered on CIDB Grades 3–9. This category of workers is considered to have acquired useful information pertaining to the occurrence of contractual claims and their associated risks in the construction projects. The information (data) acquisition bolstered the significance of mitigating the effect of contractual claims risk in civil infrastructure projects. Hesse-Biber and Leavy (2011:46) support this approach in suggesting that the availability of people with field experience and willingness to make information available is imperative to research.

5.5 DATA ANALYSIS APPROACH

Applying the applicable techniques for data analysis is considered crucial in ensuring data collected from the field are carefully screened to derive applicable research results. Nonetheless, a nominal-ordinal dataset was assembled for the study due to the nature of the research. Responses were quantified using an appropriate Likert scale structure. Therefore, a descriptive statistics approach was used to analyse the demographic and background information of the respondents, including the Likert scale data. These were evaluated to obtain the mean scores and variance of the data. The dimensionality of the Likert scale data was determined with the use of factor analysis (FA) to deduce the best model through partial least square–structure equation modelling (PLS–SEM). The initial part of the data analysis, descriptive statistics, was performed using the Statistical Package for Social Sciences (SPSS) v23 and data grouping was executed with Microsoft Excel 2016 for Windows. The second part of the data analysis, inferential statistics, was also performed using SPSS v23, with the purpose of achieving the criteria that enabled the use of FA to substantiate the PLS-SEM in establishing relationship between the constructs as the path to risk mitigation model development. The development of the risk mitigation model was conducted using SmartPLS4.

5.5.1 Descriptive statistics analysis

Descriptive statistics constitutes the application of measure of central tendencies, variability, frequency, and position to illustrate findings obtained by descriptive analysis of the survey executed. These approaches were adopted to explore data obtained from the questionnaire administered to the selected respondents. The data were grouped to pave the way for smooth analytical procedures, wherein such descriptive statistical techniques as percentages, frequencies, mean scores, etc. were applied to explore the dataset related to the background detail and demography. The results derived were tabulated and graphically presented to enable easy interpretation.

5.5.1.1 Mean scores

Mean scores pertaining to each variable (item) were carefully determined to identify the significant factors associated with each of the constructs. The determination of the mean scores was made possible through appropriate formation of the 5-point Likert scale as characterised in the questionnaires. Pertaining to the formation of the 5-point Likert scale, a point is allocated to the rating of variables as marked by respondents; for instance, *extremely significant* is rated 5 points for a particular variable (item), while *extremely insignificant* is rated 1 point. Extensive use of the mean scores was considered in research with similar variables by (Assaf *et al.,* 2010; Othman, and Abdellatif, 2011; Mulliner *et al.,* 2013). The mean score for each variable was computed in SPSS Statistics 23 according to Equation 5 to support the understanding of the constructs developed:

$$\text{Mean score} = \frac{5n_5+4n_4+3n_3+2n_2+1n_1}{n_5+n_4+n_3+n_2+n_1} \quad \ldots\ldots 5$$

Where; n_1 = number of respondents who answer extremely insignificant

n_2 = number of respondents who answer not significant

n_3 = number of respondents who answer moderately significant

n_4 = number of respondents who answer significant

n_5 = number of respondents who answer extremely significant

A mean score of above 3.00 is a threshold indicating the importance (strong impact) of an item in comprehending and determining the causes of contractual claims risk.

5.5.2 Factor analysis

In this study, the application of the factor analysis (FA) comprises various related methods, wherein one of them is reduction of the dimension of a large group of variables (Pallant, 2020:188). This approach involves the computation of the internal consistency (Cronbach's Alpha coefficient) of the Likert Scale data to ascertain the acceptable reliability threshold of the questions responded to by the respondents. In this case, the Cronbach's Alpha coefficient threshold considered ranges from $0.700 \leqslant \alpha < 0.900$, from the good to excellent internal reliability of data (Gliem and Gliem, 2003; Yong and Pearce, 2013; Vogt and Johnson, 2015; Civelek, 2018; Senthilnathan, 2019). In some research cases, FA was swapped for PCA (principal component analysis) since they acquire similar attributes to produce a reduced dimension of variables that can capture the variations in patterns and structures of correlations. The closer the correlation coefficient is to 1.0s0 (positive correlation) or -1.00 (negative correlation), the better the threshold of the items' relatedness (Yong and Pearce, 2013; Westland, 2015; Civelek, 2018). Both procedural analyses may be used interchangeably along the analysis, since FA is perceived as a product of PCA with some rotation of axes. FA aids easy extraction of less uncorrelated underlying factors accounting for a converged set of interrelated variables (Lei, 2009:505). In that case, when the latent factors are partially revealed from the response variables, then there remain no correlations between a given set of response variables (Lei, 2009:505).

FA is a multivariate statistical technique used to examine the latent structure or the interrelationship pattern (or correlations) among many variables (Hair et al., 1998). It is imperative to have an in-depth understanding of the independent criteria required to determine relevant findings about the significance and adequacy of the variables to achieve the appropriateness of the dataset for analysis. In this case, SPSS Statistics 23 was used to establish the importance of the criteria when applying FA.

The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were conducted to examine the sampling adequacy for each variable to measure the suitability level of the entire data set for FA. The adequacy for KMO test scores for data (items) is acceptable at a threshold of KMO > 0.50, while the Bartlett's test of Sphericity scores for data (items) is acceptable at a threshold of > 0.50 (Weston and Jr, 2006; Hoyle, 2009; Westland, 2015; Civelek, 2018).

Groups of factors were extracted through the application of FA to produce eigenvalues greater than 1.00 while disregarding other factors with eigenvalues less than 1.00 based on Kaiser's criterion (Pallant, 2020:188,189). In addition, Oblimin rotation, one of the most used rotation methods, was applied to interpret the relationship between observable variables and latent factors (O'Rourke and Hatcher, 2013). Therefore, factor loading scores lower than 0.500 were not considered fit for further analysis, and variables (items) with a single cross loading ⩾ 0.500 were considered significant, while variables (items) with multiple cross loading irrespective of their loading scores were considered insignificant (Ncube and Moroke, 2016 and Civelek, 2018).

5.5.3 Structural equation models

The final objectives of the study were to develop a model for construction operators to manage risk in civil infrastructure projects and to establish an operational framework for risk mitigation of contractual claims in civil infrastructure projects. To attain this goal, however, it is essential to develop an applicable model to assess a sequence of real-time hypotheses on the impacts of underlying and observable variables, including the measurement errors. Therefore, structural equation modelling (SEM), used as a statistical tool by many researchers, was considered feasible for the particular objectives (Lei, 2009:495).

The standard SEM constitutes confirmatory factor analysis (CFA) model, path analysis, regression type structural equation, and SEM-PLS approach by using SmartPLS4.0 to establish the relationship between variables as well as validating the constructs. The use of the CFA model in the study is to link the indicators (manifest variables) to their corresponding underlying variables, including the measurement errors the measurement errors. This type of structural equation analysis can be observed as a regression model, because it regresses the variables with fewer underlying variables.

On the other hand, of the forms of regression analysis in structural equation regress the dependent (endogenous) underlying variables with the unidimensional associated dependent (endogenous) and independent (exogenous) underlying variables (Lei, 2009:496 and Hoyle, 2012:6). This is because the underlying variables are random in nature; therefore, it is challenging to have a complete evaluation in ordinary regression, wherein raw observations (data) are required. Conceptually, the familiar regression type model formulates SEMs based on basic theories from which the model is verified.

5.5.4 Baseline assumptions in SEM

Data analysis in construction management research requires the implementation of certain assumptions that could guide adequate development of a structural model. The multiple regression (MR) analysis establishes that residuals are normally distributed (Kleinbaum and Klein, 2010). The regression technique has uniform variances throughout all levels of the predictors (Kleinbaum and Klein, 2010), whereas a standard regression analysis assumes a linear relationship only. Conversely, the assumption underlining ANOVA is a normal population distribution, homogeneity of variance, and uncorrelated error factors. It is stated that any divergence from the theories will influence the results of F-test and T-test analyses. According to Kleinbaum and Klein (2010), five basic assumptions are outlined for SEM:

- the presumed cause (e.g., X) must occur before the effect (e.g., Y)
- that there is an association or an observed covariation between X and Y,
- there is an isolation, which means that there are no other plausible explanations of the covariation between X and Y,
- that the observed distributions match those assumed by the method used to estimate associations, and
- the direction of the causal relation is correctly specified that X indeed causes Y, or X and Y reciprocally cause each other.

It is therefore essential to establish in SEM temporal precedence between the variables.

5.6 RESEARCH LAYOUT

The research layout, presented in Figure 5.3, paves the way for the understanding of the research topic to support the evaluation, definition, and enhancement of the research idea. The objectives of the study highlighted the importance of the study pertaining to the mitigation of the contractual claims risk in the civil infrastructure projects in South Africa. Literature was studied alongside the research constructs as a guideline for integrating and comparing ideas and techniques to comprehend and develop the definitive approach in identifying the right variables and methodology suitable for this study.

The study variables were identified based on the activities performed by the construction stakeholders that relate to the operations observed during project execution. The study participants were identified based on their level of involvement and experience in civil infrastructure project execution. The methodology comprised the research designs and research methods, which were related in terms of their applicability in this study. The research designs involved the application of the quantitative (close-ended questionnaire) and qualitative (open-ended questionnaire) methods through an explanatory sequential mixed method to produce an integrated that could be applicable in the development of the risk mitigation model for the contractual claims risk management in civil infrastructure projects.

The content analysis interpreted the interviews to generate findings, while the descriptive analysis prepared the data for the application of FA and path analysis to pave the way for the deployment of PLS-SEM on SmartPLS4. This approach facilitated a simplified development of the risk mitigation model to evaluate risk occurrence along the construction production. Implementation of the model yields observable conclusions and recommendations.

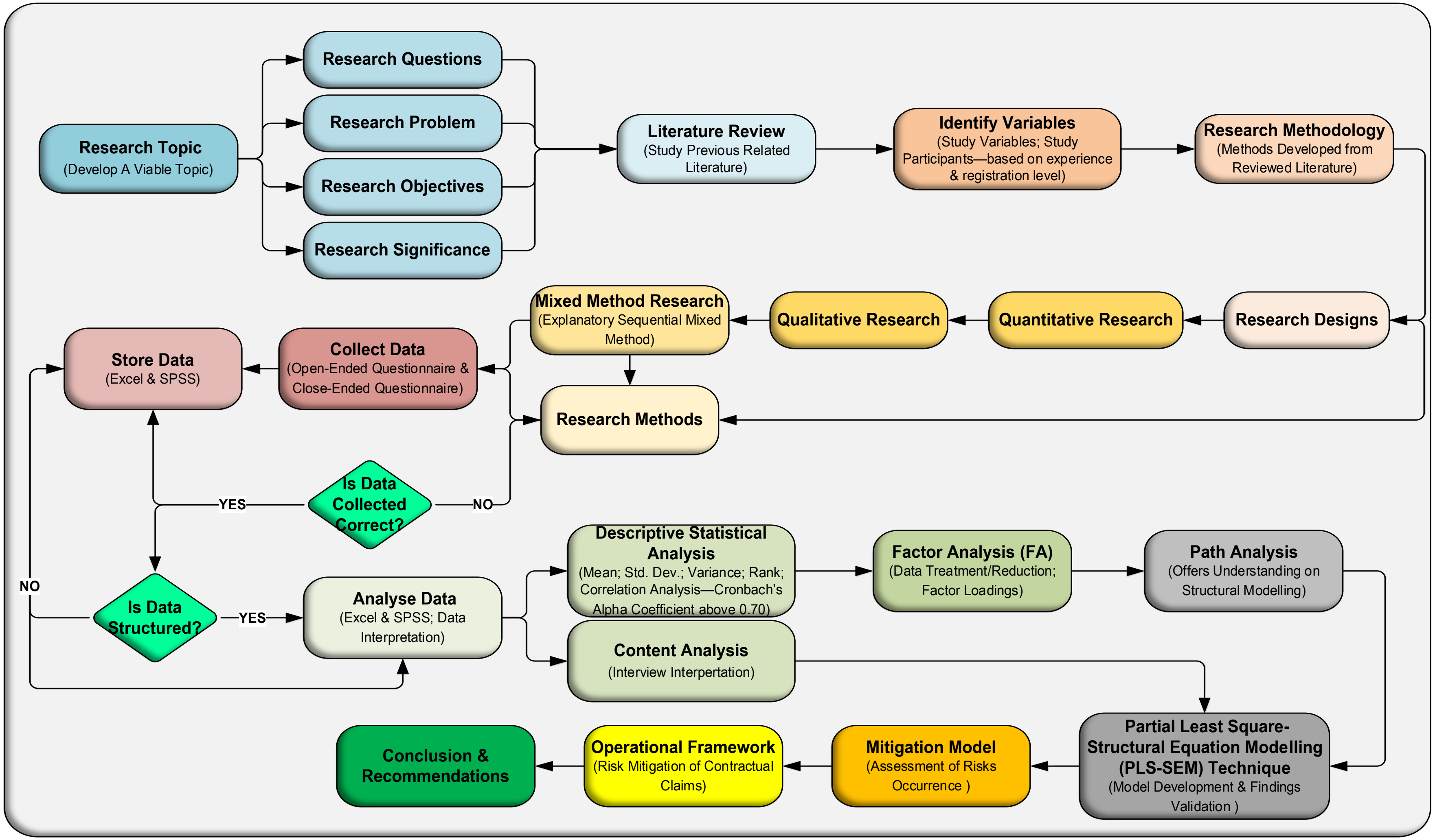

Figure 5.3: Research structure illustrating the sequential steps taken towards attaining the conclusive investigation

5.7 CHAPTER SUMMARY

This chapter presented techniques adopted in this study. The research methodology used, with the chosen philosophical view and various data collection and analyses techniques used were discussed. The study implemented a mixed method technique for collation of applicable data through a survey exercise to enable procedural analysis of quantitative and qualitative data. Data analysis was subjected to descriptive statistical techniques, correlation analysis, PCA, amongst other statistical techniques used to analyse the quantitative survey. SEM was used to develop a model that could be feasibly used to mitigate risk in civil infrastructure projects in the South African construction industry.

CHAPTER SIX

6. QUANTITATIVE RESEARCH DATA COLLECTION, ANALYSIS AND DISCUSSION

6.1 INTRODUCTION

This chapter presents the analysis of the quantitative data gathered using questionnaires. The data were extracted and grouped into variables on Excel 2016 and exported to the SPSS Statistics v23 data analysis platform to conduct descriptive and inferential analyses. Variables analysed were respondents' general information, particulars of civil projects, causes of contractual claims risk and its significance for the delivery of civil infrastructure projects, effect of risk on the projects, construction contractual claims in projects, and factors that affect stakeholders' interests during implementation of such projects. The results obtained were used to interpret the impact of contractual claims risk on project delivery and were validated with the qualitative results obtained from the analysis of the open-ended interviews of the selected respondents (Chapter 7), who had vast experience as professionals in the investigated areas. The validation outcome was used to establish a risk mitigation model in Chapter 8.

6.2 RESPONSES DERIVED FROM THE USE OF QUESTIONNAIRES

One hundred and sixty-six (166) questionnaire surveys were retrieved from SurveyMonkey online, emails and physical interaction. Before commencement, the selected respondents were identified and categorised as professionals in the field of investigation. The selection was based on the confirmation of construction and consulting firms registered with the CIDB and consulting quantity surveying firms registered with the SACQSP from grades 3–9, as noted in section 1.9.

6.2.1 Respondents' positions and years of construction experience

Table 6.1 presents information on the work positions of the selected respondents and their years of construction experience based on the types of projects executed in this field of investigation. All 166 respondents worked in five positions as either project director, project manager, supervisor, consultant, or contractor. The data shows that 42.8% (71) of the respondents work as project managers, 29.5% (49) as supervisors, and 14.5% (24) as contractors, while 13.2% were project directors and consultants. Heravi *et al.* (2015) and Nahiyan *et al.* (2019) stated the importance of involving stakeholders such as project managers, contractors, consultants, supervisors with vast experience in understanding the problems facing contractual claims in the construction industry.

Table 6.1: Work positions and years of working experience of respondents

Respondents' Work Positions			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Position in organisation	Project Directors	13	7.8
	Project Managers	71	42.8
	Supervisors	49	29.5
	Consultants	9	5.4
	Contractors	24	14.5
	Total	**166**	
Respondents' Years of Construction Experience			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Years of work	0 – 5 years	12	7.2
	6 – 10 years	40	24.1
	11 – 15 years	35	21.1
	16 – 20 years	40	24.1
	above 20 years	39	23.5
	Total	**166**	

Information of respondents' years of work was collected to validate their relevance to this study. The data shows that over 90% respondents had more than 5 years of working experience, with less than 10% with less than 5 years. This indicates that the survey involved respondents that were more experienced. Nahiyan *et al.* (2019) supported the above findings by demonstrating that most respondents, with high level of experience in contractual projects, have a working experience of more than 5 years.

6.2.2 Types of projects executed and size of construction company

Information on the projects executed and the size of construction companies was also collected (Table 6.2). The data indicates that more than 60% of the respondents had executed building and roads and bridges projects, while nearly 40% were involved in projects related to railway and other infrastructure as well as water engineering and sewage disposal lines. Data indicates that more than 60% respondents worked for construction companies between grades 4–6 less than 30% for companies between grades 7–9, while none of them worked for a construction company below grade 3. This result validates strong participation of the respondents in significant projects (Heravi *et al.,* 2015).

Table 6.2: Types of projects executed and size of the construction company

Projects Executed			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Types of projects executed	Building	47	28.3
	Roads and Bridges	58	34.9
	Rail Lines and Infrastructure	27	16.3
	Water Engineering and Sewage Disposal Lines	34	20.5
	Others	0	0.0
	Total	**166**	
Size of Construction Company			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Organisation size	Grade 1	0	0.0
	Grade 2	0	0.0
	Grade 3	17	10.2
	Grade 4	35	21.
	Grade 5	36	21.7
	Grade 6	38	22.9
	Grade 7	13	7.8
	Grade 8	12	7.2
	Grade 9	15	9.0
	Total	**166**	

6.2.3 Client type and operational areas

Two thirds of the construction companies dealt mostly with the private sector, while one third engaged more with the public sector. Eighty four percent (84.0%) of these projects were executed in the Western Cape, Gauteng, and Kwazulu-Natal as shown in Table 6.3, showing where most of the economic activities took place.

Table 6.3: Types of clients engaged and operational areas for the construction companies

Client Type for the Construction Company			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Client types	Public Sector	56	33.7
	Private Sector	110	66.3
	Total	**166**	
Operational Areas for the Construction Company			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Operational areas	Eastern Cape	4	2.4
	Free State	7	4.2
	Gauteng	60	36.1
	KwaZulu-Natal	18	10.8
	Limpopo	7	4.2
	Mpumalanga	1	0.6
	Northern Cape	3	1.8
	North West	2	1.2
	Western Cape	64	38.6
	Total	**166**	

6.2.4 Project price ranges and duration

Data on the price ranges for projects executed, agreed project duration, projects completion and delivery, including project extension, were analysed and presented in Table 6.4 and Table 6.5. In Table 6.4, data shows that 83.8% of the projects were executed in a price range of R500, 000 to R100 million, while 16.2% were in a price range above R100 million.

This indicates that a smaller number of respondents were involved in large construction project. The data in the second part of the table illustrated contract project execution duration. The result obtained indicate that over 90.0% of the projects were of 2 to 3 years duration while 5.4% were a year duration (Table 6.4). An additional question was asked to validate the applicability of the above result. The responses determined that the actual number of projects were executed and delivered within the stipulated period as presented in Table 6.4.

Table 6.4: Price ranges and agreed duration for construction project

Project Price Range			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Project price ranges	Less than R500 000	39	23.5
	R500 000 to R1 million	69	41.6
	Above R1 million to R100 million	31	18.7
	Above R100 million to R500 million	14	8.4
	Above R500 million to R1 billion	7	4.2
	Above R1 billion	6	3.6
	Total	**166**	
Contracted Project Duration			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Agreed project duration	<1 year	1	0.6
	1 year	8	4.8
	2 years	122	73.5
	3 years	35	21.1
	Total	**166**	

Data in Table 6.5 show that 80.7% of the projects were executed and delivered on time, whereas less than 20.0% of the projects were neither completed nor delivered. Project durations were extended for organisations that could not deliver the project within the agreed periods, which had an impact on the budgeted cost as well as incurring contractual claim risk. Eighty seven percent of the respondents claimed that an uncompleted 2-year project was extended for 4 months, and an uncompleted 3 years project was extended for 5 months respectively, to ensure project completion and delivery. Thirteen percent of the respondents stated that uncompleted one-year projects were extended for 2 months.

Table 6.5: Completion and delivery of project by construction company and project duration extension

Project Completed and Delivered			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Was the project completed and delivered on the agreed date?	Yes	134	80.7
	No	32	19.3
	Total	**166**	
Extended Duration for Unfinished Project			
Factor	**Responses**	**Respondents**	**Percentage (%)**
Extended time for project	1 year, with 2 months ext.	4	13.3
	2 years, with 4 months ext.	11	36.7
	3 years, with 5 months ext.	15	50.0
	Total	**30**	

6.3 INTERNAL CONSISTENCY TESTING OF THE LIKERT SCALE QUESTIONS

In this section, the internal consistency level of all 14 Likert scale questions explored are discussed to understand the reliability or intercorrelation among the items grouped under each factor (Gliem and Gliem, 2003; Acharya et al., 2006; Ansary and Renault, 2018; Coleman et al., 2020). The Cronbach Alpha coefficient obtained for each Likert scale question is arrayed in Table 6.6 to show their acceptable reliability levels for the purpose of this study (Gliem and Gliem, 2003; Acharya *et al.,* 2006; NajiQasem and Gul, 2014).

Table 6.6: Cronbach's Alpha Coefficients derived for the fourteen Likert scale questions explored

S/N	Code	Likert Scale Questions Explored	Number of Items	Cronbach Alpha Coefficients	Objectives
1	CRC	Client-Related Causes	8	0.847	**Objective 1**
2	CoRC	Contractor-Related Causes	17	**0.871**	
3	CsRC	Consultant-Related Causes	6	0.773	
4	ExC	External Causes	6	0.712	
5	FiR	Finance-Related Causes	5	0.749	
6	CRF	Contractual Risk Factors	11	0.701	
7	RkO	Risk Occurrence	5	0.739	**Objective 2**
8	REPD	Risk Effects on Project Delivery	5	0.794	
9	RARCV	Risk Associated with Underlisted Risk-causative Variables	11	0.711	
10	FOCC	Frequency Occurrence of Contractual Claims in Civil Infrastructure Projects	18	**0.827**	
11	BTC	By the Client	7	**0.756**	**Objective 3**
12	BTMC	By the Main Contractor	6	0.713	
13	BTCo	By the Consultant	4	0.706	
14	SFM	Strategies for Mitigation	10	0.722	
Total			**119**		

The reliability levels for all the questions fall within the internal consistency ranges of $0.800 \leq \alpha < 0.900$ and $0.700 \leq \alpha < 0.800$ respectively (Gliem and Gliem, 2003). These two ranges are classified as *excellent* and *good* internal reliability of data. The reliability test result prepares the data for further analysis (Gliem and Gliem, 2003; Acharya et al., 2006; Osborne, 2015).

6.4 FACTORS CAUSING CONTRACTUAL CLAIMS RISK IN CIVIL INFRASTRUCTURE PROJECT DELIVERY: OBJECTIVE 1

This section discusses factors that cause contractual claims risk in civil infrastructure project delivery. The extent to which identified variables/items contribute to the occurrence of contractual claims are discussed using a five point-Likert scale where 5 = Very important, 4 = Important, 3 = Slightly important, 2 = Not important, and 1 = Extremely unimportant. The internal consistency test results presented in section 6.3 for each Likert Scale question established the reliability of the responses acquired from the construction workers.

6.4.1 Client-related causes

In this section the importance of client-related causes (CRC) as one of the contributory factors to the occurrence of contractual claims risk in civil infrastructure projects is discussed. Data related to this section were collected through appropriate classification of the 5-point Likert scale as indicated in the survey by the respondents. Eight items were analysed to deduce the frequency and descriptive statistics scores of the Likert scales for each item after the derivation of the of Cronbach's Alpha coefficient of 0.847 as an indication of acceptable reliability levels. The Likert scale format applied 1 – 5 responses to enable the respondents to quantify the level of importance of each item identified under client-related causes (Acharya *et al.,* 2006). The responses collected were used to determine the impact of these items on the delivery of construction projects. The frequency scores of the items were computed to determine the distribution of responses across the Likert scales.

The descriptive data for client-related causes indicated mean scores above 3.00. In Table 6.7, CRC1 (delay in release of main contractor's claims by the client) has the most significance mean score of 4.37, followed by CRC2 (contractor selection process) with a mean score of 4.08, respectively. These two variables were ranked 'most' client related causes of contractual claims, with other items exhibiting impact below a mean score of 4.00. This shows the importance of all eight variables in identifying the causes of contractual claims risk relating to client involvement in civil infrastructure.

Table 6.8 presents the distribution of responses for four items with the strongest mean scores based on the perceptions of the respondents concerning client-related causes. The responses indicated that 48.2% of the respondents considered CRC1 'very important' in identifying client-related causes of contractual claims risk, while CRC2 (contractor selection process), CRC3 (changes in the design by the client due to environmental issues) and CRC6 (delays in taking possession of the site by the main contractors) were 'important'. Other distribution estimates for the remaining items are presented in Appendix E.

Table 6.7: Descriptive statistical results of items in client-related causes (CRC)

Descriptive Statistical Scores for Clients-Related Causes (CRC)								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
CRC1	Delay in release of main contractor's claims by the client	166	3.00	5.00	**4.37**	0.67	0.45	1
CRC2	Contractor selection process	166	2.00	5.00	**4.08**	0.77	0.59	2
CRC3	Changes in design by the client due to environmental issues	166	2.00	5.00	3.98	0.79	0.62	3
CRC6	Delays in taking possession of the site by the main contractors	166	2.00	5.00	3.80	0.76	0.58	4
CRC5	Delay in decision-making by the client	166	2.00	5.00	3.77	0.78	0.60	5
CRC4	Changes in the scope of the work by the client	166	1.00	5.00	3.72	0.80	0.64	6
CRC7	Poor communication and coordination between clients and the project team	166	1.00	5.00	3.63	0.80	0.63	7
CRC8	Client's financial problems	166	1.00	5.00	3.47	0.78	0.61	8

Table 6.8: Frequency scores of the first-four items ranked in client-related causes (CRC)

Frequency Scores for Client-Related Causes (CRC)								
Likert scales	**Delay in release of main contractor's claims by the client (CRC1)**				**Contractor selection process (CRC2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not important	0	0.0	0.0	0.0	3	1.8	1.8	1.8
3 = Slightly important	18	10.8	10.8	10.8	34	20.5	20.5	22.3
4 = Important	68	41.0	41.0	51.8	76	45.8	45.8	68.1
5 = Very important	80	48.2	48.2	**100.0**	53	31.9	31.9	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Changes in design by the client due to environmental issues (CRC3)**				**Delays in taking possession of the site by the main contractors (CRC6)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not important	4	2.4	2.4	2.4	7	4.2	4.2	4.2
3 = Slightly important	41	24.7	24.7	27.1	47	28.3	28.3	32.5
4 = Important	75	45.2	45.2	72.3	84	50.6	50.6	83.1
5 = Very important	46	27.7	27.7	**100.0**	28	16.9	16.9	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

The inter-item correlation matrix was computed to establish the association between the items as shown in Table 6.9. The data shows that all items are positively correlated, which signifies that they vary in the same direction. Among the first four principal client-related causes of contractual claims risk, CRC6 (delays in taking possession of the site by the main contractors) shows strongest relationship with CRC7 (poor communication and coordination between clients and the project team) (0.656). The association between the items in Table 6.9 specifies their strong interrelated impacts on the timely commencement of construction projects, except the association between CRC3 (changes in design by the client due to environmental issues) and CRC6 (delays in taking possession of the site by the main contractors) with least correlation (0.140). The higher the correlation between two items, the better the reliability. Therefore, the correlation between CRC6 and CRC7 indicates a better reliability model than the other correlations.

Table 6.9: Inter-item correlation matrix illustration of items in client-related causes (CRC)

Inter-Item Correlation Matrix for Client-Related Causes (CRC)									
Code	**Item**	**Delay in release of main contractor's claims by the client**	**Contractor selection process**	**Changes in design by the client due to environmental issues**	**Changes in the scope of the work by the client**	**Delay in decision-making by the client**	**Delays in taking possession of the site by the main contractors**	**Poor communication and coordination between clients and the project team**	**Client's financial problems**
		CRC1	**CRC2**	**CRC3**	**CRC4**	**CRC5**	**CRC6**	**CRC7**	**CRC8**
CRC1	Delay in release of main contractor's claims by the client	1.000	0.609	0.560	0.453	0.524	0.380	0.371	0.331
CRC2	Contractor selection process	0.609	1.000	0.620	0.380	0.344	**0.140**	0.185	0.230
CRC3	Changes in design by the client due to environmental issues	0.560	0.620	1.000	0.636	0.438	0.285	0.298	0.366
CRC4	Changes in the scope of the work by the client	0.453	0.380	0.636	1.000	0.523	0.306	0.277	0.258
CRC5	Delay in decision-making by the client	0.524	0.344	0.438	0.523	1.000	0.526	0.383	0.298
CRC6	Delays in taking possession of the site by the main contractors	0.380	**0.140**	0.285	0.306	0.526	1.000	**0.656**	0.501
CRC7	Poor communication and coordination between clients and the project team	0.371	0.185	0.298	0.277	0.383	**0.656**	1.000	0.628
CRC8	Client's financial problems	0.331	0.230	0.366	0.258	0.298	0.501	0.628	1.000

6.4.2 Contractor-related causes

The impact of contractor-related causes (CoRC) as one of the major causes of contractual claims risk in the civil infrastructure projects is determined through the analysis of 17 items. A Cronbach Alpha coefficient of 0.871 was obtained as an indication for acceptable reliability threshold for data collected for CoRC.

The descriptive results in Table 6.10 show that all the 17 items have mean scores above 3.00, which illustrates their significance in determining the impact of contractor-related causes. In the table, CoRC1 (main contractor's experience) and CoRC2 (main contractor poor cash-flow forecast) indicated the highest mean scores of 3.97 and 3.69 respectively, and therefore the highest ranked contractor-related causes, with other items indicating impact below a mean score of 3.60 as 'relative' client-related causes of contractor-related causes of contractual claims. The above results were further reinforced by presenting the distribution of responses in Table 6.11. The data shows that higher percentage of respondents agreed that CoRC1, CoRC2, CoRC11, and CoRC6 are all 'important' items in identifying the causes of contractual claims risk in construction projects. Refer to Appendix E for the rest of the data.

The correlation analysis conducted shows positive correlation results across all the seventeen items (Gliem and Gliem, 2003; Vogt and Johnson, 2015; Adeleke et al., 2019). This signifies that all 17 items positively influenced each other. From Table 6.12, CoRC1 (main contractor's experience) and CoRC2 (main contractor poor cash-flow forecast) demonstrated strongest correlation (0.553). The relationship between the items in Table 6.12 signifies strongly interrelated impacts on the timely delivery of construction projects. However, the association between CoRC3 (delay in supply of construction materials) and CoRC6 (lack of skilled management team) produced the lowest correlation (0.050). The correlation between CoRC1 and CoRC2 indicates the most reliable relationship as compared with the CoRC3 and CORC6.

Table 6.10: Descriptive statistical results of items in contractor-related causes (CoRC)

Descriptive Statistical Scores for Contractor-Related Causes (CoRC)								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
CoRC1	Main contractor's experience	166	2.00	5.00	**3.97**	0.74	0.55	1
CoRC2	Main contractor poor cash-flow forecast	166	1.00	5.00	**3.69**	0.75	0.56	2
CoRC11	Delay in getting licenses and approvals from the government by the main contractor	166	1.00	5.00	3.58	0.69	0.48	3
CoRC6	Lack of skilled management team	166	2.00	5.00	3.56	0.64	0.41	4
CoRC4	Inadequate site management by the main contractor	166	1.00	5.00	3.52	0.71	0.51	5
CoRC5	Low productivity of the main contractor workforce	166	1.00	5.00	3.49	0.78	0.60	6
CoRC7	Insufficient number of workers	166	2.00	5.00	3.49	0.69	0.48	6
CoRC9	Delay in mobilisation to project site by the main contractor	166	1.00	5.00	3.45	0.71	0.50	7
CoRC14	Shortage of equipment on site	166	1.00	5.00	3.45	0.70	0.49	7
CoRC8	Poor construction planning by the main contractor	166	1.00	5.00	3.45	0.74	0.55	7
CoRC12	Delayed salary payments to the main contractor's staff	166	2.00	5.00	3.43	0.62	0.38	8
CoRC3	Delay in supply of construction materials	166	2.00	5.00	3.42	0.63	0.40	9
CoRC10	Poor cost estimation by the main contractor	166	1.00	5.00	3.41	0.63	0.40	10
CoRC13	Lack of incentives for the workers	166	1.00	5.00	3.38	0.63	0.39	11
CoRC16	Lack of well-being facilities by the main contractor	166	1.00	5.00	3.37	0.69	0.48	12
CoRC15	Disagreement between the main contractor and the consultant	166	1.00	5.00	3.34	0.69	0.48	13
CoRC17	Inappropriate methods of construction	166	1.00	5.00	3.33	0.67	0.45	14

Table 6.11: Frequency scores of the first-four items in contractor-related causes (CoRC)

Frequency Scores for Contractor-Related Causes (CoRC)								
Likert scales	**Main contractor's experience (CoRC1)**				**Main contractor poor cash-flow forecast (CoRC2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	1	0.6	0.6	0.6
2 = Not important	2	1.2	1.2	1.2	3	1.8	1.8	2.4
3 = Slightly important	42	25.3	25.3	26.5	65	39.2	39.2	41.6
4 = Important	81	48.8	48.8	75.3	75	45.2	45.2	86.7
5 = Very important	41	24.7	24.7	**100.0**	22	13.3	13.3	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Delay in getting licenses and approvals from the government by the main contractor (CoRC11)**				**Lack of skilled management team (CoRC6)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	2	1.2	1.2	1.2	0	0.0	0.0	0.0
2 = Not important	3	1.8	1.8	3.0	5	3.0	3.0	3.0
3 = Slightly important	68	41.0	41.0	44.0	71	42.8	42.8	45.8
4 = Important	83	50.0	50.0	94.0	82	49.4	49.4	95.2
5 = Very important	10	6.0	6.0	**100.0**	8	4.8	4.8	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.12: Inter-item correlation matrix illustration of items in contractor-related causes (CoRC)

Inter-Item Correlation Matrix for Contractor-Related Causes (CoRC)																		
Code	**Item**	**Main contractors's experience**	**Main contractor poor cash-flow forecast**	**Delay in supply of construction materials**	**Inadequate site management by the main contractor**	**Low productivity of the main contractor workforce**	**Lack of skilled management team**	**Insufficient number of workers**	**Poor construction planning by the main contractor**	**Delay in mobilisation to project site by the main contractor**	**Poor cost estimation by the main contractor**	**Delay in getting licenses and approvals from the government by the main contractor**	**Delayed salary payments to the main contractors staff**	**Lack of incentives for the workers**	**Shortage of equipment on site**	**Disagreement between the main contractor and the consultant**	**Lack of well-being facilities by the main contractor**	**Inappropriate methods of construction**
		CoRC1	**CoRC2**	**CoRC3**	**CoRC4**	**CoRC5**	**CoRC6**	**CoRC7**	**CoRC8**	**CoRC9**	**CoRC10**	**CoRC11**	**CoRC12**	**CoRC13**	**CoRC14**	**CoRC15**	**CoRC16**	**CoRC17**
CoRC1	Main contractor's experience	1.000	**0.553**	0.439	0.374	0.342	0.267	0.311	0.332	0.291	0.272	0.307	0.227	0.155	0.271	0.256	0.294	0.299
CoRC2	Main contractor poor cash-flow forecast	**0.553**	1.000	0.354	0.468	0.384	0.283	0.239	0.276	0.269	0.286	0.319	0.310	0.242	0.350	0.288	0.322	0.341
CoRC3	Delay in supply of construction materials	0.439	0.354	1.000	0.111	0.307	**0.050**	0.280	0.286	0.227	0.207	0.182	0.125	0.195	0.126	0.217	0.086	0.272
CoRC4	Inadequate site management by the main contractor	0.374	0.468	0.111	1.000	0.434	0.279	0.271	0.317	0.242	0.307	0.213	0.189	0.154	0.203	0.221	0.319	0.196
CoRC5	Low productivity of the main contractor workforce	0.342	0.384	0.307	0.434	1.000	0.417	0.382	0.478	0.395	0.363	0.312	0.221	0.235	0.306	0.376	0.196	0.520
CoRC6	Lack of skilled management team	0.267	0.283	**0.050**	0.279	0.417	1.000	0.365	0.263	0.214	0.269	0.307	0.149	0.086	0.143	0.187	0.141	0.356
CoRC7	Insufficient number of workers	0.311	0.239	0.280	0.271	0.382	0.365	1.000	0.387	0.325	0.287	0.281	0.225	0.184	0.273	0.223	0.224	0.236
CoRC8	Poor construction planning by the main contractor	0.332	0.276	0.286	0.317	0.478	0.263	0.387	1.000	0.489	0.344	0.346	0.237	0.272	0.326	0.213	0.240	0.406
CoRC9	Delay in mobilisation to project site by the main contractor	0.291	0.269	0.227	0.242	0.395	0.214	0.325	0.489	1.000	0.354	0.330	0.256	0.143	0.348	0.305	0.259	0.306

Table 6.12 continued.

Inter-Item Correlation Matrix for Contractor-Related Causes (CoRC)																		
Code	Item	Main contractors experience	Main contractor poor cash-flow forecast	Delay in supply of construction materials	Inadequate site management by the main contractor	Low productivity of the main contractor workforce	Lack of skilled management team	Insufficient number of workers	Poor construction planning by the main contractor	Delay in mobilisation to project site by the main contractor	Poor cost estimation by the main contractor	Delay in getting licenses and approvals from the government by the main contractor	Delayed salary payments to the main contractors' staff	Lack of the incentives for the workers	Shortage of equipment on site	Disagreement between the main contractor and the consultant	Lack of well-being facilities by the main contractor	Inappropriate methods of construction
		CoRC1	CoRC2	CoRC3	CoRC4	CoRC5	CoRC6	CoRC7	CoRC8	CoRC9	CoRC10	CoRC11	CoRC12	CoRC13	CoRC14	CoRC15	CoRC16	CoRC17
CoRC10	Poor cost estimation by the main contractor	0.272	0.286	0.207	0.307	0.363	0.269	0.287	0.344	0.354	1.000	0.273	0.179	0.216	0.187	0.208	0.202	0.305
CoRC11	Delay in getting licenses and approvals from the government by the main contractor	0.307	0.319	0.182	0.213	0.312	0.307	0.281	0.346	0.330	0.273	1.000	0.276	0.190	0.241	0.312	0.269	0.303
CoRC12	Delayed salary payments to the main contractor's staff	0.227	0.310	0.125	0.189	0.221	0.149	0.225	0.237	0.256	0.179	0.276	1.000	0.308	0.405	0.138	0.314	0.206
CoRC13	Lack of incentives for the workers	0.155	0.242	0.195	0.154	0.235	0.086	0.184	0.272	0.143	0.216	0.190	0.308	1.000	0.384	0.219	0.272	0.374
CoRC14	Shortage of equipment on site	0.271	0.350	0.126	0.203	0.306	0.143	0.273	0.326	0.348	0.187	0.241	0.405	0.384	1.000	0.425	0.330	0.327
CoRC15	Disagreement between the main contractor and the consultant	0.256	0.288	0.217	0.221	0.376	0.187	0.223	0.213	0.305	0.208	0.312	0.138	0.219	0.425	1.000	0.381	0.396
CoRC16	Lack of well-being facilities by the main contractor	0.294	0.322	0.086	0.319	0.196	0.141	0.224	0.240	0.259	0.202	0.269	0.314	0.272	0.330	0.381	1.000	0.306
CoRC17	Inappropriate methods of construction	0.299	0.341	0.272	0.196	0.520	0.356	0.236	0.406	0.306	0.305	0.303	0.206	0.374	0.327	0.396	0.306	1.000

6.4.3 Consultant-related causes

The estimation of the internal consistency level of six Likert scale items under consultant-related causes (CsRC) yielded a Cronbach Alpha coefficient of 0.773, which signifies the adequacy threshold of the data collected. Descriptive data arrayed in Table 6.13 shows that all items produced mean scores greater than 3.00. CsRC1 (delay in approval of drawings by the consultants) has the highest mean score of 4.28, followed by CsRC2 (delay in site inspection by the consultant) (3.82) as 'most' ranked consultant-related causes, with other items signifying impact below a mean score of 3.70.

Table 6.13: Descriptive statistical results of items in consultant-related causes (CsRC)

Descriptive Statistical Scores for Consultant-Related Causes (CsRC)								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
CsRC1	Delay in approval of drawings by the consultants	166	2.00	5.00	**4.28**	0.69	0.48	1
CsRC2	Delay in site inspection by the consultant	166	1.00	5.00	**3.82**	0.79	0.62	2
CsRC4	Lack of experience by the consultant's staff	166	1.00	5.00	3.67	0.73	0.53	3
CsRC3	Slow response by the consultant to contractor's enquiries	166	1.00	5.00	3.61	0.70	0.49	4
CsRC5	Poor quality control by the consultant	166	1.00	5.00	3.60	0.72	0.52	5
CsRC6	Misunderstanding of the client's requirements by the consultant	166	1.00	5.00	3.58	0.76	0.59	6

Table 6.14 shows distributions of responses representing the perceptions of respondents on the six items. A considerable number of respondents identified all four items as important in determining consultant-related causes of contractual claims risk. 88.6% respondents considered CsRC1 (delay in approval of drawings by the consultants) important or very important, followed by CsRC2 (delay in site inspection by the consultant) with 66.3% respondents, CsRC4 (lack of experience by the consultant's staff) with 58.4% respondents and CsRC3 (slow response by the consultant to contractor's enquiries) with 55.4% respondents. See Appendix E for the complete distribution of responses for the rest items under CsRC.

The inter-item correlation results in Table 6.15 show a positive correlation across the six items, which signifies that they all positively influenced each other. CsRC1 (delay in approval of drawings by the consultants) and CsRC2 (delay in site inspection by the consultant) have the highest correlation of 0.558. The lowest correlation coefficient of 0.267 was observed between CsRC3 (slow response by the consultant to contractor's enquiries) and CsRC4 (lack of experience by the consultant's staff). The association between CsRC3 and CsRC4 implies a poor reliability (Gliem and Gliem, 2003; Vogt and Johnson, 2015).

Table 6.14: Frequency scores of the first-four items in consultant-related causes (CsRC)

Frequency Scores for Consultant-Related Causes (CsRC)								
Likert scales	**Delay in approval of drawings by the consultants (CsRC1)**				**Delay in site inspection by the consultant (CsRC2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	1	0.6	0.6	0.6
2 = Not important	2	1.2	1.2	1.2	4	2.4	2.4	3.0
3 = Slightly important	17	10.2	10.2	11.4	51	30.7	30.7	33.7
4 = Important	79	47.6	47.6	59.0	78	47.0	47.0	80.7
5 = Very important	68	41.0	41.0	**100.0**	32	19.3	19.3	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Lack of experience by the consultant's staff (CsRC4)**				**Slow response by the consultant to contractor's enquiries (CsRC3)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	1	0.6	0.6	0.6	2	1.2	1.2	1.2
2 = Not important	3	1.8	1.8	2.4	1	0.6	0.6	1.8
3 = Slightly important	65	39.2	39.2	41.6	71	42.8	42.8	44.6
4 = Important	78	47.0	47.0	88.6	78	47.0	47.0	91.6
5 = Very important	19	11.4	11.4	**100.0**	14	8.4	8.4	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.15: Inter-item correlation matrix illustration of items in consultant-related causes (CsRC)

Inter-Item Correlation Matrix for Consultant-Related Causes (CsRC)							
Code	**Item**	**Delay in approval of drawings by the consultants**	**Delay in site inspection by the consultant**	**Slow response by the consultant to contractor' s enquiries**	**Lack of experience by the consultant's staff**	**Poor quality control by the consultant**	**Misunderstanding of the client's requirements by the consultant**
		CsRC1	**CsRC2**	**CsRC3**	**CsRC4**	**CsRC5**	**CsRC6**
CsRC1	Delay in approval of drawings by the consultants	1.000	0.558	0.402	0.380	0.350	0.386
CsRC2	Delay in site inspection by the consultant	**0.558**	1.000	0.473	0.319	0.340	0.375
CsRC3	Slow response by the consultant to contractor's enquiries	0.402	0.473	1.000	**0.267**	0.356	0.289
CsRC4	Lack of experience by the consultant's staff	0.380	0.319	**0.267**	1.000	0.276	0.326
CsRC5	Poor quality control by the consultant	0.350	0.340	0.356	0.276	1.000	0.349
CsRC6	Misunderstanding of the client's requirements by the consultant	0.386	0.375	0.289	0.326	0.349	1.000

6.4.4 External causes

The descriptive results for the external causes (ExC) were derived with similar approach to analysis of preceding related causes of contractual claims risk. The reliability level for all six items under external causes yielded a Cronbach's Alpha coefficient of 0.712 for the data collected. The results contained in Table 6.16 show that all six items have mean scores above 3.00, meaning they are significant in determining the external causes of contractual claims risks. Data shows that ExC1 (unpredictable soil conditions) had the highest mean score of 4.07, followed by ExC2 (bad weather conditions) (3.55), ExC3 (control by the government and restrictions on the site) (3.51), and ExC4 (civil disturbance) (3.50) as highest ranked external causes of contractual causes in civil infrastructure projects, with other items indicating impact below a mean score of 3.40.

Table 6.16: Descriptive statistical results of items in external causes (ExC)

Descriptive Statistical Scores for External Causes (ExC)								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
ExC1	Unpredictable soil conditions	166	2.00	5.00	**4.07**	0.66	0.43	1
ExC2	Bad weather conditions (excessive rainfall, winter storms and high temperatures)	166	3.00	5.00	3.55	0.60	0.36	2
ExC3	Control by the government and restrictions on the site	166	2.00	5.00	3.51	0.64	0.41	3
ExC4	Civil disturbance	166	2.00	5.00	3.50	0.76	0.58	4
ExC5	Unforeseen site condition	166	1.00	5.00	3.35	0.75	0.57	5
ExC6	Price fluctuation	166	1.00	5.00	3.24	0.73	0.54	6

Table 6.17 shows the distribution of responses across the six items for the external causes. The responses indicated that 83.10% respondents considered ExC1 (unpredictable soil conditions) important or very important in determining the external causes of contractual claims risk, followed by ExC2 (bad weather conditions) with 49.4% respondents, ExC3 (control by the government and restrictions on the site) with 47.6% respondents, and ExC4 (civil disturbance) with 48.2% respondents.

The inter-item correlation results in Table 6.18 shows a positive correlation. Observations also indicate that ExC1 (unpredictable soil conditions) and ExC2 (bad weather conditions) exhibited the strongest correlation of 0.454, while ExC2 (bad weather conditions) and ExC3 (control by the government and restrictions on the site) had the lowest correlation of 0.047. This clearly shows that ExC1 and ExC2 demonstrate the best reliability compared to ExC3 and ExC2, which demonstrated the poorest reliability (Gliem and Gliem, 2003; Vogt and Johnson, 2015).

Table 6.17: Frequency scores of the first-four items in external causes (ExC)

Frequency Scores for External Causes (ExC)								
Likert scales	**Unpredictable soil conditions (ExC1)**				**Bad weather conditions (excessive rainfall, winter storms and high temperatures) (ExC2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not important	1	0.6	0.6	0.6	0	0.0	0.0	0.0
3 = Slightly important	27	16.3	16.3	16.9	84	50.6	50.6	50.6
4 = Important	97	58.4	58.4	75.3	73	44.0	44.0	94.6
5 = Very important	41	24.7	24.7	**100.0**	9	5.4	5.4	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Control by the government and restrictions on the site (ExC3)**				**Civil disturbance (ExC4)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not important	4	2.4	2.4	2.4	12	7.2	7.2	7.2
3 = Slightly important	83	50.0	50.0	52.4	74	44.6	44.6	51.8
4 = Important	70	42.2	42.2	94.6	65	39.2	39.2	91.0
5 = Very important	9	5.4	5.4	**100.0**	15	9.0	9.0	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.18: Inter-item correlation matrix illustration of items in external causes (ExC)

Inter-Item Correlation Matrix for External Causes (ExC)							
Code	**Item**	**Unpredictable soil conditions**	**Bad weather conditions (excessive rainfall, winter storms and high temperatures)**	**Control by the government and restrictions on the site**	**Civil disturbance**	**Unforeseen site condition**	**Price fluctuation**
		ExC1	**ExC2**	**ExC3**	**ExC4**	**ExC5**	**ExC6**
ExC1	Unpredictable soil conditions	1.000	**0.454**	0.389	0.425	0.402	0.342
ExC2	Bad weather conditions (excessive rainfall, winter storms and high temperatures)	**0.454**	1.000	**0.047**	0.246	0.271	0.126
ExC3	Control by the government and restrictions on the site	0.389	**0.047**	1.000	0.187	0.209	0.165
ExC4	Civil disturbance	0.425	0.246	0.187	1.000	0.402	0.327
ExC5	Unforeseen site condition	0.402	0.271	0.209	0.402	1.000	0.352
ExC6	Price fluctuation	0.342	0.126	0.165	0.327	0.352	1.000

6.4.5 Finance-related causes

Finance-related issues (FiR) can also cause contractual claims risks in civil infrastructure projects. The items evaluated under FiR yielded a Cronbach's Alpha coefficient of 0.749, implying an acceptable reliability level. Table 6.19 shows that all the 5 items produced mean scores above 3.00, which indicates that financial issues contribute to the cause of contractual claims risks. FiR1 (financing difficulties of contractor) was identified as the highest ranked finance related cause of contractual claims risk in construction project delivery with a mean score of 4.07, followed by FiR2 (financing difficulties of owner) with a mean score of 3.66, FiR3 (effects of global economy/unforeseeable financial and economic crises) and FiR4 (high interest on loans and overdrafts for contractors) with an equal mean score of 3.43, and FiR5 (changes in government policy on prices of construction materials) with a lowest mean score of 3.30.

The perceptions of the respondents pertaining to the four items with the highest mean scores are presented in Table 6.20. The result showed that 84.3% respondents agreed that FiR1 was important or very important in identifying the cause of contractual claims risk in civil infrastructure projects pertaining to financial related causes. Further results indicated that 54.3% respondents found FiR2 (financing difficulties of owner) important or very important, followed by FiR3 (effects of global economy/unforeseeable financial and economic crises) with 42.1% respondents, and FiR4 (high interest on loans and overdraft to contractor) with 40.3% respondents. See Appendix E for the remaining data.

Table 6.19: Descriptive statistical results of items in finance-related (FiR)

Descriptive Statistical Scores for Finance-Related (FiR)								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
FiR1	Financing difficulties of contractor	166	2.00	5.00	**4.07**	0.74	0.55	1
FiR2	Financing difficulties of owner	166	2.00	5.00	**3.66**	0.79	0.63	2
FiR4	High interest on loans and overdraft to contractor	166	1.00	5.00	3.43	0.79	0.62	3
FiR3	Effects of global economy/unforeseeable financial and economic crises	166	1.00	5.00	3.43	0.78	0.61	3
FiR5	Change in government policy on prices of construction materials	166	2.00	5.00	3.30	0.76	0.57	4

Table 6.20: Frequency scores of the first-four items in finance-related (FiR)

Frequency Scores for Finance Related (FiR)								
Likert scales	**Financing difficulties of contractor (FiR1)**				**Financing difficulties of owner (FiR2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not important	7	4.2	4.2	4.2	7	4.2	4.2	4.2
3 = Slightly important	19	11.4	11.4	15.7	69	41.6	41.6	45.8
4 = Important	95	57.2	57.2	72.9	64	38.6	38.6	84.3
5 = Very important	45	27.1	27.1	**100.0**	26	15.7	15.7	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**High interest on loans and overdrafts for contractors (FiR4)**				**Effects of global economy/unforeseeable financial and economic crises (FiR3)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	1	0.6	0.6	0.6	1	0.6	0.6	0.6
2 = Not important	11	6.6	6.6	7.2	12	7.2	7.2	7.8
3 = Slightly important	87	52.4	52.4	59.6	83	50.0	50.0	57.8
4 = Important	50	30.1	30.1	89.8	55	33.1	33.1	91.0
5 = Very important	17	10.2	10.2	**100.0**	15	9.0	9.0	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

In Table 6.21, the inter-item correlation results show positive correlations, which means that all five items influenced each other positively. FiR1 (financing difficulties of contractor) and FiR2 (financing difficulties of owner) are highly correlated (0.465). The relationship between FiR1 and FiR2 demonstrates a reliable correlation, while the relationship between FiR2 and FiR4 demonstrates a poor correlation with a lowest correlation coefficient of 0.266 (Gliem and Gliem, 2003; Vogt and Johnson, 2015).

Table 6.21: Inter-item correlation matrix illustration of items in finance-related (FiR)

Inter-Item Correlation Matrix for Finance Related (FiR)						
Code	**Item**	**Financing difficulties of contractor**	**Financing difficulties of owner**	**Effects of global economy/unfore-seeable financial and economic crises**	**High interest on loans and overdraft to Contractor**	**Change in government policy on prices of construction materials**
		FiR1	**FiR2**	**FiR3**	**FiR4**	**FiR5**
FiR1	Financing difficulties of contractor	1.000	**0.465**	0.427	0.350	0.457
FiR2	Financing difficulties of owner	**0.465**	1.000	0.366	**0.266**	0.393
FiR3	Effects of global economy/unforeseeable financial and economic crises	0.427	0.366	1.000	0.311	0.298
FiR4	High interest on loans and overdrafts for contractors	0.350	**0.266**	0.311	1.000	0.417
FiR5	Change in government policy on prices of construction materials	0.457	0.393	0.298	0.417	1.000

6.4.6 Contractual risk factors

The descriptive data presented in Table 6.22 depict the mean scores of 11 items under contractual risk factors. The internal consistency test conducted yielded a Cronbach Alpha coefficient of 0.701, which falls within the acceptable range for internal reliability of data. All items had mean scores above 3.00. The mean scores obtained indicate that CRF1 (contract modifications) has the highest mean score of 4.02, followed by CRF2 (poor contract management) (3.75), CRF3 (payment method during construction) (3.68), CRF5 (omission and errors in contract documents) (3.63), and CRF4 (inadequate definition of substantial completion) (3.62) as the highest ranked contractual risk factors with the other items having impact below a mean score of 3.60.

Table 6.23 contains the frequency distribution of responses across the four items with the highest mean scores. 77.1% respdondents considered CRF1 (contract modifications) sifnificant or very significant in identifying the causes of contractual claims risk, followed by

CRF2 (poor contract management) with 60.3% respondents, CRF5 (omission and errors in contract documents) with 57.8% respondents, and CRF3 (payment method during construction) with 56.1%. See Appendix E for the remaining data.

Inter-item correlation analysis conducted shows positive and negative correlations of items as given in Table 6.24. The analysis signifies that some items are positively associated with each other, while others are negatively associated with each other. The association between CRF1 (contract modifications) and CRF2 (poor contract management) has the most positive correlation coefficient of 0.376, which signifies a strong correlation as both items affect each other in the same direction (Gliem and Gliem, 2003; Vogt and Johnson, 2015). Among these items, only CRF8 (slow information flow between parties) and CRF9 (poor communication/coordination between consultant and other parties) had the lowest negative correlation coefficient of -0.012, signifying a poor correlation as both items affect each other in opposite directions (Gliem and Gliem, 2003; Vogt and Johnson, 2015).

Table 6.22: Descriptive statistical results of items in contractual risk factors

Descriptive Statistical Scores for contractual risk factors								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
CRF1	Contract modifications	166	2.00	5.00	**4.02**	0.79	0.62	1
CRF2	Poor contract management	166	2.00	5.00	**3.75**	0.79	0.63	2
CRF3	Payment method during construction	166	2.00	5.00	3.68	0.76	0.58	3
CRF5	Omission and errors in contract documents	166	2.00	5.00	3.63	0.74	0.55	4
CRF4	Inadequate definition of substantial completion	166	1.00	5.00	3.62	0.79	0.63	5
CRF6	Legal disputes and Inappropriate method of dispute resolution	166	2.00	5.00	3.54	0.72	0.52	6
CRF9	Poor communication/coordination between consultant and other parties	166	2.00	5.00	3.48	0.78	0.60	7
CRF8	Slow information flow between parties	166	2.00	5.00	3.46	0.74	0.54	8
CRF11	Poor communication and coordination by contractor with other parties	166	1.00	5.00	3.33	0.80	0.64	9
CRF7	Type of contract procurement method	166	1.00	5.00	3.33	0.68	0.47	9
CRF10	Lack of communicating the requirements by owner	166	2.00	5.00	3.31	0.70	0.50	10

Table 6.23: Frequency scores of the first-four items in contractual risk factors

Frequency Scores for contractual risk factors								
Likert scales	**Contract modifications (CRF1)**				**Poor contract management (CRF2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely insignificant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not significant	6	3.6	3.6	3.6	6	3.6	3.6	3.6
3 = Slightly significant	32	19.3	19.3	22.9	60	36.1	36.1	39.8
4 = Significant	81	48.8	48.8	71.7	70	42.2	42.2	81.9
5 = Very significant	47	28.3	28.3	**100.0**	30	18.1	18.1	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Payment method during construction (CRF3)**				**Omission and errors in contract documents (CRF5)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely insignificant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not significant	5	3.0	3.0	3.0	9	5.4	5.4	5.4
3 = Slightly significant	68	41.0	41.0	44.0	61	36.7	36.7	42.2
4 = Significant	68	41.0	41.0	84.9	79	47.6	47.6	89.8
5 = Very significant	25	15.1	15.1	**100.0**	17	10.2	10.2	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.6.24: Inter-item correlation matrix illustration of items in contractual risk factors

Code	Item	Contract modifications CRF1	Poor contract management CRF2	Payment method during construction CRF3	Inadequate definition of substantial completion CRF4	Omission and errors in contract documents CRF5	Legal disputes and Inappropriate method of dispute resolution CRF6	Type of contract procurement method CRF7	Slow information flow between parties CRF8	Poor communication/coordin-ation between consultant and other parties CRF9	Lack of communicating the requirements by owner CRF10	Poor communication and coordination by contractor with other parties CRF11
CRF1	Contract modifications	1.000	**0.376**	0.362	0.205	0.115	0.164	0.124	0.048	0.272	0.164	0.270
CRF2	Poor contract management	**0.376**	1.000	0.267	0.262	0.158	0.091	0.123	0.088	0.249	0.111	0.268
CRF3	Payment method during construction	0.362	0.267	1.000	0.320	0.238	0.214	0.076	0.255	0.128	0.210	0.175
CRF4	Inadequate definition of substantial completion	0.205	0.262	0.320	1.000	0.336	0.232	0.122	0.127	0.004	0.215	0.133
CRF5	Omission and errors in contract documents	0.115	0.158	0.238	0.336	1.000	0.139	0.162	0.108	0.041	0.075	0.108
CRF6	Legal disputes and Inappropriate method of dispute resolution	0.164	0.091	0.214	0.232	0.139	1.000	0.105	0.214	0.077	0.229	0.122
CRF7	Type of contract procurement method	0.124	0.123	0.076	0.122	0.162	0.105	1.000	0.199	0.280	0.098	0.131
CRF8	Slow information flow between parties	0.048	0.088	0.255	0.127	0.108	0.214	0.199	1.000	**-0.012**	0.162	0.233
CRF9	Poor communication/coordination between consultant and other parties	0.272	0.249	0.128	0.004	0.041	0.077	0.280	**-0.012**	1.000	0.155	0.191
CRF10	Lack of communicating the requirements by owner	0.164	0.111	0.210	0.215	0.075	0.229	0.098	0.162	0.155	1.000	0.279
CRF11	Poor communication and coordination by contractor with other parties	0.270	0.268	0.175	0.133	0.108	0.122	0.131	0.233	0.191	0.279	1.000

Inter-Item Correlation Matrix for contractual risk factors

6.4.7 Identifying underlying factors causing contractual claims risk in civil infrastructure projects

The need to identify the underlying factors causing contractual claims in civil infrastructure projects is to have a simpler interpretation of the structural association between observed and unobserved variables. The data were analysed by applying a multivariate approach, such as FA, to establish the interrelationship patterns between items with smaller numbers of underlying variables as well as ensuring that essential information was retained (Chan *et al.,* 2012; Yong and Pearce, 2013; Ershadi *et al.,* 2019; Civelek, 2018; Schumacker and Lomax, 2021). The findings obtained from the descriptive analysis (section 6.4) do not result iin conclusive deductions, thus it is essential to conduct the FA procedure to determine the underlying factors that could be causing contractual claims risk in civil infrastructure projects (Yong and Pearce, 2013; Westland, 2015). PCA was also used to enhance reliable selection of a subset of highly predictive items (variables) from a group of items (Amemiya, 1966; Yong and Pearce, 2013; Westland, 2015). Some established criteria were observed in the process of performing the analysis. These are as follows:

- Ensure that a factor has at least three variables; any fewer must demonstrate a correlation $r > 0.700$ before being considered (Gliem and Gliem, 2003; Yong and Pearce, 2013; Vogt and Johnson, 2015; Civelek, 2018; Senthilnathan, 2019).
- Correlation amongst items (variables) must be computed to ascertain the level of relatedness (Westland, 2015).
- Ensure a correlation $r \geq 0.300$ to minimise internal inconsistency in the data (Yong and Pearce, 2013; Westland, 2015; Civelek, 2018).
- Ensure a high number of observations for each item (variable), because a large sample size will minimise error occurrence (Weston and Jr, 2006; Hoyle, 2009; Westland, 2015; Civelek, 2018).
- Compute Kaiser-Meyer-Olkin (KMO) > 0.50 and Bartlett's test of sphericity < 0.05 to determine if there are sufficient items and substantial correlation in the data (Civelek 2018).
- Factor loadings < 0.500 are considered unfit due to the sample size (Andrew, 2016).
- Variables with cross-loading ≥ 0.500 (significant) on factors in the pattern analysis are considered, but if there is more than one significant cross-loading on factors, such variables are disregarded (Andrew, 2016; Civelek, 2018).

The criteria were attained, which signifies that all the items (variables) pertaining to the determination of the factors causing contractual claims risk in civil infrastructure projects are suitable for use in the analysis. The KMO test measures the sampling adequacy of the items (data) between 0 and 1 (Civelek, 2018), where values close to one are considered better. Bartlett's test of sphericity measures the substantiality of correlation in data by rejecting a null hypothesis that states that a 'correlation matrix is an identity matrix'. In this case, an identity matrix is described as a matrix wherein all the diagonal elements are one, while off the diagonal elements are zero (Yong and Pearce, 2013; Civelek, 2018). This literally implies that variables are uncorrelated and unsuitable for dimensional reduction of data (Yong and Pearce, 2013; Civelek, 2018).

According to statistical studies, a KMO test measure higher than 0.70 is considered *average*, while higher than 0.80 is *good,* and higher than 0.90 is *excellent* (Yong and Pearce, 2013; Civelek, 2018). In this study, all the test scores are within the acceptable range. This specifies that the information characterised by these items correlate well with each other as well as being sufficient for the FA procedure. For Bartlett's test of sphericity, the acceptable value is $p<0.50$. This signifies that the test rejects a null hypothesis that the 'correlation matrix is an identity matrix'. The test scores established that there is a significant correlation among items since they are within the acceptable scale. This explains that all the questions are appropriately adequate for FA procedure.

6.4.7.1 KMO test and Bartlett's sphericity test of client-related causes

The significance and adequacy of the items in client-related causes (CRC) for the purpose of FA was quantified by conducting the KMO and Bartlett's sphericity tests. The test scores derived are presented in Table 2.25, wherein the KMO test score was 0.80 and Bartlett's test sphericity value was $p=0.00$ (Yong and Pearce, 2013; Andrew, 2016; Civelek, 2018). The two test scores established that the data are fit and adequate for the application of FA.

Table 6.25: KMO test and Bartlett's sphericity test scores for client-related causes (CRC)

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of Sphericity		Observations
CRC	0.80	Approx. Chi-Square	584.93	Items are significant and adequate for FA
		df	28	
		Sig.	0.00	

6.4.7.2 Communality estimates of items in client-related causes

Communality is the next stage after establishing that CRC is adequate and significant for FA. This section ascertains the amount of variation that can be explained in a variable as illustrated in Table 6.26. Yong and Pearce (2013) described communality as the sum of the squared loading of an item in all correlated factors. It can also be described as the estimate of each item's variance that could be explained by the underlying factors (factors extracted) (Vehkalahti, 2000; Huang and Abdel-Aty, 2010; Yong and Pearce, 2013; Schumacker and Lomax, 2021). The standard interpretation of communality establishes that the closer the proportion (percentage) of variation in a variable is to 1.00, the better the factor analysis (FA) explained (Schumacker and Lomax, 2021). This means that items with communality proportions closer to 1.00 suggest that FA explains most of the variation for those items (Yong and Pearce, 2013).

Table 6.26: Communalities of items in client-related causes (CRC)

Communality Proportions of Items in Client-Related Causes (CRC)			
Code	**Item**	**Initial**	**Extraction**
CRC1	Delay in release of main contractor's claims by the client	1.00	0.66
CRC2	Contractor selection process	1.00	0.68
CRC3	Changes in design by the client due to environmental issues	1.00	**0.74**
CRC4	Changes in the scope of the work by the client	1.00	0.57
CRC5	Delay in decision-making by the client	1.00	0.54
CRC6	Delays in taking possession of the site by the main contractors	1.00	**0.74**
CRC7	Poor communication and coordination between clients and the project team	1.00	**0.78**
CRC8	Client's financial problems	1.00	0.62

The communalities of the CRC causing contractual claims risk were computed to demonstrate the proportion of variation in the eight items that can be explained by the factors extracted (Vehkalahti, 2000). Table 6.26 shows that CRC yielded communality proportions above 0.40, which signifies adequate performance of the factor of the eight items (Yong and Pearce, 2013). A simplified understanding of the results indicate that decent proportions of variation (in bold) were observed in CRC7 (poor communication and coordination between clients and the project team), followed by CRC6 (delays in taking possession of the site by the main contractors) and CRC3 (changes in design by the client due to environmental issues). This explains that the correlation is better for the three items than other items because factors extracted explain more of variance in these items (Yong and Pearce, 2013; Civelek, 2018). Nonetheless, all the eight items exhibited adequatecommunality proportions.

6.4.7.3 Total variance of items explained in client-related causes

Total variance of CRC explained was computed in relation to the communality estimates derived. The total variance provides estimates on the underlying factors that can be extracted through the amount of variance explained. This stage enhances simplified interpretation of results to guide the understanding of CRC causing contractual risk (Yong and Pearce, 2013; Civelek, 2018). The eigenvalues index of ≥1.00 signifies factor extract ranges to indicate percentage of variance explained relating to CRC causing contractual claims risk in construction projects (Schumacker and Lomax, 2021; Yong and Pearce, 2013). The illustration was visually interpreted by plotting a scree graph in Appendix E to validate the point of factor extraction displayed in Table 6.27. The scree plot presents a visual comparison of the eigenvalues to the number of factors that are significant. The graph indicates that only two factors should be retained (Yong and Pearce, 2013; Osborne, 2015). This inference is made based on the dimensions of eigenvalues within ≥ 1.00 (elbow joint) of the line graph, which indicates no further extraction of factors (Vehkalahti, 2000; Yong and Pearce, 2013; Schumacker and Lomax, 2021).

In this study, the eigenvalue index is used as the standard measure to determine the number of factors to retain. Only the factors within this range are considered most significant. The most interesting part is that the total variance of these factors is equal to the number of items (variables) used in the analysis (Vehkalahti, 2000; Yong and Pearce, 2013; Osborne, 2015; Ncube and Moroke, 2016; Schumacker and Lomax, 2021).

In essence, the number of factors required to reflect the underlying pattern of the original data is numerically illustrated with initial eigenvalues. Table 6.27 shows that only two factors explained a great amount of variance within the extraction range of eigenvalue ≥1.00. These two factors were the most significant among the eight items, with a cumulative percentage above 50%. The cumulative proportion relatively decreases in value from factors 3 – 8, which indicates that only the two factors yielded extractable loadings from the total variance accounted for in CRC.

Factors 1 and 2 have eigenvalues of 3.89 and 1.43 respectively, as optimal number of extractable loadings from the total variance explained in CRC. According to the statistics in Table 6.27, factor 1 explained nearly 50% variability in the data and factor 2 less than 20%. This signifies that factor 1 will have a higher amount of loadings compared to factor 2. It can also be stated that more items contributed to factor 1 than factor 2. Therefore, it is understood that these two factors influenced the items (variables) at a maximum cumulative proportion of 66.56%, which implies that only this proportion of variation is adequately explained in the data pertaining to CRC; it also indicates the strength of the correlation between the items and the two factors (Yong and Pearce, 2013; Osborne, 2015; Civelek, 2018; Schumacker and Lomax, 2021).

Table 6.27: Total variance of items explained in client-related causes (CRC)

Total Variance Explained in Client-Related Causes (CRC)							
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.89	48.67	48.67	3.89	48.67	48.67	3.37
2	1.43	17.88	66.56	1.43	17.88	66.56	2.93
3	0.77	9.68	76.23				
4	0.63	7.82	84.05				
5	0.38	4.69	88.74				
6	0.35	4.33	93.07				
7	0.30	3.77	96.84				
8	0.25	3.16	100.00				

The variance distribution among extracted factors were redistributed to facilitate explainable results. The process considered oblique rotations, wherein a direct oblimin rotation method with Kaiser normalisation was utilised to measure the correlation amongst items and factors (O'Rourke and Hatcher, 2013; Osborne, 2015). The process minimises the anomalies that may render the structure of factor loadings inexplainable, by ensuring that each item (variable) is adequately distributed. Factor 1 yielded a rotation loading of 3.37 and factor 2 yielded an improved rotation loading of 2.93.

6.4.7.4 Factor loadings of items in CRC

A factor loading as high as 0.300 is excluded (Osborne, 2015), with a factor loading as low as 0.500 considered significant in dimension for CRC to cause contractual claims risk (Meyers et al., 2015; Costello and Osborne, 2019). This dimension was considered to remove any clustering of unfit loadings in the FA of CRC. This technique was applied throughout the analysis of other related causes. In Table 6.28, a positive correlation was observed between factors 1 and 2 because of the total variance explained by the two factors. The pattern matrix shows that the two factors varied mutually with their items. In this study, the pattern matrix was considered the most appropriate solution for identifying the underlying factors or risks affecting project delivery.

In Table 6.28, the results of the factor matrix are too complex to interpret due to a high amount of cross-loadings as a result of one-sided variability distribution (Yong and Pearce, 2013; Osborne, 2015). Therefore, they are not considered in this study; only the pattern and structure matrices are considered applicable in determining the factor causing contractual claims risk. The result was considered unusable; therefore, oblique rotations (refer to subsection 6.4.7.3) were conducted to generate the results in the pattern matrix and structure matrix in order to have a better interpretation (O'Rourke and Hatcher, 2013; Osborne, 2015). The pattern matrix offers clarity on the 'linear combination' of the items on factors (Yong and Pearce, 2013; O'Rourke and Hatcher, 2013) and the structure matrix demonstrates the 'correlation' between items and factors (O'Rourke and Hatcher, 2013; Osborne, 2015).

In the pattern matrix, data indicate that five items are loaded on factor 1, and four items on factor 2, with only one cross-loading item on each factor. Only the cross-loading score of 0.508 on factor 1 is significantly fit because of its high loading within the acceptable range. According to the result, CRC2 (contractor selection process) (0.881), CRC3 (changes in design by the client due to environmental issues) (0.857), CRC1 (delay in release of main contractor's claims by the client) (0.744), CRC4 (changes in the scope of the work by the client) (0.729), and CRC5 (delay in decision-making by the client) are linearly converged on factor 1, whereas CRC7 (poor communication and coordination between clients and the project team) (0.897), CRC6 (delays in taking possession of the site by the main contractors) (0.861), and CRC8 (client's financial problems) (0.771) are linearly converged on factor 2 as most significant loadings. These items contribute significantly to the factors as concerning CRC causing contractual claims risk. In addition, the interrelationship patterns between these items established the impact of these factors as underlying causes of contractual claims risk in civil infrastructure projects pertaining to CRC.

Table 6.28: Factor matrix, pattern matrix, and structure matrix of items in client-related causes (CRC)

Factor Loadings of Items in Client-Related Causes (CRC)							
Code	**Item**	**Unrotated Loadings Result**		**Rotated Loadings Result**			
		Factor Matrix		**Pattern Matrix**		**Structure Matrix**	
		Factor 1	**Factor 2**	**Factor 1**	**Factor 2**	**Factor 1**	**Factor 2**
CRC1	Delay in release of main contractor's claims by the client	**0.768**		**0.744**		**0.800**	0.438
CRC2	Contractor selection process	**0.629**	**-0.530**	**0.881**		**0.803**	
CRC3	Changes in design by the client due to environmental issues	**0.763**	-0.395	**0.857**		**0.859**	0.347
CRC4	Changes in the scope of the work by the client	**0.695**		**0.729**		**0.754**	0.355
CRC5	Delay in decision-making by the client	**0.732**		**0.508**	0.361	**0.653**	**0.565**
CRC6	Delays in taking possession of the site by the main contractors	**0.675**	**0.538**		**0.861**	0.349	**0.863**
CRC7	Poor communication and coordination between clients and the project team	**0.671**	**0.577**		**0.897**	0.328	**0.884**
CRC8	Client's financial problems	**0.634**	0.466		**0.771**	0.346	**0.786**

The pattern matrix is further substantiated with the structure matrix to provide additional understanding of the association between factors and items. All eight items are positively correlated with factor 1 and factor 2, as principal underlying causes of contractual claims risk. In effect, this demonstrates the strong dependability between factors and items as principal causes.

6.4.7.5 Path diagram for client-related causes

The path diagram provides the virtual structural modelling of the pattern between factors and the variables (Ingram et al., 2000; Streiner, 2005; Suhr, 2008). This approach was established through the application of confirmatory analysis as part of SEM (Streiner, 2005; Suhr, 2006; Suhr, 2008). The path diagram is a diagrammatical model representation of factors and error (e) variances with the items (Yong and Pearce, 2013; Civelek, 2018). In other words, the model presents the loading scores indicating the influence of the factors over the items (Streiner, 2005; Suhr, 2008). The correlation links (arrow lines) in the diagram display the weight of their association as shown in Figure 6.1. The path model was constructed on AMO Graphics IBM SPSS Statistics 23 (Ingram *et al.,* 2000; Civelek, 2018). In the path model, the items (variables) are denoted as endogenous variables converged on the factors. They are endogenous because they give error (e) terms.

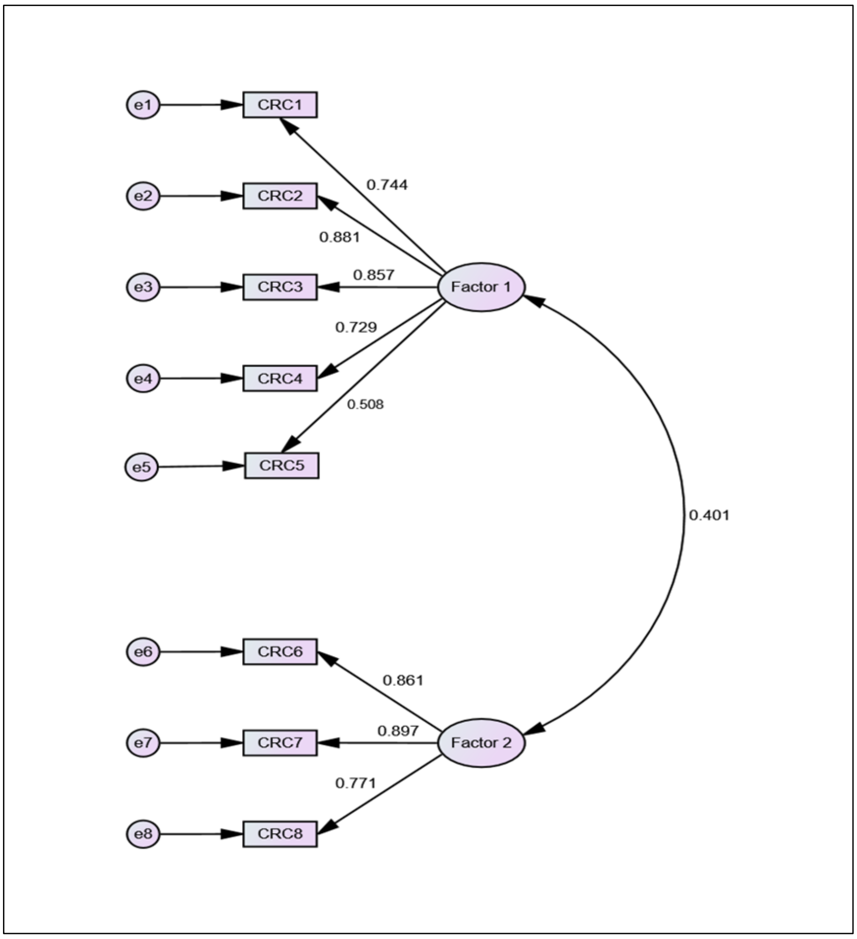

Figure 6.1: The path model for client-related causes (CRC)

Factor 1 represents '*operations' and 'design difficulties'* as it influences the occurrence of inadequate selection of contractor, delay in release of main contractor's claims, and spontaneous adjustments in design and scope of operation. Equally, factor 2 represents *'inefficient planning'* as it influences a client's inability to bankroll a project, delays in a contractor's immediate operation at the construction site, and project planning amongst clients and project team. The factors are correlated with a positive loading score of 0.401, which indicates their level of dependence (Streiner, 2005; Suhr, 2006). This demonstrates the dimension and significance of the association.

6.4.7.6 KMO test and Bartlett's sphericity test of contractor-related causes

The data sampling adequacy and fitness tests for contractor-related causes (CoRC) yielded a KMO test score of 0.86 and Bartlett's test of sphericity value of p = 0.00 (Civelek, 2018). These test scores validate the fitness of the data in generating interpretable results to identify the CoRC causing the risk of contractual claims (Table 6.29).

Table 6.29: KMO test and Bartlett's sphericity test scores for CoRC

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
CoRC	0.86	Approx. Chi-Square	807.92	Items are significant and adequate for FA
		df	136	
		Sig.	0.00	

6.4.7.7 Communality estimates of items in contractor-related causes

The communality estimates for CoRC are shown in Table 6.30. A substantial number of items exhibited communality proportions above 0.40, only CoRC15 (disagreement between the main contractor and the consultant), CoRC10 (poor cost estimation by the main contractor), and CoRC11 (delay in getting licenses and approvals from the government by the main contractor) exhibited communality proportions below 0.40. This specifies that low proportions of variation were explained in the three items. CoRC3 (delay in supply of construction materials), CoRC2 (main contractor poor cash-flow forecast), and CoRC1 (main contractor's experience) demonstrated highest communality proportions of variation. These three items were expected to attain adequate path model performance (Yong and Pearce, 2013), including other items with communality proportions above 0.50.

Table 6.30: Communalities of items in CoRC

Communality Proportions of Items in Contractor-Related Causes (CoRC)			
Code	**Item**	**Initial**	**Extraction**
CoRC1	Main contractor's experience	1.00	**0.70**
CoRC2	Main contractor poor cash-flow forecast	1.00	**0.71**
CoRC3	Delay in supply of construction materials	1.00	**0.83**
CoRC4	Inadequate site management by the main contractor	1.00	0.63
CoRC5	Low productivity of the main contractor workforce	1.00	0.60
CoRC6	Lack of skilled management team	1.00	0.59
CoRC7	Insufficient number of workers	1.00	0.40
CoRC8	Poor construction planning by the main contractor	1.00	0.55
CoRC9	Delay in mobilisation of project site by the main contractor	1.00	0.44
CoRC10	Poor cost estimation by the main contractor	1.00	0.37
CoRC11	Delay in getting licenses and approvals from the government by the main contractor	1.00	0.34
CoRC12	Delayed salary payments to the main contractor's staff	1.00	0.43
CoRC13	Lack of incentives for the workers	1.00	0.50
CoRC14	Shortage of equipment on site	1.00	0.60
CoRC15	Disagreement between the main contractor and the consultant	1.00	0.38
CoRC16	Lack of well-being facilities by the main contractor	1.00	0.55
CoRC17	Inappropriate methods of construction	1.00	0.51

6.4.7.8 Total variance of items explained in contractor-related causes

The proportion of variances of CoRC explained by the underlying factors present in the data were represented in a scree plot (Appendix E) to graphically express factor extraction points. The graph shows that only four factors are above the flattened line (eigenvalues < 1.00). Therefore, only these factors have extractable loadings from the total variance explained in

CRC, which explained 53.62% variance in the data (Hox and Bechger, 1999; Vehkalahti, 2000; Huang and Abdel-Aty, 2010; Schumacker and Lomax, 2021; Yong and Pearce, 2013). There is however a weighted dispersion of amount of variance explained amongst the four factors, which could cause cross-loadings of items across the factors. The data was redistributed by utilising the direct oblimin rotation method with Kaiser Normalisation to generate interpretable results (Osborne, 2015). Factor rotation reduces the ambiguity in the data to ensure a clear loading pattern across the four factors (Yong and Pearce, 2013; Osborne, 2015). The rotation results show a better dispersion of variance across the four extractable factors. Observation indicates that factor 1 has a redistributed loading of 4.59, while factors 2, 3, and 4 have improved rotation loadings of 3.40, 2.69, and 1.44 respectively.

Table 6.31: Total variance of items explained in CoRC

Total Variance Explained in Contractor-Related Causes (CoRC)							
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.57	32.76	32.76	5.57	32.76	32.76	4.59
2	1.35	7.93	40.69	1.35	7.93	40.69	3.40
3	1.14	6.68	47.37	1.14	6.68	47.37	2.69
4	1.06	6.26	53.62	1.06	6.26	53.62	1.44
5	0.96	5.66	59.28				
6	0.89	5.23	64.51				
7	0.83	4.90	69.41				
8	0.76	4.48	73.88				
9	0.71	4.18	78.06				
10	0.65	3.84	81.90				
11	0.60	3.55	85.44				
12	0.56	3.28	88.72				
13	0.46	2.68	91.40				
14	0.41	2.39	93.79				
15	0.39	2.27	96.06				
16	0.34	2.03	98.09				
17	0.33	1.92	100.00				

6.4.7.9 Factor loadings of items in contractor-related causes

The factor loading estimates of CoRC causing contractual claims risk are arranged in Table 6.32. The loading scores demonstrate the significance of the items in quantifying and explicating the extent of the factors in influencing the cause of contractual claims risk in construction projects pertaining to CoRC. In the pattern matrix, data specify that eight items are loaded on factor 1, five items on factor 2, four items on factor 3, and three items on factor 4. However, there are item cross-loadings and loadings less than 0.500. Concerning the item cross-loadings, only items with significant loading scores were considered fit (Yong and Pearce, 2013; Osborne, 2015). CoRC5 (low productivity of the main contractor workforce) with the highest loading score of 0.726, followed by CoRC6 (lack of skilled management team) (0.714), CoRC8 (poor construction planning by the main contractor) (0.691), CoRC9 (delay in mobilisation to project site by the main contractor) (0.606), CoRC7 (insufficient number of workers) (0.602), CoRC10 (poor cost estimation by the main contractor) (0.580), and CoRC17 (inappropriate methods of construction) (0.547) that are all linearly converged on factor 1.

On the other hand, CoRC14 (shortage of equipment on site) (0.736), CoRC13 (lack of incentives for the workers) (0.650), CoRC16 (lack of well-being facilities by the main contractor) (0.632) and CoRC12 (delayed salary payments to the main contractor's staff) (0.628) were linearly converged with factor 2. Factor 3 linearly converges with CoRC2 (main contractor poor cash-flow forecast) (0.715), CoRC1 (main contractor’s experience) (0.676) and CoRC4 (inadequate site management by the main contractor) (0.659), while only CoRC3 (delay in supply of construction materials) (0.849) is only the significant item converging with factor 4. The structure matrix revealed that all seventeen items are positively correlated with factor 1, factor 2, factor 3, and factor 4 as principal underlying causes of contractual claims risk (Vogt and Johnson, 2015).

Table 6.32: Factor matrix, pattern matrix, and structure matrix of items in CoRC

Factor Loadings of Items in Contractor-Related Causes (CoRC)													
Code	Item	Unrotated Loadings Result				Rotated Loadings Result							
		Factor Matrix				Pattern Matrix				Structure Matrix			
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 1	Factor 2	Factor 3	Factor 4	Factor 1	Factor 2	Factor 3	Factor 4
CoRC1	Main contractor’s experience	**0.625**		**0.519**				**0.676**	0.390	0.428		**0.718**	0.406
CoRC2	Main contractor poor cash-flow forecast	**0.656**		0.489				**0.715**		0.406	0.422	**0.770**	
CoRC3	Delay in supply of construction materials	**0.453**		0.466	**0.604**				**0.849**	0.334			**0.856**
CoRC4	Inadequate site management by the main contractor	**0.552**			-0.492			**0.659**		0.446		**0.750**	
CoRC5	Low productivity of the main contractor workforce	**0.706**				**0.726**				**0.767**	0.311	0.354	
CoRC6	Lack of skilled management team	0.493	-0.381	-0.310	-0.328	**0.714**			-0.343	**0.643**		0.379	
CoRC7	Insufficient number of workers	**0.565**				**0.602**				**0.625**			
CoRC8	Poor construction planning by the main contractor	**0.654**				**0.691**				**0.714**	0.359		
CoRC9	Delay in mobilisation of project site by the main contractor	**0.603**				**0.606**				**0.642**	0.383		
CoRC10	Poor cost estimation by the main contractor	**0.542**				**0.580**				**0.600**			
CoRC11	Delay in getting licenses and approvals from the government by the main contractor	**0.563**				0.438				**0.542**	0.381	0.309	
CoRC12	Delayed salary payments to the main contractor’s staff	0.476	0.426				**0.628**				**0.636**		
CoRC13	Lack of incentives for the workers	0.461	0.481				**0.650**				**0.667**		
CoRC14	Shortage of equipment on site	**0.582**	**0.504**				**0.736**			0.379	**0.769**		
CoRC15	Disagreement between the main contractor and the consultant	**0.554**					0.462			0.435	**0.567**		
CoRC16	Lack of well-being facilities by the main contractor	**0.524**	0.400		-0.328		**0.632**	0.310			**0.649**	0.433	
CoRC17	Inappropriate methods of construction	**0.645**				**0.547**				**0.635**	0.493		

6.4.7.10 Path diagram for contractor-related causes

The path model for CoRC is presented in Figure 6.2, with factor 1 representing 'poor procurement and production planning' as it influences the ability of the main contractor to procure adequate number of skilled workers to raise productivity as well as causing failure to implement the right approach to construction cost analysis. Factor 2 represents 'poor site management' as it impacts late payments of salaries and lack of incentives for construction workers, with inadequate equipment to increase construction productivity.

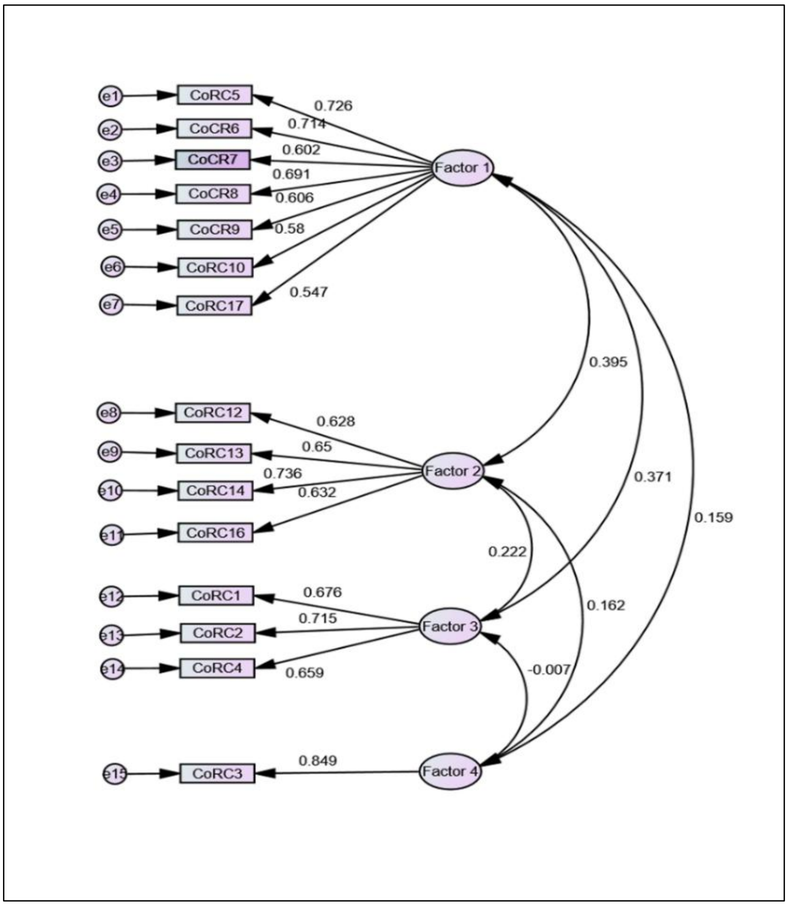

Figure 6.2: The path model for CoRC

Factor 3 signifies 'lack of proficient management' as it impacts contractor's poor handling of construction site and cash flow forecast, and factor 4 denotes 'poor approach to inventory' as it promotes late availability of construction materials. The linear relationship between factors, as indicated in the path diagram, show that factor 1 and factor 2 exhibited a positive loading score of 0.371, followed by factor 2 and factor 3 (0.222), factor 2 and factor 4 (0.169); while factor 1 and factor 4 had a positive loading score of 0.159. The positive association between these factors specifies the dependence between them as underlying factors influencing the occurrence of contractual claims risk pertaining to CoRC. In contrast, the linear association between factor 3 and factor 4 exhibited a negative loading score of -0.007, which signifies a poor correlation in opposite directions (Streiner, 2005; Suhr, 2006).

6.4.7.11 KMO Test and Bartlett's sphericity test of consultant-related causes

The KMO test and Bartlett's sphericity test results pertaining to tests of consultant-related causes (CsRC) are within the acceptable range as shown in Table 6.33. A KMO test score of 0.83 shows that data are significant in identifying the factors causing contractual claims risk, and Bartlett's sphericity test of p=0.00 specifies that data are adequate for FA.

Table 6.33: KMO test and Bartlett's sphericity test scores for CsRC

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
CsRC	0.83	Approx. Chi-Square	219.63	Items are significant and adequate for FA
		df	15	
		Sig.	0.00	

6.4.7.12 Communality estimates of items in consultant-related causes

The communality results in Table 6.34 shows that only CsRC1 (delay in approval of drawings by the consultants) and CsRC2 (delay in site inspection by the consultant) amongst the six items demonstrated a variance proportion close to 1.00. These two items are estimated to attain adequate or better path models than the other items because they produced variance proportions above 0.50. Therefore, the result implies that smaller amounts of variance were explained by FA (Yong and Pearce, 2013; Schumacker and Lomax, 2021).

Table 6.34: Communalities of items in CsRC

	Communalities Proportions of Items in Consultant-Related Causes (CsRC)		
Code	**Item**	**Initial**	**Extraction**
CsRC1	Delay in approval of drawings by the consultants	1.00	**0.59**
CsRC2	Delay in site inspection by the consultant	1.00	**0.59**
CsRC3	Slow response by the consultant to contractor's enquiries	1.00	0.46
CsRC4	Lack of experience by the consultant's staff	1.00	0.36
CsRC5	Poor quality control by the consultant	1.00	0.40
CsRC6	Misunderstanding of the client's requirements by the consultant	1.00	0.43

6.4.7.13 Total variance of items explained in consultant-related causes

Table 6.35 presents the total variance explained in the data representing CsRC. In the table, only one factor was significant among the six items (eigenvalue > 1.00). The cumulative variance explained by this factor is close to 50%, and the percentage of variance decreases from factor 2 down to 6. This establishes that factors below the extraction point are unextractable as illustrated in the scree plot presented in Appendix E. The result cannot be rotated because only one factor produced extractable loadings from the total variance explained in CsR. Therefore, it is considered unfit for the purpose of this investigation.

Table 6.35: Total variance of items explained in consultant-related causes (CsRC)

Total Variance Explained in Contractor-Related Causes (CsRC)						
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.83	47.20	47.20	2.83	47.20	47.20
2	0.79	13.12	60.32			
3	0.73	12.20	72.52			
4	0.66	10.97	83.48			
5	0.57	9.44	92.93			
6	0.42	7.07	100.00			

6.4.7.14 Factor Loadings of Items in consultant-related causes

The data present in Table 6.36 represent the factor loadings obtained from the FA of CsRC. All the six items positively converged on the underlying factor, with each one of them exhibiting strong loading score greater than 0.500. CsRC1 (delay in approval of drawings by the consultants) exhibited the highest loading score of 0.767, followed by CsRC2 (delay in site inspection by the consultant) (0.766), CsRC3 (slow response by the consultant to contractor's enquiries) (0.680), CsRC6 (misunderstanding of the client's requirements by the consultant) (0.654), CsRC5 (poor quality control by the consultant) (0.636), and CsRC4 (lack of experience by the consultant's staff) (0.603) are converged on factor.

Thus, the Oblimin rotation method could not be applied to the data to produce pattern and structure matrices due to the extraction of only one factor (O'Rourke and Hatcher, 2013), which hinders the development of the path analysis as one of the applications of the SEM is unattainable (Streiner, 2005; Schumacker and Lomax, 2021). The results produced are significant since a factor needs to be extracted to identify the factors causing contractual claims risk.

The underlying factor represents *operations impediment and inexperience* as it impacts the ability of the consultant to comprehend project requirements, initiate timely approval of the project and inspection of the site, and procure highly skilled workers to raise the level of quality.

Table 6.36: Factor matrix of items in CsRC

Factor Loadings of Items in Consultant-Related Causes (CsRC)		
Code	Item	Factor Matrix
		Factor
CsRC1	Delay in approval of drawings by the consultants	**0.767**
CsRC2	Delay in site inspection by the consultant	**0.766**
CsRC3	Slow response by the consultant to contractor's enquiries	**0.680**
CsRC4	Lack of experience by the consultant's staff	**0.603**
CsRC5	Poor quality control by the consultant	**0.636**
CsRC6	Misunderstanding of the client's requirements by the consultant	**0.654**

6.4.7.15 KMO Test and Bartlett's sphericity test of external causes

The KMO test score of 0.73 shown in Table 6.37 indicates that the data sampling in the test of external causes (ExC) is adequate and a Bartlett's sphericity test of p=0.00 specifies that the data are significant within the acceptable range for the application of FA. This validates the existence of a substantial association between the six items pertaining to ExC.

Table 6.37: KMO test and Bartlett's sphericity test scores for external causes

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
ExC	0.73	Approx. Chi-Square	180.57	Items are significant and adequate for FA
		df	15	
		Sig.	0.00	

6.4.7.16 Communality estimates of items in external causes

The data displayed in Table 6.38 shows that only ExC1 (unpredictable soil conditions) (0.65) and ExC5 (unforeseen site condition) (0.50) are two items with a sufficient proportion of variance that can be explained in the data pertaining to ExC. The least proportion of variance that can be explained in the data pertaining to ExC is demonstrated by ExC3. These results show that the performance model for ExC is unreliable.

Table 6.38: Communalities of items in ExC

Communalities Proportions of Items in External Causes (ExC)			
Code	**Item**	**Initial**	**Extraction**
ExC1	Unpredictable soil conditions	1.00	**0.65**
ExC2	Bad weather conditions (excessive rainfall, winter storms and high temperatures)	1.00	0.30
ExC3	Control by the government and restrictions on the site	1.00	0.23
ExC4	Civil disturbance	1.00	0.48
ExC5	Unforeseen site condition	1.00	**0.50**
ExC6	Price fluctuation	1.00	0.36

6.4.7.17 Total variance of items explained in external causes

Table 6.39 presents the data estimation of the total variance of items explained in ExC. Data shows that factor 1 has an eigenvalue of 2.51, which explains 41.76% of extractable loadings from the total variance explained in ExC. Other factors with an eigenvalue below 1.00 had lower proportion of variance from factor 2 to factor 6. Factor 2 to factor 6 fall below the extraction point of eigenvalue >1.00 (Appendix E), which shows that these factors are unfit for the purpose of this investigation.

Table 6.39: Total variance of items explained in external causes

Total Variance Explained in External Causes						
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.51	41.76	41.76	2.51	41.76	41.76
2	0.96	16.07	57.82			
3	0.89	14.78	72.61			
4	0.65	10.87	83.47			
5	0.60	9.99	93.46			
6	0.39	6.54	100.00			

6.4.7.18 Factor Loadings of Items in external causes (ExC)

Table 6.40 displays the results derived from the analysis of the factor loadings of items pertaining to ExC. The analysis yielded only a factor matrix, which contains one factor with six items positively converging on it. In circumstances like this, the data is considered inadequate to apply the Oblimin rotation method to derive clear pattern and structure matrices. Out of the six items, five exhibited strong factor loadings above 0.500. Only items with strong loading scores are significant for the identification of the factors causing contractual claims risks in civil infrastructure projects. Therefore, ExC1 (unpredictable soil conditions) indicated the highest loading score of 0.806, followed by ExC5 (unforeseen site condition) (0.704), ExC4 (civil disturbance) (0.693), ExC6 (price fluctuation) (0.596), and ExC2 (bad weather conditions (excessive rainfall, winter storms and high temperature)) (0.548) are combined with the underlying factor. The underlying factor represents *'external circumstances beyond stakeholders' control'* as it hinders the ability of the stakeholders to have common goals as well as attaining the planned projects to avoid unnecessary occurrence of contractual claims risk.

Table 6.40: Factor matrix of items in ExC)

Factor Loadings of Items in External Causes		
Code	Item	Factor Matrix
		Factor
ExC1	Unpredictable soil conditions	**0.806**
ExC2	Bad weather conditions (excessive rainfall, winter storms and high temperatures)	**0.548**
ExC3	Control by the government and restrictions on the site	0.474
ExC4	Civil disturbance	**0.693**
ExC5	Unforeseen site condition	**0.704**
ExC6	Price fluctuation	**0.596**

6.4.7.19 KMO Test and Bartlett's sphericity test of finance-related (FiR)

The KMO and Bartlett's sphericity tests conducted on the data in FiR yielded test scores of 0.79 and p=0.00 respectively, which signify the sampling adequacy and significance of the data for the application of the FA (Table 6.41).

Table 6.41: KMO test and Bartlett's sphericity test scores for FiR

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
FiR	0.79	Approx. Chi-Square	169.39	Items are significant and adequate for FA
		df	10	
		Sig.	0.00	

6.4.7.20 Communality estimates of items in finance-related

Table 6.42 presents the communality estimates showing the proportion of variance that can be explained in the five items relating to FiR. From the results, only three items exhibited estimates close to 1.00 (>0.50). FiR1 (financing difficulties of contractor) (0.61) had the highest proportion of variance that can be explained, followed by FiR5 (change in government policy on prices of construction materials) (0.54), and FiR2 (financing difficulties of owner) (0.50). Other items had a proportion of variance above 0.40, which shows their significance in producing adequate amount of variance that can be explained in achieving appropriate path model performance.

Table 6.42: Communalities of items in FiR

Communalities Proportions of Items in Finance-Related			
Code	**Item**	**Initial**	**Extraction**
FiR1	Financing difficulties of contractor	1.00	**0.61**
FiR2	Financing difficulties of owner	1.00	**0.50**
FiR3	Effects of global economy/unforeseeable financial and economic crises	1.00	0.45
FiR4	High interest on loans and overdrafts for contractors	1.00	0.42
FiR5	Change in government policy on prices of construction materials	1.00	**0.54**

6.4.7.21 Total variance of items explained in finance-related

The total variance of items explained in FiR is presented in Table 6.43. Factor 1 represents an eigenvalue of 2.51, which explained 50.16% of variance in the data. This demonstates that only one factor generated extractable loadings from the total variance explained in FiR. Other factors represent eigenvalues below 1.00, which indicates that they are inadequate for the rotation to achieve explicable results required to generate the pattern and structure matrices.

Table 6.43: Total variance of items explained in FiR

Total Variance Explained in FiR						
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.51	50.16	50.16	2.51	50.16	50.16
2	0.78	15.59	65.76			
3	0.69	13.71	79.46			
4	0.54	10.73	90.19			
5	0.49	9.81	100.00			

6.4.7.22 Factor loadings of items in finance-related

The factor loading results displayed in Table 6.44 shows that only one factor is extracted from FiR. In the table, five items are positively converged on the underlying factor, with all of them demonstrating strong factor loadings above 0.500. Among these five items, FiR1 (financing difficulties of contractor) demonstrated the strongest loading score of 0.779, followed by FiR5 (change in government policy on prices of construction materials) (0.731), FiR2 (financing difficulties of owner) (0.707), FiR3 (effects of global economy/unforeseeable financial and economic crises) (0.670), and FiR4 (high interest on loans and overdrafts for contractors) (0.646) are all converged on the underlying factor.

Table 6.44: Factor matrix of items in FiR

Factor Loadings of Items in Finance-Related		
Code	**Item**	**Factor Matrix Factor**
FiR1	Financing difficulties of contractor	**0.779**
FiR2	Financing difficulties of owner	**0.707**
FiR3	Effects of global economy/unforeseeable financial and economic crises	**0.670**
FiR4	High interest on loans and overdrafts for contractors	**0.646**
FiR5	Change in government policy on prices of construction materials	**0.731**

The factor represents *'impact of rigid government policies'* as it affects the ability of the stakeholders to procure finances, construction materials, labour and machineries at affordable rates. In some cases, this factor has contributed significantly to high project cost and extensive project duration.

6.4.7.23 KMO Test and Bartlett's sphericity test of contractual risk factors

The KMO test and Bartlett's sphericity test scores derived for contractual risk factors indicated that the data is adequate and significant for the application of FA (Table 6.45). The data is within the index ranges of sampling correlation (Civelek, 2018).

Table 6.45: KMO test and Bartlett's sphericity test scores for contractual risk factors (CRF)

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
CRF	0.73	Approx. Chi-Square	227.89	Items are significant and adequate for FA
		df	55	
		Sig.	0.00	

6.4.7.24 Communality estimates of items in contractual risk factors

Table 6.46 presents the communality proportions of eleven (11) items in contractual risk factors (CRF) causing contractual claims risk in civil infrastructure projects. In the table, communality proportions in bold specify items with strong a large variation that can be explained (Yong and Pearce, 2013). CRF7 (type of contract procurement method) (0.80) demonstrated the closest communality proportion to 1.00, which means the item exhibits a more adequate path model performance than any other item. CRF6 (legal disputes and inappropriate method of dispute resolution), unlike other items, exhibits an inadequate path model performance.

Table 6.46: Communalities of items in contractual risk factors

Community Proportions of Items in Contractual Risk Factors			
Code	**Item**	**Initial**	**Extraction**
CRF1	Contract modifications	1.00	**0.61**
CRF2	Poor contract management	1.00	0.55
CRF3	Payment method during construction	1.00	0.50
CRF4	Inadequate definition of substantial completion	1.00	**0.60**
CRF5	Omission and errors in contract documents	1.00	**0.64**
CRF6	Legal disputes and inappropriate method of dispute resolution	1.00	0.38
CRF7	Type of contract procurement method	1.00	**0.80**
CRF8	Slow information flow between parties	1.00	0.57
CRF9	Poor communication/coordination between consultant and other parties	1.00	**0.65**
CRF10	Lack of communicating the requirements by owner	1.00	0.49
CRF11	Poor communication and coordination by contractor with other parties	1.00	0.47

6.4.7.25 Total variance of items explained in contractual risk factors

The total variance explained in CRF by underlying factors is presented in Table 6.47. The results show that factors 1 – 4 accounted for eigenvalues greater than 1.00. This implies that only these four factors produced extractable loadings from the total variance explained in CRF (Yong and Pearce, 2013; Civelek, 2018). Therefore, factor 1 accounted for a maximum eigenvalue of 2.79 before the initiation of rotation, which explained 25.40% of variability in the data, while the other three factors explained a sum of 31.38% of the variance. All

Deductions made from the eigenvalues given in Table 6.47 are supported with a scree plot shown in Appendix E. The graph shows a sharp drop ineigenvalue, starting from the flatten line to the lowest eigenvalue This supports the accuracy of the numerical deductions derived from the table by confirming factors 1 – 4 with the most variability in the data (Yong and Pearce, 2013; Osborne, 2015).

Table 6.47: Total variance of items explained in contractual risk factors

Total Variance explained in Contractual Risk Factors							
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**
1	2.79	25.40	25.40	2.79	25.40	25.40	2.03
2	1.29	11.69	37.09	1.29	11.69	37.09	1.26
3	1.13	10.27	47.36	1.13	10.27	47.36	1.95
4	1.04	9.42	56.78	1.04	9.42	56.78	1.64
5	0.89	8.10	64.88				
6	0.84	7.60	72.48				
7	0.72	6.52	78.99				
8	0.68	6.18	85.17				
9	0.61	5.57	90.74				
10	0.54	4.88	95.61				
11	0.48	4.39	100.00				

Similarly, these deductions were further of the cumulative proportion, where a ‘sharp’ increase in proportion of variance was observed from factor 1 – 2, followed by a decrease from factors 5–11 with the least proportion of variance. The extraction of these four underlying factors generated a cumulative proportion of 56.78%, which specifies the proportion of variation in the data explained. However, the Oblimin rotation method with Kaiser Normalisation was used to redistribute data across the underlying factors to attain an improved variance distribution as a precondition for interpretable results (Osborne, 2015; Yong and Pearce, 2013; Civelek, 2018). The result shows that factor 3 and factor 4 yielded improved rotation loadings from 1.13 → 1.95 and 1.04 → 1.64 respectively.

6.4.7.26 Factor loadings of items in contractual risk factors

The results obtained from the rotation of data pertaining to CRF, as causes of contractual claims risk in civil infrastructure projects, produced the data displayed in Table 6.48. The data demonstrate positive and negative linear patterns of items and factors, which imply that some items are positively influenced by the factors, while others are negatively influenced by the factors. In addition, the pattern matrix specifies that five items are loaded on factor 1, two items on factor 2, four items on factor 3, and three items on factor 4. However, presence of item cross-loadings and loadings lower than 0.500 were observed in the pattern. Items such as CRF9 (poor communication/coordination between consultant and other parties) (0.514 – 0.564) with two significant cross-loading scores on two factors, were disregarded to avoid density or having one item loaded strongly on two factors (Osborne, 2015).

Table 6.48: Factor matrix, pattern matrix, and structure matrix of items in contractual risk factors

Factor Loadings of Items in Contractual Risk Factors													
Code	**Item**	**Unrotated Loadings Result**				**Rotated Loadings Result**							
		Factor Matrix				**Pattern Matrix**				**Structure Matrix**			
		Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
CRF1	Contract modifications	**0.604**	-0.339			**0.759**				**0.773**			
CRF2	Poor contract management	**0.575**	-0.305	-0.348		**0.705**				**0.714**			
CRF3	Payment method during construction	**0.630**				0.386			0.383	0.471		0.431	0.477
CRF4	Inadequate definition of substantial completion	**0.559**	0.404	-0.331					**0.681**			0.303	**0.726**
CRF5	Omission and errors in contract documents	0.433	0.358	-0.305	0.476				**0.784**				**0.770**
CRF6	Legal disputes and Inappropriate method of dispute resolution	0.452	0.336					**0.561**				**0.587**	0.302
CRF7	Type of contract procurement method	0.385		0.375	**0.688**		**-0.863**				**-0.865**		
CRF8	Slow information flow between parties	0.407	0.351	**0.525**				**0.707**				**0.681**	
CRF9	Poor communication/coordination between consultant and other parties	0.403	**-0.658**			0.514	-0.564			**0.540**	**-0.612**		
CRF10	Lack of communicating the requirements by owner	0.483		0.347	-0.359			**0.668**				**0.668**	
CRF11	Poor communication and coordination by contractor with other parties	**0.535**				0.368		**0.500**		0.468		**0.549**	

Only one significant cross-loading was considered to strengthen the importance of identifying underlying factors causing contractual claims risk in civil infrastructure projects. This simplification enhances the satisfactory interpretations of the underlying factors. Only two items are considered usable on factor 1, one on factor 2, four on factor 3, and two on factor 4. The convergence of these items on the factors demonstrates the strength of the correlation between them as underlying principal causes of contractual claims risk in civil infrastructure projects.

CRF1 (contract modifications) (0.759) and CRF2 (poor contract management) (0.705) are positively converged on factor 1, while CRF7 (type of contract procurement method) (-0.873) is negatively loaded on factor 2. Equally, CRF8 (slow information flow between parties) (0.707), followed by CRF10 (lack of communicating the requirements by owner) (0.668), CRF6 (legal disputes and inappropriate method of dispute resolution) (0.561), and CRF11 (poor communication and coordination by contractor with other parties) (0.500) are positively converged on factor 3. CRF5 (omission and errors in contract documents) (0.784) and CRF4 (inadequate definition of substantial completion) (0.681) linearly converged on factor 4. The structure matrix shows that some items are positively correlated, while others are negatively correlated, which signify dependent and independent relationships.

6.4.7.27 Path diagram for contractual risk factors

The path model in Figure 6.3 shows that factor 1 represents *'poor contract structure'* as it influences the ability of the parties to attain interpretable and executable contract projects. Factor 2 signifies *'approach to contract requisition'* as it affects the structure used in contract procurement. Factor 3 depicts *'poor conflict management and information sharing'* as it motivates poor contract interaction amongst parties, resulting in disputes, while factor 4 measures *'poor performance and contract preparation'* as it implies unsatisfactory project achievement and contractual issues in project execution.

The association among the four factors specifies that some factors are positively correlated, while some factors are negatively correlated. Factor 1 and factor 3 exhibited the strongest correlation score of 0.222, followed by factor 3 and factor 4 with a correlation score of 0.200; factor 1 and factor 4 with a correlation score of 0.098, and factor 1 and factor 2 with a correlation score of -0.098, including factor 2 and factor 3 with a correlation score of -0.080; and factor 2 and factor 4 with a correlation score of 0.002. The above implies that factor 1 and factor 3 along with factor 3 and factor 4 have the greatest influence on the CRF causing contractual claims risk (Streiner, 2005; Suhr, 2006).

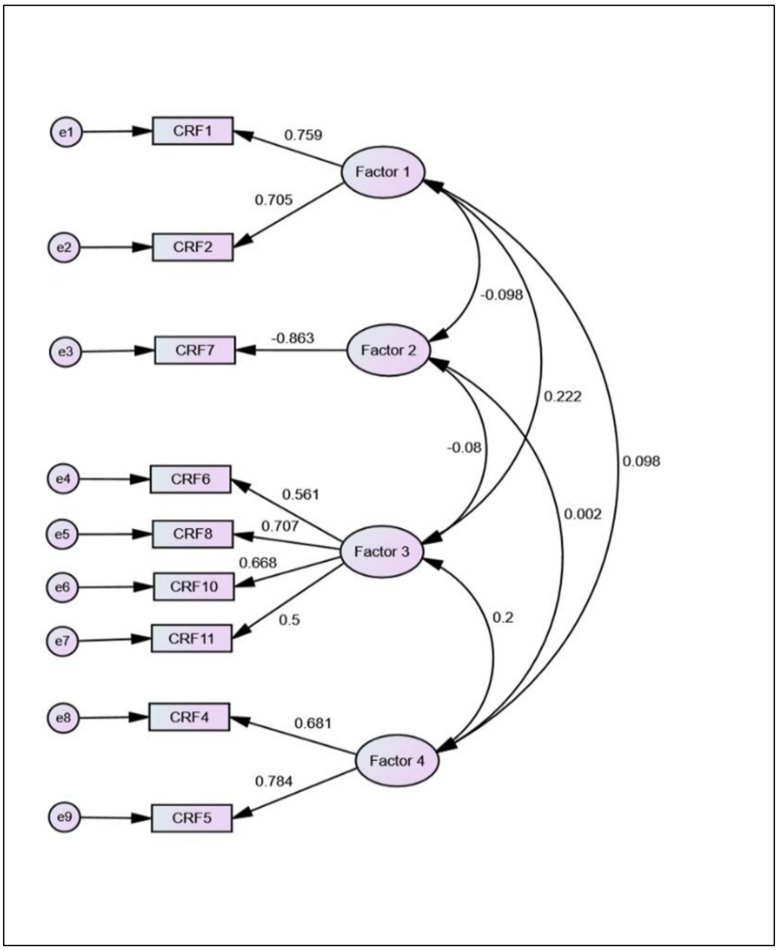

Figure 6.3: The path model for contractual risk factors

6.5 IMPACTS OF RISKS OCCURRENCE IN CIVIL INFRASTRUCTURE PROJECTS: OBJECTIVE 2

In this section the extent to which identified items contribute to the occurrence of risks is discussed. The results of the analyses provide understanding of the descriptive statistics and correlation of items classified under risk occurrence (RkO), risk effects on project delivery, risk associated with risk-causative variables (RARCV), and frequency occurrence of contractual claims (FOCC). The perceptions of the respondents were measured using a five-point Likert scale for each set of questions. A five-point Likert scale of 5 = Always, 4 = Often, 3 = Occasionally, 2 = Rarely, and 1 = Never was designed for both RkO and FOCC; 5 = Very high influence, 4 = High influence, 3 = Slight influence, 2 = Extremely little influence and 1 = No influence, for REPD; and 5 = Construction site health and safety practices risk, 4 = Risk associated with consultant performance, 3 = Managerial risk, 2 = Time delay risk, and 1 = Risk associated with claims due to errors and omissions in design for RARCV.

6.5.1 Risk occurrence

Table 6.49 presents the descriptive analysis results for risk occurrence (RkO) as an assessment of risk in civil infrastructure projects. In the table, all five items exhibited mean scores above 3.00 as indication of their involvement in contractual claims risk occurrence during construction project execution. RkO1 (risk associated with claims due to errors and omissions in design) had the highest significant impact of 4.30, with other items having impact below a mean score of 4.00. The impacts of these risks are associated with the activities performed by the construction management.

Table 6.49: Descriptive statistical results of items in RkO

Descriptive Statistical Scores for RkO								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
RkO1	Risk associated with claims due to errors and omissions in design	166	2.00	5.00	**4.30**	0.68	0.46	1
RkO2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	166	2.00	5.00	3.80	0.75	0.56	2
RkO5	Construction site health and safety practices risk	166	1.00	5.00	3.73	0.80	0.63	3
RkO4	Risk associated with consultant performance (consultant competencies skills)	166	1.00	5.00	3.73	0.71	0.50	3
RkO3	Construction risk associated with poor management by contractor's (managerial risk)	166	2.00	5.00	3.69	0.74	0.55	4

Table 6.50 presents the distribution of responses across the four items. The result specified that RkO1 (risk associated with claims due to errors and omissions in design) *'often'* or *'always'* occurred during construction projects as confirmed by 89.8% respondents. While RkO2 ((time delay risk (risk due to delay in delivery of the project on or before the schedule date)), RkO4 (risk associated with consultant performance (consultant competencies skills)), and RkO5 (construction site health and safety practices risk) equally occurred *'occasionally'* and *'often'* as claimed by 80.1%, 79.5%, and 86.1% respondents, respectively. This shows that errors and omissions in design, delay in delivery of project on or before schedule date, consultant competencies skills, and health and safety practices risk encourage regular and occasional occurrence of claims risk in civil infrastructure projects with respect to design, timeliness, welfare and performance (Charehzehi et al., 2017; Aryal and Dahal, 2018). This also explains the need to mitigate contractual claims risk to ward off excessive costs and delays, as well as ensuring consistent delivery of construction projects in South Africa.

Table 6.50: Frequency scores of the first-four items in RkO

Frequency Scores for RkO								
Likert scales	**Risk associated with claims due to errors and omissions in design (RkO1)**				**Time delay risk (risk due to delay in delivery of the project on or before the schedule date) (RkO2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	2	1.2	1.2	1.2	4	2.4	2.4	2.4
3 = Occasionally	15	9.0	9.0	10.2	55	33.1	33.1	35.5
4 = Often	81	48.8	48.8	59.0	78	47.0	47.0	82.5
5 = Always	68	41.0	41.0	**100.0**	29	17.5	17.5	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Construction site health and safety practices risk (RkO5)**				**Risk associated with consultant performance (consultant competencies skills) (RkO4)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	1	0.6	0.6	0.6	1	0.6	0.6	0.6
2 = Rarely	4	2.4	2.4	3.0	3	1.8	1.8	2.4
3 = Occasionally	62	37.3	37.3	40.4	55	33.1	33.1	35.5
4 = Often	70	42.2	42.2	82.5	88	53.0	53.0	88.6
5 = Always	29	17.5	17.5	**100.0**	19	11.4	11.4	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

The inter-item correlation analysis in Table 6.51 offers observations on the strength of the correlation between items in RkO and demonstrates a positively influenced relationship between the five items. Items with highest correlations produce a robust reliability model compared to others with low correlations. Result indicated highest correlation score of 0.498 between RkO1 (risk associated with claims due to errors and omissions in design) and RkO2 (time delay risk (risk due to delay in delivery of the project on or before the schedule date), while RkO3 (construction risk associated with poor management by contractors (managerial risk) and RkO5 (construction site health and safety practices risk) demonstrated the lowest correlation of 0.271. Thus, the relationship between RkO3 and RkO5 implies a poor reliability compared with the correlations between other items.

Table 6.51: Inter-item correlation matrix illustration of items in RkO

Inter-Item Correlation Matrix for RkO						
Code	**Item**	**Risk associated with claims due to errors and omissions in design**	**Time delay risk (risk due to delay in delivery of the project on or before the schedule date)**	**Construction risk associated with poor management by contractor's (managerial risk)**	**Risk associated with consultant performance (consultant competencies skills)**	**Construction site health and safety practices risk**
		RkO1	**RkO2**	**RkO3**	**RkO4**	**RkO5**
RkO1	Risk associated with claims due to errors and omissions in design	1.000	**0.498**	0.348	0.318	0.414
RkO2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	**0.498**	1.000	0.321	0.282	0.355
RkO3	Construction risk associated with poor management by contractor's (managerial risk)	0.348	0.321	1.000	0.393	**0.271**
RkO4	Risk associated with consultant performance (consultant competencies skills)	0.318	0.282	0.393	1.000	0.442
RkO5	Construction site health and safety practices risk	0.414	0.355	**0.271**	0.442	1.000

6.5.2 Risk effects on project delivery

Risk effects on project delivery (REPD) was measured using the same items evaluated in the preceding section to assess their impacts on civil infrastructure project delivery. The results obtained are depicted in Table 6.52, which show that all five items exhibited mean scores above 3.00 as an indication of their importance in quantifying the effects of risk on project delivery. The results also showed that REPD1 (risk associated with claims due to errors and omissions in design) (4.04) has the most effect on risk in project delivery based on its *'high influence'* or *'very high influence'* as indicated by 75.3% respondents, followed by REPD2 (time delay risk (risk due to delay in delivery of the project on or before the schedule date)) with a mean score of 3.68 based on its *'slight influence'* or *'very high influence'* as indicated by 79.5% respondents (Table 6.53), while other items had low impact level with mean scores below 3.50 based on their *'slight influence'* or *'high influence'* as indicated by 85.0% and 85.5% respondents, respectively. This result pinpoints errors and omissions in design, delay in delivery of project on or before schedule date, poor management by contractors, and consultant competencies skills as 'principal' risk effects on project delivery relating to design, timeliness, management, and performance (Charehzehi et al., 2017; Aryal and Dahal, 2018). These risks occurred due to management inefficiency, incompetent skills demonstrated by consultants, construction design errors, and delay in project delivery (Doloi et al., 2012; Charehzehi et al., 2017; Aryal and Dahal, 2018).

Table 6.52: Descriptive statistical results of items in REPD

Descriptive Statistical Scores for REPD								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
REPD1	Risk associated with claims due to errors and omissions in design	166	2.00	5.00	**4.04**	0.85	0.73	1
REPD2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	166	2.00	5.00	**3.68**	0.79	0.63	2
REPD3	Construction risk associated with poor management by contractors (managerial risk)	166	2.00	5.00	3.43	0.74	0.55	3
REPD4	Risk associated with consultant performance (consultant competencies skills)	166	1.00	5.00	3.39	0.78	0.60	4
REPD5	Construction site health and safety practices risk	166	1.00	5.00	3.28	0.79	0.63	5

Table 6.53: Frequency scores of the first-four items in REPD

Frequency Scores for REPD								
Likert scales	**Risk associated with claims due to errors and omissions in design (REPD1)**				**Time delay risk (risk due to delay in delivery of the project on or before the schedule date) (REPD2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extreme little influence	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = No influence	8	4.8	4.8	4.8	10	6.0	6.0	6.0
3 = Slight influence	33	19.9	19.9	24.7	57	34.3	34.3	40.4
4 = High influence	70	42.2	42.2	66.9	75	45.2	45.2	85.5
5 = Very high influence	55	33.1	33.1	**100.0**	24	14.5	14.5	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Construction risk associated with poor management by contractor's (managerial risk) (REPD3)**				**Risk associated with consultant performance (consultant competencies skills) (REPD4)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extreme little influence	0	0.0	0.0	0.0	3	1.8	1.8	1.8
2 = No influence	15	9.0	9.0	9.0	8	4.8	4.8	6.6
3 = Slight influence	74	44.6	44.6	53.6	90	54.2	54.2	60.8
4 = High influence	67	40.4	40.4	94.0	52	31.3	31.3	92.2
5 = Very high influence	10	6.0	6.0	**100.0**	13	7.8	7.8	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

The inter-item correlation result showed positive correlation between the five items (Table 6.54). The result indicates that REPD1 (risk associated with claims due to errors and omissions in design) and REPD2 (Time delay risk (risk due to delay in delivery of the project on or before the schedule date)) yielded highest correlation score of 0.590. The association between REPD1 and REPD2 yielded a reliable path model (Senthilnathan, 2019; Westland, 2015; Vogt and Johnson, 2015). REPD2 (time delay risk (risk due to delay in delivery of the project on or before the schedule date) and REPD4 (risk associated with consultant performance (consultant competencies skills) had the lowest correlation of 0.289.

Table 6.54: Inter-item correlation matrix illustration of items in REPD

Inter-Item Correlation Matrix for REPD						
Code	**Item**	**Risk associated with claims due to errors and omissions in design**	**Time delay risk (risk due to delay in delivery of the project on or before the schedule date))**	**Construction risk associated with poor management by contractors (managerial risk)**	**Risk associated with consultant performance (consultant competencies skills)**	**Construction site health and safety practices risk**
		REPD1	**REPD2**	**REPD3**	**REPD4**	**REPD5**
REPD1	Risk associated with claims due to errors and omissions in design	1.000	**0.590**	0.522	0.437	0.462
REPD2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	**0.590**	1.000	0.391	**0.289**	0.373
REPD3	Construction risk associated with poor management by contractors (managerial risk)	0.522	0.391	1.000	0.392	0.434
REPD4	Risk associated with consultant performance (consultant competencies skills)	0.437	**0.289**	0.392	1.000	0.457
REPD5	Construction site health and safety practices risk	0.462	0.373	0.434	0.457	1.000

6.5.3 Risk associated with risk-causative variables

Descriptive data presented in Table 6.55 regarding the impact of risk-causative variables (RARCV) on civil infrastructure projects in South Africa demonstrate that all eleven items have mean scores above 3.00. This explains their significant influence in determining the risk impacts on the delivery of such projects.

In Table 6.55, RARCV1 (occurrence of financial claims) has the highest mean score of 4.16 as the most risk-causative item based on its significant influence on *consultant performance* (50.0%), *health and safety practices* (33.1%), while other items had mean scores below 4.00. RARCV2 (claim causes delays in project delivery) (3.73) with a significant influence on *consultant performance (47.0%)* and *managerial risk (37.3%)*, followed by RARCV6 (lack proper notification procedures) (3.64) with a significant influence on *consultant performance (48.8%)* and *managerial risk (39.8%)*, and RARCV3 (overbearing influence of project stakeholders during project execution) with an equal manage significant influence on *managerial risk (43.4%)* and *consultant performance (43.4%)*.

From the above findings, it is observed that the respondents considered managerial risk and consultant performance to be strongly associated with the risk-causative items.

Table 6.57 presents the results obtained from the correlation analysis of these items. RARCV1 (occurrence of financial claims) and RARCV2 (claim causes delays in project delivery) has the highest correlation score of 0.543, whereas the relationship between RARCV1 and RARCV2 indicates a strongly reliable path model (Gliem and Gliem, 2003; Vogt and Johnson, 2015; Senthilnathan, 2019). RARCV6 (lack of proper notification procedures) and RARCV 9 (procurement method (awarding the bid to the lowest bidder)) had the weakest correlation (-0.027).

Table 6.55: Descriptive statistical results of items in risk associated with RARCV

Descriptive Statistical Scores for Risk Associated with RARCV								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
RARCV1	Occurrence of financial claims	166	3.00	5.00	**4.16**	0.69	0.48	1
RARCV2	Claim causes delays in project delivery	166	2.00	5.00	3.73	0.72	0.51	2
RARCV6	Lack of proper notification procedures	166	2.00	5.00	3.64	0.68	0.46	3
RARCV3	Overbearing influence of project stakeholders during project execution	166	2.00	5.00	3.61	0.71	0.51	4
RARCV5	Frequent delay on-site due to site conditions, designer and user changes	166	2.00	5.00	3.61	0.69	0.48	4
RARCV9	Procurement method (awarding the bid to the lowest bidder)	166	2.00	5.00	3.56	0.65	0.42	5
RARCV4	Lack of understanding of the contractual terms and conditions	166	2.00	5.00	3.55	0.65	0.42	6
RARCV8	Formation of a standard form of contract	166	2.00	5.00	3.54	0.68	0.47	7
RARCV10	Adoption of new construction technology has great potential to improve productivity and decrease project duration	166	2.00	5.00	3.49	0.65	0.42	8
RARCV7	Poor documentation and management practices during construction	166	2.00	5.00	3.49	0.64	0.41	8
RARCV11	Constant delay caused by litigation between owner and contractors, contract termination and loss of productivity	166	2.00	5.00	3.48	0.70	0.49	9

Table 6.56: Frequency scores of the first-four items in risk associated with RARCV

Frequency Scores for Risk Associated with RARCV								
Likert scales	**Occurrence of financial claims (RARCV1)**				**Claim causes delays in project delivery (RARCV2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Time delay risk	0	0.0	0.0	0.0	3	1.8	1.8	1.8
3 = Managerial risk	28	16.9	16.9	16.9	62	37.3	37.3	39.2
4 = Risk associated with consultant performance	83	50.0	50.0	66.9	78	47.0	47.0	86.1
5 = Construction site health and safety practices risk	55	33.1	33.1	**100.0**	23	13.9	13.9	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Lack of proper notification procedures (RARCV6)**				**Overbearing influence of project stakeholders during project execution (RARCV3)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Time delay risk	4	2.4	2.4	2.4	5	3.0	3.0	3.0
3 = Managerial risk	66	39.8	39.8	42.2	72	43.4	43.4	46.4
4 = Risk associated with consultant performance	81	48.8	48.8	91.0	72	43.4	43.4	89.8
5 = Construction site health and safety practices risk	15	9.0	9.0	**100.0**	17	10.2	10.2	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.57: Inter-item correlation matrix illustration of items in risk associated with RARCV

Inter-Item Correlation Matrix for Risk Associated with RARCV												
Code	**Item**	**Occurrence of financial claims**	**Claim causes delays in project delivery**	**Overbearing influence of project stakeholders during project execution**	**Lack of understanding of the contractual terms and conditions**	**Frequent delay on-site due to site conditions, designer and user changes**	**Lack of proper notification procedures**	**Poor documentation and management practices during construction**	**Formation of a standard form of contract**	**Procurement method (awarding the bid to the lowest bidder)**	**Adoption of new construction technology has great potential to improve productivity and decrease project duration**	**Constant delay caused by litigation between owner and contractors, contract termination and loss of productivity**
		RARCV1	**RARCV2**	**RARCV3**	**RARCV4**	**RARCV5**	**RARCV6**	**RARCV7**	**RARCV8**	**RARCV9**	**RARCV10**	**RARCV11**
RARCV1	Occurrence of financial claims	1.000	**0.543**	0.365	0.353	0.248	0.292	0.039	0.172	0.066	0.187	0.187
RARCV2	Claim causes delays in project delivery	**0.543**	1.000	0.349	0.287	0.236	0.287	0.092	0.129	0.094	0.182	0.177
RARCV3	Overbearing influence of project stakeholders during project execution	0.365	0.349	1.000	0.290	0.142	0.300	0.129	0.115	0.124	0.311	0.210
RARCV4	Lack of understanding of the contractual terms and conditions	0.353	0.287	0.290	1.000	0.257	0.300	0.163	-0.012	0.007	0.262	0.102
RARCV5	Frequent delay on-site due to site conditions, designer and user changes	0.248	0.236	0.142	0.257	1.000	0.037	0.174	0.041	0.141	0.104	0.066
RARCV6	Lack of proper notification procedures	0.292	0.287	0.300	0.300	0.037	1.000	0.179	0.235	**-0.027**	-0.003	0.158
RARCV7	Poor documentation and management practices during construction	0.039	0.092	0.129	0.163	0.174	0.179	1.000	0.209	0.009	0.153	0.121
RARCV8	Formation of a standard form of contract	0.172	0.129	0.115	-0.012	0.041	0.235	0.209	1.000	0.282	0.179	0.285
RARCV9	Procurement method (awarding the bid to the lowest bidder)	0.066	0.094	0.124	0.007	0.141	**-0.027**	0.009	0.282	1.000	0.255	0.189
RARCV10	Adoption of new construction technology has great potential to improve productivity and decrease project duration	0.187	0.182	0.311	0.262	0.104	-0.003	0.153	0.179	0.255	1.000	0.212
RARCV11	Constant delay caused by litigation between owner and contractors, contract termination and loss of productivity	0.187	0.177	0.210	0.102	0.066	0.158	0.121	0.285	0.189	0.212	1.000

6.5.4 Frequency occurrence of contractual claims

This section presents the assessment of frequent occurrence of contractual claims (FOCC) in civil infrastructure projects. The analysis of the responses produced mean scores given in Table 6.58. All 18 items showed mean scores above 3.00, indicating their significance in affecting the causes of frequent contractual claims (FOCC). FOCC1 (delay claims) is highly significant (MS = 4.44) and occurred *'often'* or *'always'* as claimed by 92.8% respondents. Also, FOCC2 (extension of time claims) had a mean score of 4.06 and occurred *'often'* and *'always'* as claimed by 80.7% respondents. Other items had mean scores below 4.00. FOCC7 (damage claims) and FOCC3 (disruption and loss of productivity claims) had mean scores of 3.91 and 3.90, respectively. Both items strongly occurred 'ocassionally', 'often', and 'always' as claimed by 99.4% and 98.8% respondents, respectively (Table 6.59).

These claims primarily arise during construction projects due to factors such as ecological impacts, unethical activities by stakeholders, mismanagement of project funds, frequent changes in work scope and orders, unnecessary delays, and other related issues.

In Table 6.60, the correlations between these items are both positive and negative. FOCC1 (delay claims) and FOCC2 (extension of time claims) had a highest correlation score of 0.501. The association between these items yields a reliable path model. In contrast, FOCC9 (loss and expenses) and FOCC12 (variation order claims) demonstrated the lowest correlation (-0.011) as the poorest reliability amongst all the eighteen items (Vogt and Johnson, 2015; Senthilnathan, 2019).

Table 6.58: Descriptive statistical results of items in FOCC

Descriptive Statistical Scores for Frequency Occurrence of Contractual Claims in Civil Infrastructure Projects (FOCC)								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
FOCC1	Delay claims	166	2.00	5.00	**4.44**	0.66	0.44	1
FOCC2	Extension of time claims	166	2.00	5.00	**4.06**	0.68	0.47	2
FOCC7	Damage claims	166	2.00	5.00	3.91	0.77	0.59	3
FOCC3	Disruption and loss of productivity claims	166	2.00	5.00	3.90	0.79	0.62	4
FOCC11	Wrongful withholding of deposits claims	166	3.00	5.00	3.88	0.69	0.48	5
FOCC17	Different construction site condition claims	166	2.00	5.00	3.86	0.73	0.53	6
FOCC6	Change of work order claims	166	2.00	5.00	3.83	0.72	0.52	7
FOCC4	Acceleration claims	166	2.00	5.00	3.82	0.74	0.55	8
FOCC15	Dayworks claims	166	2.00	5.00	3.80	0.74	0.55	9
FOCC5	Prolongation claims	166	2.00	5.00	3.80	0.76	0.58	9
FOCC8	Loss of profit claims	166	2.00	5.00	3.79	0.77	0.59	10
FOCC13	Extra work claims	166	2.00	5.00	3.78	0.76	0.57	11
FOCC18	Others	166	2.00	5.00	3.78	0.73	0.54	11
FOCC16	Contract ambiguity claims	166	2.00	5.00	3.75	0.76	0.58	12
FOCC12	Variation order claims	166	2.00	5.00	3.73	0.74	0.55	13
FOCC9	Loss and expenses claim	166	2.00	5.00	3.73	0.66	0.44	13
FOCC14	Non-performance claims	166	2.00	5.00	3.73	0.76	0.58	13
FOCC10	Payment-related Claims	166	2.00	5.00	3.73	0.71	0.50	13

Table 6.59: Frequency scores of the first four items in frequency occurrence of contractual claims

Frequency Scores for Frequency Occurrence of Contractual Claims in Civil Infrastructure Projects (FOCC)								
Likert scales	**Delay claims (FOCC1)**				**Extension of time claims (FOCC2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	2	1.2	1.2	1.2	1	0.6	0.6	0.6
3 = Occasionally	10	6.0	6.0	7.2	31	18.7	18.7	19.3
4 = Often	67	40.4	40.4	47.6	91	54.8	54.8	74.1
5 = Always	87	52.4	52.4	**100.0**	43	25.9	25.9	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Likert scales	**Damage claims (FOCC7)**				**Disruption and loss of productivity claims (FOCC3)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	1	0.6	0.6	0.6	2	1.2	1.2	1.2
3 = Occasionally	54	32.5	32.5	33.1	54	32.5	32.5	33.7
4 = Often	70	42.2	42.2	75.3	68	41.0	41.0	74.7
5 = Always	41	24.7	24.7	**100.0**	42	25.3	25.3	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.60: Inter-item correlation matrix illustration of items in FOCC

Inter-Item Correlation Matrix for Frequency Occurrence of Contractual Claims in Civil Infrastructure Projects (FOCC)																			
Code	Item	Delay claims	Extension of time claims	Disruption and loss of productivity claims	Acceleration claims	Prolongation claims	Change of work order claims	Damage claims	Loss of profit claims	Loss and expenses claim	Payment-related Claims	Wrongful withholding of deposits claims	Variation order claims	Extra work claims	Non-performance claims	Dayworks claims	Contract ambiguity claims	Different construction site condition claims	Others
		FOCC1	FOCC2	FOCC3	FOCC4	FOCC5	FOCC6	FOCC7	FOCC8	FOCC9	FOCC10	FOCC11	FOCC12	FOCC13	FOCC14	FOCC15	FOCC16	FOCC17	FOCC18
FOCC1	Delay claims	1.000	**0.501**	0.440	0.347	0.340	0.313	0.280	0.242	0.176	0.268	0.207	0.140	0.191	0.142	0.093	0.193	0.176	0.066
FOCC2	Extension of time claims	**0.501**	1.000	0.449	0.320	0.347	0.340	0.206	0.162	0.209	0.284	0.117	0.127	0.084	0.113	0.084	0.204	0.247	0.051
FOCC3	Disruption and loss of productivity claims	0.440	0.449	1.000	0.344	0.350	0.301	0.285	0.366	0.181	0.116	0.145	0.164	0.219	0.230	0.164	0.264	0.251	0.183
FOCC4	Acceleration claims	0.347	0.320	0.344	1.000	0.321	0.179	0.184	0.092	0.171	0.149	0.181	0.222	0.265	0.268	0.022	0.222	0.222	0.204
FOCC5	Prolongation claims	0.340	0.347	0.350	0.321	1.000	0.299	0.278	0.134	0.144	0.202	0.160	0.174	0.135	0.220	0.112	0.145	0.233	0.158
FOCC6	Change of work order claims	0.313	0.340	0.301	0.179	0.299	1.000	0.343	0.304	0.141	0.073	0.272	0.140	0.208	0.201	0.025	0.098	0.242	0.052
FOCC7	Damage claims	0.280	0.206	0.285	0.184	0.278	0.343	1.000	0.285	0.225	0.177	0.093	0.160	0.206	0.145	0.075	0.190	0.150	0.039
FOCC8	Loss of profit claims	0.242	0.162	0.366	0.092	0.134	0.304	0.285	1.000	0.160	0.095	0.224	0.104	0.296	0.296	0.213	0.274	0.228	0.217
FOCC9	Loss and expenses claim	0.176	0.209	0.181	0.171	0.144	0.141	0.225	0.160	1.000	0.165	0.060	**-0.011**	0.100	0.118	0.001	0.083	0.210	0.149
FOCC10	Payment-related Claims	0.268	0.284	0.116	0.149	0.202	0.073	0.177	0.095	0.165	1.000	0.204	0.128	0.195	0.269	0.105	0.224	0.161	0.128
FOCC11	Wrongful withholding of deposits claims	0.207	0.117	0.145	0.181	0.160	0.272	0.093	0.224	0.060	0.204	1.000	0.433	0.400	0.294	0.201	0.162	0.182	0.197
FOCC12	Variation order claims	0.140	0.127	0.164	0.222	0.174	0.140	0.160	0.104	**-0.011**	0.128	0.433	1.000	0.319	0.282	0.136	0.174	0.325	0.226
FOCC13	Extra work claims	0.191	0.084	0.219	0.265	0.135	0.208	0.206	0.296	0.100	0.195	0.400	0.319	1.000	0.384	0.291	0.287	0.319	0.153
FOCC14	Non-performance claims	0.142	0.113	0.230	0.268	0.220	0.201	0.145	0.296	0.118	0.269	0.294	0.282	0.384	1.000	0.303	0.283	0.326	0.283
FOCC15	Dayworks claims	0.093	0.084	0.164	0.022	0.112	0.025	0.075	0.213	0.001	0.105	0.201	0.136	0.291	0.303	1.000	0.268	0.308	0.096
FOCC16	Contract ambiguity claims	0.193	0.204	0.264	0.222	0.145	0.098	0.190	0.274	0.083	0.224	0.162	0.174	0.287	0.283	0.268	1.000	0.398	0.260
FOCC17	Different construction site condition claims	0.176	0.247	0.251	0.222	0.233	0.242	0.150	0.228	0.210	0.161	0.182	0.325	0.319	0.326	0.308	0.398	1.000	0.395
FOCC18	Others	0.066	0.051	0.183	0.204	0.158	0.052	0.039	0.217	0.149	0.128	0.197	0.226	0.153	0.283	0.096	0.260	0.395	1.000

6.5.5 Determining underlying impacts of risks occurrence in civil infrastructure projects

In this section the adoption of FA in reducing the dimensionality of data and identifying the underlying factors in the items pertaining to the impacts of risks occurrence in civil infrastructure projects is discussed. The approach provides usable data by conducting the KMO and Bartlett's sphericity tests, communality estimates, total variance and scree plot, factor loadings, and path modelling of items (Westland, 2015; Ncube and Moroke, 2016). The reliability of the data was initially performed in the early section of Chapter 6 (Gliem and Gliem, 2003; Osborne, 2015; Ncube and Moroke, 2016). The descriptive analysis and preliminary correlation analysis of the data were computed to give a detailed understanding about the dependability of the items.

6.5.5.1 KMO Test and Bartlett's sphericity test of risk occurrence

The KMO test and Bartlett's test of sphericity were conducted to ascertain the significance and adequacy of the data pertaining to test of risk occurrence (RkO). Table 6.61 shows that the two test results fall within the acceptable range, with a KMO test value of 0.76 and Bartlett's test value of p=0.00 respectively.

Table 6.61: KMO test and Bartlett's sphericity test scores for RkO

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
RkO	0.76	Approx. Chi-Square	165.51	Items are significant and adequate for FA
		df	10	
		Sig.	0.00	

6.5.5.2 Communality estimates of items in risk occurrence

Table 6.62 presents the communality estimates of the items in RkO, in which only two items had a high proportion of variance that can be explained in the data in determining the underlying impacts of risk occurrence in civil infrastructure projects. RkO1 (risk associated with claims due to errors and omissions in design) (0.56) and RkO5 (construction site health and safety practices risk) (0.51) contributed communality proportions close to 1.00, more than other items in RkO. Therefore, these two items are estimated to produce a better path model.

Table 6.62: Communalities of items in RkO

Communality Proportions of Items in RkO			
Code	**Item**	**Initial**	**Extraction**
RkO1	Risk associated with claims due to errors and omissions in design	1.00	0.56
RkO2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	1.00	0.49
RkO3	Construction risk associated with poor management by contractors (managerial risk)	1.00	0.42
RkO4	Risk associated with consultant performance (consultant competencies skills)	1.00	0.47
RkO5	Construction site health and safety practices risk	1.00	0.51

6.5.5.3 Total variance of items explained in risk occurrence

Table 6.63 shows the estimates of the variance explained in RkO. The data revealed the number of factors that can be extracted from RkO. Findings indicate that only one factor has an eigenvalue greater than 1.00, while other factors have eigenvalues lesser than 1.00 as shown in Figure Appendix F. Factor 1 had an eigenvalue of 2.75, explaining 54.97% variance in the data. This indicates that only one factor produced extractable loadings from the total variance explained in RkO. However, the data is unfit for the rotation to attain improved results to generate the pattern and structure matrices.

Table 6.63: Total variance of items explained in RkO

Total Variance Explained in Risk Associated with RkO						
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.75	54.97	54.97	2.75	54.97	54.97
2	0.77	15.39	70.36			
3	0.58	11.53	81.89			
4	0.54	10.74	92.64			
5	0.37	7.36	100.00			

6.5.5.4 Factor loadings of items in risk occurrence

Table 6.64 presents the factor matrix of items relating to RkO, with all five items positively converging on the underlying factor. Among these items, RkO1 (risk associated with claims due to errors and omission in design) (0.827) yielded the highest factor loading, and RkO4 (risk associated with consultant performance (consultant competencies skills)) exhibited the lowest loading score of 0.683. These results established a strong relationship between the items and the underlying factor, but it is not feasible to generate a path model due to the one factor extraction result. From the results, the underlying factor represents *'risk-causative impacts'* as it associatively contributes to the design-related issues, project delivery issues, stakeholders' administration- and skill-related issues, and site operations-related issues.

Table 6.64: Factor matrix of items in RkO

Factor Loadings of Items in RkO		
Code	**Item**	**Factor Matrix**
		Factor
RkO1	Risk associated with claims due to errors and omissions in design	**0.827**
RkO2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	**0.715**
RkO3	Construction risk associated with poor management by contractors (managerial risk)	**0.742**
RkO4	Risk associated with consultant performance (consultant competencies skills)	**0.683**
RkO5	Construction site health and safety practices risk	**0.733**

6.5.5.5 KMO Test and Bartlett's sphericity test of risk effects on project delivery

The KMO test and Bartlett's sphericity test scores of the data pertaining to risk effects on project delivery (REPD) are presented in Table 6.65. The result shows that a KMO test result of 0.80 and Bartlett's sphericity test of p=0.00 validated the adequacy and significance of the data for the purpose of applying FA.

Table 6.65: KMO test and Bartlett's sphericity test scores for REPD

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
REPD	0.80	Approx. Chi-Square	231.14	Items are significant and adequate for FA
		df	10	
		Sig.	0.00	

6.5.5.6 Communality estimates of items in risk effects on project delivery

The communality estimates of the items in REPD were computed and presented in Table 6.66. The estimates show that four out of five items demonstrated better extraction proportions of the amount of variance that can be explained pertaining to REPD to determine the impact of risks occurrence in civil infrastructure projects. REPD1 (risk associated with claims due to errors and omissions in design) (0.68), followed by REPD3 (construction risk associated with poor management by contractor's (managerial risk)) (0.55), while REPD4 (risk associated with consultant performance (consultant competencies skills)) (0.47) produced the least amount of variance that can be explained in the data.

Table 6.66: Communalities of items in REPD

Communality Proportions of Items in REPD			
Code	**Item**	**Initial**	**Extraction**
REPD1	Risk associated with claims due to errors and omissions in design	1.00	0.68
REPD2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	1.00	0.51
REPD3	Construction risk associated with poor management by contractor's (managerial risk)	1.00	0.55
REPD4	Risk associated with consultant performance (consultant competencies skills)	1.00	0.47
REPD5	Construction site health and safety practices risk	1.00	0.54

6.5.5.7 Total variance of items explained in risk effects on project delivery

The analysis of the amount of variance explained in REPD is presented in Table 6.67. In the table, factor 1 has the largest eigenvalue of 2.75, which produced extractable loadings from the total variance explained in REDP. Other factors represented eigenvalues below 1.00 as shown in Appendix F. These findings indicate that 54.97% of variance represents the number of factors that can be extracted from REPD. The extraction section of the table shows that only one factor is extracted which is not adequate for factor rotation because of the magnitude of variance explained in factors 2 – 5. Therefore, the variation in the data cannot be alternated to obtain pattern and structure matrices for the purpose of this investigation.

Table 6.67: Total variance of items explained in REPD

Total Variance Explained in Risk Associated with REPD						
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.75	54.97	54.97	2.75	54.97	54.97
2	0.77	15.39	70.36			
3	0.58	11.53	81.89			
4	0.54	10.73	92.64			
5	0.37	7.36	100.00			

6.5.5.8 Factor loadings of items in risk effects on project delivery

The factor loading results array in Table 6.68 shows that all the five items have a strong relationship as well as positively converging on one factor. Nonetheless, the relationship however does not adequately give an extensive interpretation of the data in producing more than one underlying factor affecting progress of civil infrastructure projects pertaining to REPD. The model is inadequate to generate the path analysis to model the linearity amongst more than one factor. REPD1 (risk associated with claims due to errors and omissions in design) (0.827) indicated the largest factor loading, while REPD4 (risk associated with consultant performance (consultant competencies skills)) indicated least loading score of 0.683.

Table 6.68: Factor matrix of items in REPD

Factor Loadings of Items in REPD		
Code	**Item**	**Factor Matrix**
		Factor
REPD1	Risk associated with claims due to errors and omissions in design	**0.827**
REPD2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)	**0.715**
REPD3	Construction risk associated with poor management by contractors (managerial risk)	**0.742**
REPD4	Risk associated with consultant performance (consultant competencies skills)	**0.683**
REPD5	Construction site health and safety practices risk	**0.733**

The underlying factor represents *'risk associative impacts on project realisation'* as it affects the delivery of civil infrastructure projects as a result of design-related issues, project delivery issues, stakeholders' administration- and skill-related as well as site operations-related issues.

6.5.5.9 KMO Test and Bartlett's sphericity test of risk associated with risk-causative variables

The KMO test and Bartlett's test of sphericity computed for RARCV yielded acceptable values. Table 6.69 shows that KMO test value of 0.72 and Bartlett's test of sphericity value of p=0.00 are within the acceptable limits (Yong and Pearce, 2013; Civelek, 2018). These tests ease the assessment of the fitness and adequacy of data for dimensionality reduction.

Table 6.69: KMO test and Bartlett's sphericity test scores for risk associated with RARCV

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
RARCV	0.72	Approx. Chi-Square	282.50	Items are significant and adequate for FA
		df	55	
		Sig.	0.00	

6.5.5.10 Communality estimates of items in risk associated with risk-causative variables

Table 6.70 illustrates the communality estimates of items in RARCV. Data shows that all the items have communality proportions above 0.40 as an indication of appropriate path model performance (Vehkalahti, 2000; Yong and Pearce, 2013). In the table, items with communality factors, with less proportion of variance explained in the data. However, the data is unfit for the rotation to attain improved results to generate the pattern and structure matrices.

Table 6.70: Communalities of items in risk associated with RARCV

Communality Proportions of Items in Risk Associated with RARCV			
Code	**Item**	**Initial**	**Extraction**
RARCV1	Occurrence of financial claims	1.00	**0.65**
RARCV2	Claim causes delays in project delivery	1.00	0.59
RARCV3	Overbearing influence of project stakeholders during project execution	1.00	0.45
RARCV4	Lack of understanding of the contractual terms and conditions	1.00	0.55
RARCV5	Frequent delays on-site due to site conditions, designer and user changes	1.00	0.54
RARCV6	Lack of proper notification procedures	1.00	**0.69**
RARCV7	Poor documentation and management practices during construction	1.00	**0.82**
RARCV8	Formation of a standard form of contract	1.00	**0.66**
RARCV9	Procurement method (awarding the bid to the lowest bidder)	1.00	**0.63**
RARCV10	Adoption of new construction technology has great potential to improve productivity and decrease project duration	1.00	0.51
RARCV11	Constant delay caused by litigation between owner and contractors, contract termination and loss of productivity	1.00	0.43

6.5.5.11 Total variance of items explained in risk associated with risk-causative variables

The estimates of the variance explained in risk associated with risk-causative variables (RARCV) are arrayed in Table 6.71 to illustrate the number of factors that can be extracted. Factors 1, 2, 3 and 4 demonstrated initial eigenvalues greater than one (Schumacker and Lomax, 2021; Yong and Pearce, 2013), which means that only these four factors demonstrated a decent proportion of variance. A scree plot was plotted to simplify the distribution of the eigenvalues to validate the extraction of factors (Appendix F). The graph confirmed that only four factors have demonstrated eigenvalues above 1.00 directly on the elbow spot before the line flattened out (Vehkalahti, 2000; Schumacker and Lomax, 2021; Yong and Pearce, 2013).

Table 6.71: Total variance of items explained in risk associated with RARCV

Total Variance Explained in Risk Associated with RARCV							
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.92	26.57	26.57	2.92	26.57	26.57	2.64
2	1.41	12.82	39.40	1.41	12.82	39.40	1.59
3	1.13	10.28	49.68	1.13	10.28	49.68	1.39
4	1.05	9.52	59.20	1.05	9.52	59.20	1.47
5	0.93	8.44	67.64				
6	0.76	6.87	74.51				
7	0.70	6.40	80.92				
8	0.66	5.97	86.88				
9	0.56	5.12	92.00				
10	0.47	4.26	96.26				
11	0.41	3.74	100.00				

Further deductions indicate that factor 1 explained nearly 27.00% variance in the data, while factors 2, 3 and 4 explained a sum of 32.62% variance. These four factors produced extractable loadings (60.00%) from the total variance explained in RARCV. However, it is observed that variance distribution is one-sided across the four factors, which could result in an undefined interpretation of the results. Direct Oblimin rotation technique with Kaiser normalisation was used to improve the distribution of variance across the four factors (Vehkalahti, 2000; Schumacker and Lomax, 2021; Yong and Pearce, 2013; Osborne, 2015; Andrew, 2016).

The outcome of the rotation shows that the proportion of variance for factor 1 has reduced by 0.28, while proportions explained by the other three factors improved; however, factor 4 gained most in variance rotation amongst the three factors. This technique facilitates the reduction of multiple loadings of items across the factors (Osborne, 2015).

6.5.5.12 Factor loadings of items in risk associated with risk-causative variables

Factor loading results present in Table 6.72 show positive and negative loading scores of items in RARCV, with cross-loading of some items across factors. According to the pattern matrix, five items each are loaded on factor 1 and factor 2, four items on factor 3, and three items on factor 4. Cross-loading of items was also noticed in some parts of the pattern matrix, where only the significant loading scores were considered for further use to ascertain their importance in quantifying the principal effects of RARCV in civil construction projects.

After discarding unfit factor loadings, it is observed that factor 1 now has four significant items, two significant items on factor 2, three significant items on factor 3, and one significant item on factor 4. Further deductions show that RARCV1 (occurrence of financial claims) (0.830), RARCV2 (claim causes delays in project delivery) (0.783), RARCV3 (overbearing influence of project stakeholders during project execution) (0.616), and RARCV4 (lack of understanding of the contractual terms and conditions) (0.566) are positively converged on factor 1. RARCV8 (formation of a standard form of contract) (0.785) and RARCV11 (constant delay caused by litigation between owner and contractors, contract termination and loss of productivity) (0.579) are positively combined on factor 2. RARCV9 (procurement method (awarding the bid to the lowest bidder)) exhibited the highest loading score of -0.667 on factor 3, followed by RARCV10 (adoption of new construction technology has great potential to improve productivity and decrease project duration) (-0.596) and RARCV6 (lack of proper notification procedures) (0.547), while only RARCV7 (poor documentation and management practices during construction) (0.913) is strongly loaded on factor 4.

The negatively loaded items on the factors signify an independent linear relationship between them, which shows that some items have impacts or contributions in different direction. The correlation between these items and factors are illustrated in the structure matrix. The linear relationship between the items and the factors, establishes that the significant items loaded on factor 1, factor 2 and factor 4 varied together positively with one of the significant items on factor 3, and in opposite direction with the other significant items on factor 3 as principal underlying risk-causative factors affecting construction project delivery.

Table 6.72: Factor matrix, pattern matrix, and structure matrix of items in risk associated with RARCV

Factor Loadings of Items in Risk Associated with Risk-causative Variables													
Code	**Items Loaded**	**Unrotated Loadings Result**				**Rotated Loadings Result**							
		Factor Matrix				**Pattern Matrix**				**Structure Matrix**			
		Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
RARCV1	Occurrence of financial claims	**0.694**				**0.830**				**0.796**			
RARCV2	Claim causes delays in project delivery	**0.672**				**0.783**				**0.759**			
RARCV3	Overbearing influence of project stakeholders during project execution	**0.646**				**0.616**				**0.649**			
RARCV4	Lack of understanding of the contractual terms and conditions	**0.578**	-0.375			**0.566**			0.330	**0.621**			0.472
RARCV5	Frequent delay on-site due to site conditions, designer and user changes	0.409		-0.433	0.412		-0.315	-0.397	0.414	0.358		-0.439	0.496
RARCV6	Lack of proper notification procedures	**0.517**		**0.610**		0.495	0.345	**0.547**		**0.525**	0.385	0.439	0.303
RARCV7	Poor documentation and management practices during construction	0.336			**0.776**				**0.913**				**0.867**
RARCV8	Formation of a standard form of contract	0.406	**0.582**	0.391			**0.785**				**0.791**		
RARCV9	Procurement method (awarding the bid to the lowest bidder)		**0.633**	-0.344			0.387	**-0.667**			0.428	**-0.682**	
RARCV10	Adoption of new construction technology has great potential to improve productivity and decrease project duration	0.488	0.330	-0.392				**-0.596**		0.329		**-0.643**	
RARCV11	Constant delay caused by litigation between owner and contractors, contract termination and loss of productivity	0.451	0.418				**0.579**				**0.614**		

6.5.5.13 Path model for risk associated with risk-causative variables

Figure 6.4 illustrates the path model for RARCV. Four items are represented as endogenous variables on factor 1, two items on factor 2, three items on factor 3 and one item on factor 4. According to the diagram, factor 1 linearly represents the *'incompetent and unethical stakeholders'* as it causes delays in project delivery as a result of poor interpretation of contract, financial issues, claims implementation and stakeholders' high-handedness.

Similarly, factor 2 describes *'poor contract development'* as it encourages poor preparation of contracts and legal claims in construction projects. Factor 3 represents *'poor reportage and obsolete technical systems'* as it influences the project reporting, procurement technique, efficient and prompt delivery of projects, while factor 4 measures *'poor handling of construction policies'* as it causes lack of effective documentation and management practices in construction.

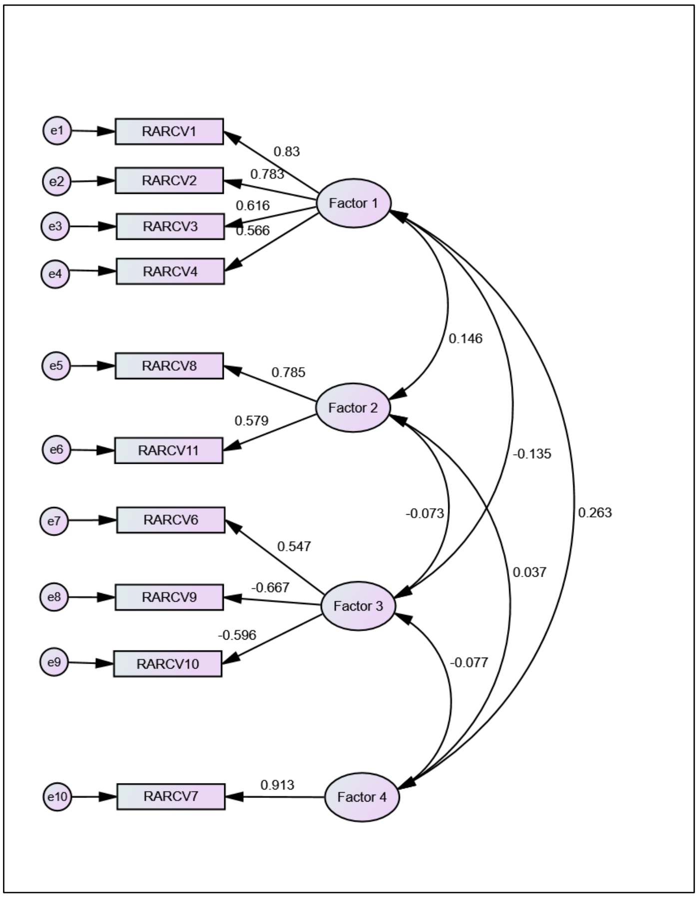

Figure 6.4: The path model for risk associated with RARCV

The relationship between the four factors was also observed to determine the factor with the strongest influence as a causative factor. The relationship demonstrates positive and negative correlations between the factors, which means that some factors have strong association as underlying risk-causative factors, with some factors having the least influences on civil construction projects. Factor 1 and factor 4 exhibited the strongest correlation score of 0.263, followed by the correlation between factor 1 and factor 2 (0.146), factor 1 and factor 3 (-0.135), factor 3 and factor 4 (-0.077), factor 2 and factor 3 (-0.073), and factor 2 and factor 4 exhibited the least correlation of 0.037.

6.5.5.14 KMO test and Bartlett's sphericity test of frequency occurrence of contractual claims

The KMO test and Bartlett's test of sphericity for FOCC were conducted to ascertain the underlying factors causing regular occurrence of contractual claims risk. The test results showed that the data pertaining to FOCC are adequate and reliable for FA procedure as confirmed with a KMO test score of 0.82 and Bartlett's sphericity test score of p=0.00 as illustrated in Table 6.73. The two tests results are within acceptable standards as validation for the data reduction process (Yong and Pearce, 2013; Andrew, 2016; Civelek, 2018).

Table 6.73: KMO test and Bartlett's sphericity test scores for FOCC

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
FOCC	0.82	Approx. Chi-Square	656.67	Items are significant and adequate for FA
		df	153	
		Sig.	0.00	

6.5.5.15 Communality Estimates of Items in frequency occurrence of contractual claims

Table 6.74 displays communality estimates of items in FOCC. All 18 items have communality proportions above 0.40, which indicates that decent proportions of variation can be explained in each item (Hox and Bechger, 1999; Vehkalahti, 2000; Huang and Abdel-Aty, 2010; Yong and Pearce, 2013; Schumacker and Lomax, 2021). Among these items, FOCC18 (others) (0.68) exhibited most adequate proportion of variation, followed by FOCC2 (extension of time claims), FOCC8 (loss of profit claims), and FOCC11 (wrongful withholding of deposits claims) with equal proportion of variation (0.64), further followed by FOCC15 (dayworks claims) (0.63), FOCC12 (variation order claims) (0.62), with FOCC1 (delay claims) and FOCC6 (change in work order claims) yielding equal proportion of variation (0.60) that can be explained. Therefore, FOCC18 produces adequate path model results (Vehkalahti, 2000; Yong and Pearce, 2013).

Table 6.74: Communalities of items in FOCC

Community Proportions of Items in FOCC			
Code	**Item**	**Initial**	**Extraction**
FOCC1	Delay claims	1.00	**0.60**
FOCC2	Extension of time claims	1.00	**0.64**
FOCC3	Disruption and loss of productivity claims	1.00	0.51
FOCC4	Acceleration claims	1.00	0.50
FOCC5	Prolongation claims	1.00	0.42
FOCC6	Change of work order claims	1.00	**0.60**
FOCC7	Damage claims	1.00	0.45
FOCC8	Loss of profit claims	1.00	**0.64**
FOCC9	Loss and expenses claims	1.00	0.42
FOCC10	Payment-related	1.00	0.43
FOCC11	Wrongful withholding of deposits claims	1.00	**0.64**
FOCC12	Variation order claims	1.00	**0.62**
FOCC13	Extra work claims	1.00	0.53
FOCC14	Non-performance claims	1.00	0.46
FOCC15	Dayworks claims	1.00	**0.63**
FOCC16	Contract ambiguity claims	1.00	0.52
FOCC17	Different construction site condition claims	1.00	0.56
FOCC18	Others	1.00	**0.68**

6.5.5.16 Total variance of items explained in frequency occurrence of contractual claims

Data representing the total variance of items explained in FOCC are arrayed in Table 6.75. Factor 1 to factor 5 account for initial eigenvalues greater than 1.00, which signify the highest proportion of variance. Factor 1 accounts for an initial eigenvalue of 4.65 with the most variance (25.85%) as shown in the data; 28.73% proportion of variance in the data were explained by factors 2 – 5. These five items produced extractable loadings from the total variance explained in FOCC.

A graphical illustration of the result is presented in the scree plot (Appendix F), which substantial the result presented in Table 6.75. The graph shows that only factors above the flatline are suitable for extraction specified by a slow increase in the cumulative proportion as a result of the decrease in the variabilities explained from factor 6 – 18 (Yong and Pearce, 2013; Schumacker and Lomax, 2021).

The extraction of the factors explained slightly more than 50.00% of the variation in the data. The distribution of variance across these factors is redistributed by using the Oblimin rotation method with Kaiser normalisation (Yong and Pearce, 2013; Osborne, 2015; Schumacker and Lomax, 2021). The result indicates a large increase in the proportion of variance as explained by factors 2 – 5. The rotation of the data ensures that the factor loadings of the data can be explained (Civelek, 2018; Schumacker and Lomax, 2021).

Table 6.75: Total variance of items explained in FOCC

Total Variance Explained in FOCC							
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.65	25.85	25.85	4.65	25.85	25.85	3.17
2	1.80	10.00	35.84	1.80	10.00	35.84	2.31
3	1.19	6.59	42.44	1.19	6.59	42.44	2.50
4	1.16	6.42	48.85	1.16	6.42	48.85	2.34
5	1.03	5.72	54.57	1.03	5.72	54.57	2.01
6	0.99	5.50	60.07				
7	0.82	4.55	64.61				
8	0.81	4.49	69.11				
9	0.78	4.35	73.45				
10	0.77	4.27	77.72				
11	0.68	3.78	81.51				
12	0.60	3.31	84.81				
13	0.54	3.01	87.83				
14	0.52	2.90	90.72				
15	0.48	2.64	93.36				
16	0.45	2.51	95.87				
17	0.39	2.19	98.06				
18	0.35	1.94	100.00				

6.5.5.17 Factor loadings of items in frequency occurrence of contractual claims

Table 6.76 presents loading scores of items on underlying factors pertaining to FOCC. The data shows the presence of positive and negative loading of items on factors, including cross-loadings and loading scores less than 0.500. In the table, six items are loaded on factor 1, but only five items are significant. Four items are loaded on factor 2, factor 3, and factor 4 respectively but only three items each are fit for use. Factor 5 is loaded with five items, but only two are significant. FOCC2 (extension of time claims) (0.791) is the most positive loading on factor 1, followed by FOCC1 (delay claims) (0.717), FOCC10 payment related claims' (0.560), FOCC5 'prolongation claims' (0.543), and FOCC4 'acceleration claims' (0.518). FOCC18 'others' (0.818), FOCC17 'different construction site condition claims' (0.571), and FOCC9 'loss and expenses claim' (0.505) are positively loaded on factor 2. FOCC11 'wrongful withholding of deposits claims' (-0.784) FOCC12 (-0.763), and FOCC13 'extra work claims' (-0.525) are negatively loaded on factor 3. FOCC8 'loss of profit claims' (-0.689), FOCC6 'change of work order claims' (-0.661), and FOCC7 'damage claims' (-0.597) are negatively loaded on factor 4, while only FOCC15 'dayworks claims' (-0.781) and FOCC16 'contract ambiguity claims' (-0.558) are the only two significant loadings on factor 5.

The structure matrix shows that the correlations between factors and items exhibit both positive and negative loadings. In the matrix, some items are positively correlated on factors 1 and 2, while some items are negatively correlated on other factors.

Table 6.76: Factor matrix, pattern matrix, and structure matrix of items in frequency occurrence (FOCC)

Factor Loadings of Items in Frequency Occurrence of Contractual Claims in Civil Infrastructure Projects (FOCC)																
Code	**Item**	**Unrotated Loadings Result**					**Rotated Loadings Result**									
		Factor Matrix					**Pattern Matrix**					**Structure Matrix**				
		Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
FOCC1	Delay claims	**0.581**	-0.447				**0.717**					**0.743**			-0.373	
FOCC2	Extension of time claims	**0.548**	**-0.502**				**0.791**					**0.785**				
FOCC3	Disruption and loss of productivity claims	**0.624**	-0.308				0.452			-0.372		**0.583**	0.310		**-0.518**	
FOCC4	Acceleration claims	**0.531**			0.416		**0.518**					**0.590**	0.414	-0.336		
FOCC5	Prolongation claims	**0.532**	-0.304				**0.543**					**0.610**				
FOCC6	Change of work order claims	**0.510**		-0.314	-0.309					**-0.661**		0.348		-0.303	**-0.704**	
FOCC7	Damage claims	0.471			-0.347					**-0.597**		0.337			**-0.645**	
FOCC8	Loss of profit claims	**0.520**			**-0.586**					**-0.689**	-0.332				**-0.702**	-0.397
FOCC9	Loss and expenses claim	0.329		0.366		0.343		**0.505**					**0.515**		-0.337	
FOCC10	Payment-related Claims	0.416				-0.410	**0.560**					**0.529**				-0.349
FOCC11	Wrongful withholding of deposits claims	0.493	0.324	**-0.532**					**-0.784**					**-0.788**		
FOCC12	Variation order claims	0.463	0.348	-0.411					**-0.763**					**-0.768**		
FOCC13	Extra work claims	**0.561**	0.373						**-0.525**		-0.325			**-0.618**		-0.457
FOCC14	Non-performance claims	**0.570**	0.367						-0.359		-0.347		0.394	-0.499		-0.475
FOCC15	Dayworks claims	0.366	0.405			-0.488					**-0.781**					**-0.784**
FOCC16	Contract ambiguity claims	**0.523**		0.370				0.308			**-0.558**	0.303	0.431			**-0.615**
FOCC17	Different construction site condition claims	**0.595**		0.321				**0.571**					**0.664**	-0.317		-0.409
FOCC18	Others	0.407	0.337	0.381		0.435		**0.818**					**0.797**			

6.5.5.18 Path diagram for frequency occurrence of contractual claims

Figure 6.5 represents the path model developed for FOCC with five factors and their corresponding items as principal occurrence of contractual claims during project execution. Five items are represented as endogenous variables on factor 1; three items each on factors 2, 3 and 4 are represented as endogenous variables; and two items on factor 5 as endogenous variables. According to the model, factor 1 represents *'project delays and payment issues'* as it influences timely completion and delivery of projects.

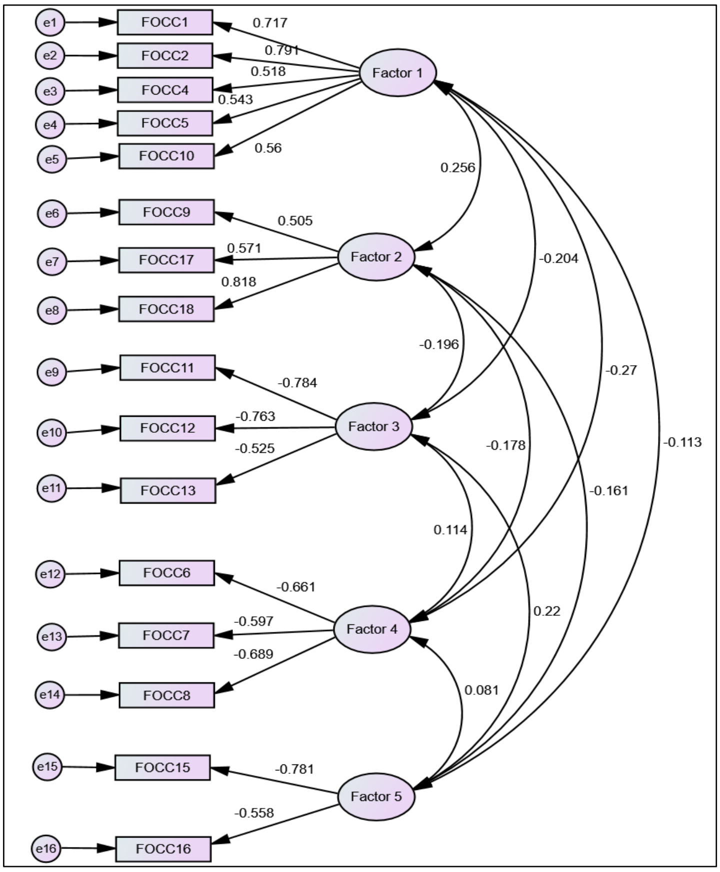

Figure 6.5: The path model for frequency occurrence of contractual claims (FOCC)

Factor 2 represents *'construction site occurrence'* as it influences commencement of construction work and proper handling of construction site. Factor 3 represents *'illegal refusal of deposits and claims payment'* as it influences work duration, performance morale and proper planning in construction project delivery. Factor 4 represents *'payment deficits and work variation'* as it prevents work acceleration and timely procurement of construction materials, while factor 5 represents claim on *'unclear contract and dayworks deficits'* as it affects project execution, cost and time efficiency, and performance delivery.

The relationship between the factors demonstrates both positive and negative correlations. The relationship between factors 1 and 4 shows the strongest correlation score of -0.270, followed by factors 1 and 2 (0.256), then factors 3 and 5 (0.220), factors 1 and 3 (-0.204), factors 2 and 3 (-0.196), factors 2 and 4 (-0.178), factors 2 and 5 (-0.161), factors 3 and 4 (0.114), factors 1 and 5 (-0.113). The relationship between factors 4 and 5 yields the lowest correlation score of 0.081. This shows that some factors occur frequently as underlying contractual claims risk, while others occur rarely.

6.6 ESSENTIAL STRATEGIES TO MITIGATE RISK IN CIVIL INFRASTRUCTURE PROJECTS: OBJECTIVE 3

This section investigates the significant strategies applicable to mitigate risk occurrence during project execution as pertaining to stakeholder related activities. The significance of these strategies is quantified through the application of a five-point Likert scale, such as where 5 = Strongly agree, 4 = Agree, 3 = Slightly agree, 2 = Disagree, and 1 = Strongly disagree.

6.6.1 Client strategies

The descriptive analysis of BTC (by the client) is based on the activities performed, which were perceived as the cause of contractual claims risk in civil infrastructure projects. Data displayed in Table 6.77 show that all seven items yielded mean scores above 3.00, specifying their significance in mitigating client-related issues that instigate contractual claims risk occurrence during construction projects. In the table, BTC1 (ensure availability of the funds) has the highest mean score of 4.26, with other items exhibiting impact below a mean score of 4.00. This indicates the significance of these items in determining the applicable strategies required to mitigate contractual claims risk in ensuring complete project delivery.

The above deductions are consolidated with the respondents' responses given in Table 6.78. The distribution of the responses revealed that 59.7% respondents agree or strongly agree that BTC1 (ensure availability of the funds) is a significant strategies in mitigating the issues pertaining to clients' contractual activities causing contractual claims risk. Other results indicated that 77.7%, 83.7%, and 83.1% respondents slightly agree or agree that BTC2 (engage experienced contractors and consultant), BTC3 (awarding bids to the best contractor not to the lowest bidder), and BTC7 (specify a realistic contract period for the contractor) are significant strategies in mitigating the issues pertaining to clients' contractual activities. Refer to Appendix G for frequency scores of the other BTC items.

Table 6.77: Descriptive statistical results of items BTC

Descriptive Statistical Scores for BTC								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
BTC1	Ensure availability of the funds	166	2.00	5.00	**4.26**	0.65	0.42	1
BTC2	Engage experienced contractors and consultant	166	2.00	5.00	3.85	0.74	0.55	2
BTC3	Award bids to the best contractor not to the lowest bidder	166	2.00	5.00	3.68	0.74	0.55	3
BTC7	Specify a realistic contract period for the contractor	166	1.00	5.00	3.63	0.77	0.60	4
BTC5	Efficient coordination with the other parties	166	2.00	5.00	3.60	0.75	0.57	5
BTC4	Efficient contract management	166	2.00	5.00	3.57	0.72	0.53	6
BTC6	Develop a reliable procurement process	166	1.00	5.00	3.54	0.74	0.55	7

Table 6.79 shows the inter-item correlation data of the seven items under BTC. The data shows that items are positively correlated as it indicates their dependability for mitigating contractual claims issues pertaining to BTC. Observations reveal that BTC1 (ensure availability of the funds) and BTC2 (engage experienced contractors and consultant) are strongly correlated (0.507), with BTC1 (ensure availability of the funds) and BTC5 (efficient coordination with the other parties) (0.177) having the lowest correlation among the five items. The dependability between BTC1 and BTC2 will yield a reliable path model in mitigating contractual claims risk concerning clients' contractual issues.

Table 6.78: Frequency scores of the first-four items in BTC

Frequency Scores for BTC								
Likert scales	**Ensure availability of the funds (BTC1)**				**Engage experienced contractors and consultant (BTC2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Strongly disagree	0	0.0	0.0	0.0	1	0.6	0.6	0.6
2 = Disagree	1	0.6	0.6	0.6	4	2.4	2.4	3.0
3 = Slightly agree	16	9.6	9.6	10.2	51	30.7	30.7	33.7
4 = Agree	88	53.0	53.0	63.3	78	47.0	47.0	80.7
5 = Strongly agree	61	36.7	36.7	**100.0**	32	19.3	19.3	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Award bids to the best contractor not to the lowest bidder (BTC3)**				**Specify a realistic contract period for the contractor (BTC7)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Strongly disagree	0	0.0	0.0	0.0	1	0.6	0.6	0.6
2 = Disagree	7	4.2	4.2	4.2	3	1.8	1.8	2.4
3 = Slightly agree	59	35.5	35.5	39.8	77	46.4	46.4	48.8
4 = Agree	80	48.2	48.2	88.0	61	36.7	36.7	85.5
5 = Strongly agree	20	12.0	12.0	**100.0**	24	14.5	14.5	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.79: Inter-item correlation matrix illustration of items in BTC

Inter-Item Correlation Matrix for BTC								
Code	**Item**	**Ensure availability of the funds**	**Engage experienced contractors and consultant**	**Award bids to the best contractor not to the lowest bidder**	**Efficient contract management**	**Efficient coordination with the other parties**	**Develop a reliable procurement process**	**Specify a realistic contract period for the contractor**
		BTC1	**BTC2**	**BTC3**	**BTC4**	**BTC5**	**BTC6**	**BTC7**
BTC1	Ensure availability of the funds	1.000	**0.507**	0.337	0.314	**0.177**	0.372	0.338
BTC2	Engage experienced contractors and consultant	**0.507**	1.000	0.375	0.228	0.183	0.302	0.312
BTC3	Award bids to the best contractor not to the lowest bidder	0.337	0.375	1.000	0.355	0.365	0.350	0.257
BTC4	Efficient contract management	0.314	0.228	0.355	1.000	0.358	0.264	0.232
BTC5	Efficient coordination with the other parties	**0.177**	0.183	0.365	0.358	1.000	0.274	0.259
BTC6	Develop a reliable procurement process	0.372	0.302	0.350	0.264	0.274	1.000	0.344
BTC7	Specify a realistic contract period for the contractor	0.338	0.312	0.257	0.232	0.259	0.344	1.000

6.6.2 Main contractor's strategies

The descriptive data generated from the analysis of the main contractor's strategies (BTMC) demonstrate that all six items have mean scores above 3.00, denoting their significance in mitigating contractual activities performed by a main contractor that could cause contractual claims risk in civil infrastructure projects (Table 6.80). It is observed that BTMC1 (efficient construction planning by the main contractor) has the highest mean score of 4.28, while other related items have relative mean scores below 4.00 as other significant strategies to mitigate activities performed by the contractor that could cause contractual claims risk.

Table 6.80: Descriptive statistical results of items in BTMC

Descriptive Statistical Scores for BTMC								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
BTMC1	Efficient construction planning by the main contractor	166	3.00	5.00	**4.28**	0.70	0.50	1
BTMC2	Efficient site management and supervision	166	2.00	5.00	3.81	0.76	0.58	2
BTMC3	Increase work shifts to increase productivity	166	2.00	5.00	3.70	0.79	0.62	3
BTMC5	Efficient quality management system	166	2.00	5.00	3.62	0.73	0.54	4
BTMC4	Timely response to the consultant instructions	166	2.00	5.00	3.58	0.66	0.44	5
BTMC6	Speed up the site activities by the use of sub-contractors	166	2.00	5.00	3.46	0.68	0.47	6

In Table 6.81, the distribution of responses across the items indicates that 85.6% respondents proportionally agree or strongly agree that BTMC1 (efficient construction planning by the main contractor) is potentially adequate to mitigate contractual issues concerning main contractor. 78.9%, 79.5%, and 85.0% respondents slightly agree or agree that BTMC2 (efficient site management), BTMC5 (efficient quality management system), and BTMC3 (increase work shifts to increase productivity) are respectively significant in mitigating contractual claims risk pertaining to contractual issues caused by the main contractor during construction projects.

The inter-item correlation data in Table 6.82 demonstrates that all items are positively correlated, with BTMC1 (efficient construction planning by the main contractor) and BTMC2 (efficient site management and supervision) exhibiting the highest correlation score of 0.451. The association between BTMC4 (timely response to the consultant instructions) and BTMC6 (speed up the site activities by the use of the sub-contractors) yielded the least correlation score of 0.115, which defines them as the worst path model for mitigation (Vogt and Johnson, 2015; Senthilnathan, 2019).

Table 6.81: Frequency scores of the first-four items ranked in BTMC

Frequency Scores for BTMC								
Likert scales	**Efficient construction planning by the main contractor (BTMC1)**				**Efficient site management and supervision (BTMC2)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Strongly disagree	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Disagree	0	0.0	0.0	0.0	5	3.0	3.0	3.0
3 = Slightly agree	24	14.5	14.5	14.5	51	30.7	30.7	33.7
4 = Agree	71	42.8	42.8	57.2	80	48.2	48.2	81.9
5 = Strongly agree	71	42.8	42.8	**100.0**	30	18.1	18.1	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Likert scales	Increase work shifts to increase productivity (BTMC3)				Efficient quality management system (BTMC5)			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Strongly disagree	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Disagree	3	1.8	1.8	1.8	8	4.8	4.8	4.8
3 = Slightly agree	75	45.2	45.2	47.0	64	38.6	38.6	43.4
4 = Agree	57	34.3	34.3	81.3	77	46.4	46.4	89.8
5 = Strongly agree	31	18.7	18.7	**100.0**	17	10.2	10.2	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.82: Inter-item correlation matrix illustration of the six items in BTMC

Inter-Item Correlation Matrix for BTMC							
Code	Item	Efficient construction planning by the main contractor	Efficient site management and supervision	Increase work shifts to increase productivity	Timely response to the consultant instructions	Efficient quality management system	Speed up the site activities by the use of the sub-contractors
		BTMC1	BTMC2	BTMC3	BTMC4	BTMC5	BTMC6
BTMC1	Efficient construction planning by the main contractor	1.000	**0.451**	0.394	0.241	0.197	0.270
BTMC2	Efficient site management and supervision	**0.451**	1.000	0.401	0.242	0.361	0.271
BTMC3	Increase work shifts to increase productivity	0.394	0.401	1.000	0.362	0.303	0.335
BTMC4	Timely response to the consultant instructions	0.241	0.242	0.362	1.000	0.160	**0.115**
BTMC5	Efficient quality management system	0.197	0.361	0.303	0.160	1.000	0.227
BTMC6	Speed up the site activities by the use of the sub-contractors	0.270	0.271	0.335	**0.115**	0.227	1.000

6.6.3 Consultant's strategies

This section presents the descriptive data for consultant's strategies (BTCo) for identifying potential strategies suitable for mitigating the contractual claims risk issues concerning contractual activities performed by the consultant during construction project delivery. In Table 6.83, the mean score for all four items was above 3.00, which indicates their significance as potential strategies in mitigating contractual claims risk that may emerge from the contractual activities exercised by the construction consultant. The data further shows that BTCo1 (efficient internal approval) has the highest mean score of 4.37, with the three other items exhibiting mean scores below 4.00.

Table 6.83: Descriptive statistical results of items in consultant's strategies

Descriptive Statistical Scores for Consultant Strategies								
Code	Item	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
BTCo1	Efficient internal approval	166	2.00	5.00	**4.37**	0.66	0.43	1
BTCo2	Efficient inspection system process	166	1.00	5.00	3.79	0.74	0.54	2
BTCo3	Timely response to contractor's inquiries	166	1.00	5.00	3.69	0.80	0.64	3
BTCo4	Cooperating with the contractor	166	1.00	5.00	3.52	0.81	0.65	4

In Table 6.84, the frequency distribution of responses further indicated that 92.8% respondents agree or strongly agree that BTCo1 (efficient internal approval) is potentially adequate to mitigate contractual issues concening consultant. 83.7%, 80.2% and 82.5% respondents slightly agree or agree that BTCo2 (efficient inspection system process), BTCo3 (timely response to contractor's inquiries), and BTCo4 (cooperating with the contractor) are respectively significant in mitigating consultant-related issues during construction projects.

Table 6.84: Frequency scores of the four items in consultant's strategies

Frequency Scores for Consultant Strategies								
Likert scales	Efficient internal approval (BTCo1)				Efficient inspection system process (BTCo2)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Strongly disagree	0	0.0	0.0	0.0	2	1.2	1.2	1.2
2 = Disagree	2	1.2	1.2	1.2	2	1.2	1.2	2.4
3 = Slightly agree	10	6.0	6.0	7.2	48	28.9	28.9	31.3
4 = Agree	78	47.0	47.0	54.2	91	54.8	54.8	86.1
5 = Strongly agree	76	45.8	45.8	**100.0**	23	13.9	13.9	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	Timely response to contractor's inquiries (BTCo3)				Cooperating with the contractor (BTCo4)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Strongly disagree	1	0.6	0.6	0.6	2	1.2	1.2	1.2
2 = Disagree	5	3.0	3.0	3.6	8	4.8	4.8	6.0
3 = Slightly agree	65	39.2	39.2	42.8	77	46.4	46.4	52.4
4 = Agree	68	41.0	41.0	83.7	60	36.1	36.1	88.6
5 = Strongly agree	27	16.3	16.3	**100.0**	19	11.4	11.4	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

The inter-item correlation results given in Table 6.85 illustrate a positive correlation between the items pertaining to BTCo, which signifies that all the four items positively influenced each other. BTCo1 (efficient internal approval) and BTCo2 (efficient inspection system process) had the highest correlation score of 0.566, while BTCo2 (efficient inspection system process) and BTCo4 (cooperating with the contractor) had the lowest correlation score of 0.266. The association between the four items demonstrated a robust dependability of items as appropriate strategies in mitigating contractual claims risk resulting from the contractual activities carried out by a construction consultant.

Table 6.85: Inter-item correlation matrix illustration of items in consultant strategies

Inter-Item Correlation Matrix for Consultant Strategies					
Code	**Item**	**Efficient internal approval**	**Efficient inspection system process**	**Timely response to contractor's inquiries**	**Cooperating with the contractor**
		BTCo1	**BTCo2**	**BTCo3**	**BTCo4**
BTCo1	Efficient internal approval	1.000	**0.566**	0.429	0.297
BTCo2	Efficient inspection system process	**0.566**	1.000	0.383	**0.266**
BTCo3	Timely response to contractor's inquiries	0.429	0.383	1.000	0.361
BTCo4	Cooperating with the contractor	0.297	**0.266**	0.361	1.000

6.6.4 Strategies for mitigation

The descriptive analysis of strategies for mitigating (SFM) demonstrated that all ten items yielded mean scores above 3.00, which signifies their relevance regarding the extent of their applicability in mitigating the contractual claims risk. The descriptive data presented in Table 6.86 shows the perceptions of the respondents pertaining to the significance of these items (strategies) in managing the operational awareness of the stakeholders, with the purpose of mitigating the occurrence of contractual claims risk that may arise in civil infrastructure projects. The data indicates that SFM1 (formulating a clear statement of project missions) has the highest mean score of 4.27 as the most significant mitigating strategy, with other items having mean scores below 4.00 as significant mitigating strategy.

Table 6.86: Descriptive statistical results of items in SFM

Descriptive Statistical Scores for SFM								
Code	**Item**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**	**Rank**
SFM1	Formulating a clear statement of project missions	166	2.00	5.00	**4.27**	0.73	0.53	1
SFM3	Understanding the area of stakeholders' interests	166	2.00	5.00	3.90	0.80	0.65	2
SFM2	Identifying stakeholders properly	166	2.00	5.00	3.87	0.69	0.48	3
SFM4	Exploring stakeholders' needs and project constraints	166	2.00	5.00	3.75	0.79	0.62	4
SFM5	Assessing stakeholders' behaviour; predicting the influence of stakeholders	166	1.00	5.00	3.74	0.69	0.47	5
SFM9	Predicting stakeholders' reaction for implementing the strategies	166	2.00	5.00	3.73	0.75	0.56	6
SFM7	Keeping and promoting a good relationship with stakeholders	166	1.00	5.00	3.70	0.71	0.50	7
SFM6	Analysing conflicts and coalitions among stakeholders	166	1.00	5.00	3.65	0.75	0.57	8
SFM8	Formulating appropriate strategies to manage stakeholders	166	1.00	5.00	3.63	0.77	0.60	9
SFM10	Enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims	166	2.00	5.00	3.58	0.74	0.55	10

The frequency estimates of responses in Table 6.87 indicate respondents' understanding of feasible approaches for lessening the occurrence of contractual claims risk relating to stakeholders' involvement. Observation shows that 85.0% respondents agree or strongly agree that SFM1 (formulating a clear statement of project missions) is a reliable strategy for the handling of the operational awareness of the stakeholders to deter occurrence of contractual claims risk in civil infrastructure projects. A close proportion of respondents slightly agree, agree, or strongly agree that SFM3 (understanding the area of stakeholders' interests) is a reliable strategy for mitigation. However, 81.9% and 78.3% respondents slightly agree or agree that SFM2 (identifying stakeholders properly) and SFM4 (exploring stakeholders' needs and project constraints) are reliable for mitigation.

Table 6.88 presents correlation data pertaining to SFM for establishing the inter-itemcorrelation of the ten items. The data shows that the 10 items are positively correlated as essential strategies for mitigation of the contractual claims risk occurring in civil infrastructure projects. From the data, SFM3 (understanding the area of stakeholders' interests) and SFM4 (exploring stakeholders' needs and project constraints) indicated the highest correlation score of 0.430, while SFM4 (exploring stakeholders' needs and project constraints) and SFM9 (predicting stakeholders' reaction for implementing the strategies) had the lowest correlation score of 0.001. This indicates that the association between SFM3 and SFM4 will yield a reliable path model compared to the association between SFM4 and SFM9 with the poorest dependability (Gliem and Gliem, 2003; Vogt and Johnson, 2015).

Table 6.87: Frequency scores of the first-four items in SFM

Frequency Scores for SFM								
Likert scales	Formulating a clear statement of project missions (SFM1)				Understanding the area of stakeholders' interests (SFM3)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Strongly disagree	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Disagree	1	0.6	0.6	0.6	3	1.8	1.8	1.8
3 = Slightly agree	24	14.5	14.5	15.1	53	31.9	31.9	33.7
4 = Agree	70	42.2	42.2	57.2	67	40.4	40.4	74.1
5 = Strongly agree	71	42.8	42.8	**100.0**	43	25.9	25.9	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	Identifying stakeholders properly (SFM2)				Exploring stakeholders' needs and project constraints (SFM4)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Strongly disagree	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Disagree	2	1.2	1.2	1.2	5	3.0	3.0	3.0
3 = Slightly agree	45	27.1	27.1	28.3	62	37.3	37.3	40.4
4 = Agree	91	54.8	54.8	83.1	68	41.0	41.0	81.3
5 = Strongly agree	28	16.9	16.9	**100.0**	31	18.7	18.7	**100.0**
Total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Table 6.88: Inter-item correlation matrix illustration of items in SFM

Inter-Item Correlation Matrix for SFM											
Code	**Item**	**Formulating a clear statement of project missions**	**Identifying stakeholders properly**	**Understanding the area of stakeholders' interests**	**Exploring stakeholders' needs and project constraints**	**Assessing stakeholders' behaviour; predicting the influence of stakeholders**	**Analysing conflicts and coalitions among stakeholders**	**Keeping and promoting a good relationship with stakeholders**	**Formulating appropriate strategies to manage stakeholders**	**Predicting stakeholders' reaction for implementing the strategies**	**Enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims**
		SFM1	**SFM2**	**SFM3**	**SFM4**	**SFM5**	**SFM6**	**SFM7**	**SFM8**	**SFM9**	**SFM10**
SFM1	Formulating a clear statement of project missions	1.000	0.384	0.243	0.234	0.166	0.318	0.195	0.168	0.100	0.045
SFM2	Identifying stakeholders properly	0.384	1.000	0.295	0.321	0.250	0.299	0.207	0.242	0.123	0.168
SFM3	Understanding the area of stakeholders' interests	0.243	0.295	1.000	**0.430**	0.152	0.164	0.140	0.060	0.078	0.135
SFM4	Exploring stakeholders' needs and project constraints	0.234	0.321	**0.430**	1.000	0.250	0.180	0.159	0.109	**0.001**	0.121
SFM5	Assessing stakeholders' behaviour; predicting the influence of stakeholders	0.166	0.250	0.152	0.250	1.000	0.327	0.212	0.253	0.137	0.082
SFM6	Analysing conflicts and coalitions among stakeholders	0.318	0.299	0.164	0.180	0.327	1.000	0.267	0.278	0.222	0.093
SFM7	Keeping and promoting a good relationship with stakeholders	0.195	0.207	0.140	0.159	0.212	0.267	1.000	0.361	0.294	0.161
SFM8	Formulating appropriate strategies to manage stakeholders	0.168	0.242	0.060	0.109	0.253	0.278	0.361	1.000	0.302	0.215
SFM9	Predicting stakeholders' reaction for implementing the strategies	0.100	0.123	0.078	**0.001**	0.137	0.222	0.294	0.302	1.000	0.388
SFM10	Enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims	0.045	0.168	0.135	0.121	0.082	0.093	0.161	0.215	0.388	1.000

6.6.5 Identifying underlying strategies for contractual claims risk mitigation

This section presents FA conducted for the identification of the underlying strategies for contractual claims risk mitigation (Westland, 2015). This analysis is implemented to reduce the dimensionality of the data to attain interpretable results (Osborne, 2015; Ncube and Moroke, 2016). The adequacy and significance of these data were validated by conducting the KMO and Bartlett's sphericity tests to determine if the underlying factors are adequate strategies to mitigate any impediment that may occur during the implementation of civil infrastructure projects.

6.6.5.1 KMO Test and Bartlett's sphericity Test of Client Strategies

Table 6.89 presents the KMO test of sampling adequacy of the data pertaining to test of client strategies (BTC) yielded a test score of 0.81 and the Bartlett's test of sphericity yielded p = 0.00, which shows the degree of adequacy and suitability of the data for the implementation of FA (Yong and Pearce, 2013; Andrew, 2016; Civelek, 2018).

Table 6.89: KMO test and Bartlett's sphericity test scores for BTC

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
BTC	0.81	Approx. Chi-Square	221.90	Items are significant and adequate for FA
		df	21	
		Sig.	0.00	

6.6.5.2 Communality estimates of items in client strategies (BTC)

The communalities of amount of variation that can be explained in the data concerning BTC were computed (Yong and Pearce, 2013). The estimates are arrayed in Table 6.90, where only six items exhibited adequate path model performance with a communality proportion above 0.40. BTC7 (specify a realistic contract period for the contractor) produced the lowest communality proportion (0.39). This indicates that the path model performance for this particular item is poor compared to BTC5 (efficient coordination with the other parties) (0.70), BTC1 (ensure availability of the funds) (0.66), and BTC2 (engage experience contractors and consultant) (0.64) with a higher variation. These three items accounted for more variances in BTC.

Table 6.90: Communalities of items in BTC

Community Proportions of Items in Client Strategies			
Code	**Item**	**Initial**	**Extraction**
BTC1	Ensure availability of the funds	1.00	**0.66**
BTC2	Engage experienced contractors and consultant	1.00	**0.64**
BTC3	Award bids to the best contractor not to the lowest bidder	1.00	0.51
BTC4	Efficient contract management	1.00	0.54
BTC5	Efficient coordination with the other parties	1.00	**0.70**
BTC6	Develop a reliable procurement process	1.00	0.43
BTC7	Specify a realistic contract period for the contractor	1.00	0.39

6.6.5.3 Total Variance of Items Explained in Client strategies

Table 6.91 depicts eigenvalues of variances explained for each item. In the table, factor 1 accounted for an eigenvalue greater than 1.00, which explained approximately 40.00% variance in the data (Schumacker and Lomax, 2021; Osborne, 2015). Factor 2 accounted for an eigenvalue equal to 1.00, which fell within the extraction point by explaining 14.34% variance in the data. This indicates that only these two factors produced extractable loadings from the total variance explained in BTC.

The rest of the factors explained lower amounts of variance in the data (Yong and Pearce, 2013; Osborne, 2015). Fifty five percent (55%) cumulative percentage of variance were explained by both factor 1 and factor 2, which shows a high increase in the proportion of variance explained in the items. The extraction process is demonstrated in Appendix G, where only two factors fall within the extraction point (deflection point - eigenvalue ≥1.00). Based on the scree plot, it can be observed that factor 1 explained the largest proportion of variance in the data, which appeared weighted. This necessitates the application of the direct Oblimin rotation method with Kaiser normalisation to reduce the disparity in the data (Osborne, 2015).

Table 6.91: Total variance of items explained in BTC

Total Variance Explained in BTC							
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**
1	2.87	40.98	40.98	2.87	40.98	40.98	2.50
2	1.00	14.34	55.33	1.00	14.34	55.33	2.11
3	0.78	11.19	66.52				
4	0.68	9.69	76.20				
5	0.65	9.33	85.54				
6	0.55	7.92	93.46				
7	0.46	6.55	100.00				

The effect of the rotation yielded a better distribution of the data variability between the two underlying factors indicating a drastic reduction of 0.37 for variance explained by factor 1, while factor 2 gained the greatest increase in variability by 1.11. The rotation of data variability amongst the two factors improved the factor loadings by reducing multiple cross-loadings of items (Andrew, 2016).

6.6.5.4 Factor loadings of items in client strategies

Table 6.92 presents the pattern and structure matrices of the data relating to the identification of the underlying strategies to mitigate contractual claims risk resulting from the contractual activities executed by a client. In the pattern matrix, there is one cross-loading, where one loading score is less than 0.500 and the other is significantly above 0.500. Five items are loaded on factor 1, but only four are significant and all three items loaded on factor 2 are significant (Osborne, 2015; Andrew, 2016; Civelek, 2018). The items and the underlying factors exhibit a positive linear relationship, indicating that they both vary or influence in the same direction.

Pertaining to the result, BTC2 (engage experienced contractors and consultant), (0.845), BTC1 (ensure availability of the funds) (0.842). BTC7 (specify a realistic contract period for the contractor) (0.550) and BTC6 (develop a reliable procurement process (0.511) are linearly converged on factor 1, while BTC5 (efficient coordination with the other parties) (0.883), BTC4 (efficient contract management) (0.699), and BTC3 (awarding bids to the best contractor not to the lowest bidder) (0.518) are linearly converged on factor 2.

Table 6.92: Factor matrix, pattern matrix, and structure matrix of items in BTC

Factor Loadings of Items in BTC							
Code	**Item**	**Unrotated Loadings Result**		**Rotated Loadings Result**			
		Factor Matrix		**Pattern Matrix**		**Structure Matrix**	
		Factor 1	**Factor 2**	**Factor 1**	**Factor 2**	**Factor 1**	**Factor 2**
BTC1	Ensure availability of the funds	**0.697**	-0.421	**0.842**		**0.812**	
BTC2	Engage experienced contractors and consultant	**0.662**	-0.453	**0.845**		**0.795**	
BTC3	Award bids to the best contractor not to the lowest bidder	**0.688**		0.324	**0.518**	**0.534**	**0.649**
BTC4	Efficient contract management	**0.604**	0.414		**0.699**	0.357	**0.729**
BTC5	Efficient coordination with the other parties	**0.561**	**0.622**		**0.883**		**0.829**
BTC6	Develop a reliable procurement process	**0.653**		**0.511**		**0.614**	0.461
BTC7	Specify a realistic contract period for the contractor	**0.604**		**0.550**		**0.608**	0.368

The structure matrix also shows that factor 1 is well correlated with BTC1 (ensure availability of the funds) (0.812), BTC2 (engage experience contractors and consultant) (0.795) and three other items. Factor 2 is well correlated with BTC5 (efficient coordination with the other parties) (0.829) and two other items. The dependability between factors and their corresponding items specifies a positive correlation as principal strategies for contractual claims mitigation pertaining to the client's involvement in construction projects.

6.6.5.5 Path diagram for client strategies

A path model developed for BTC is presented in Figure 6.6 to illustrate the path relationship between factors and items in identifying the relevant strategies to mitigate contractual claims risk in civil infrastructure projects (Streiner, 2005; Suhr, 2006; Suhr, 2008; Ingram et al., 2000). In the model, four items are specified as endogenous items on factor 1 and three items on factor 2. Factor 1 represents *'finance, duration and procurement processes'* as it promotes adequate provision of resources, efficient purchasing procedure, with highly skilled stakeholders and attainable contract duration as relevant strategies to mitigate contractual claims risk in construction project execution and delivery. Factor 2 represents *'contract allocation and operational structures'* as it specifies that provision of project contracts to the most successful contractor and coordinative development of construction contracts between parties can aid strategic mitigation of contractual claims risk in construction projects.

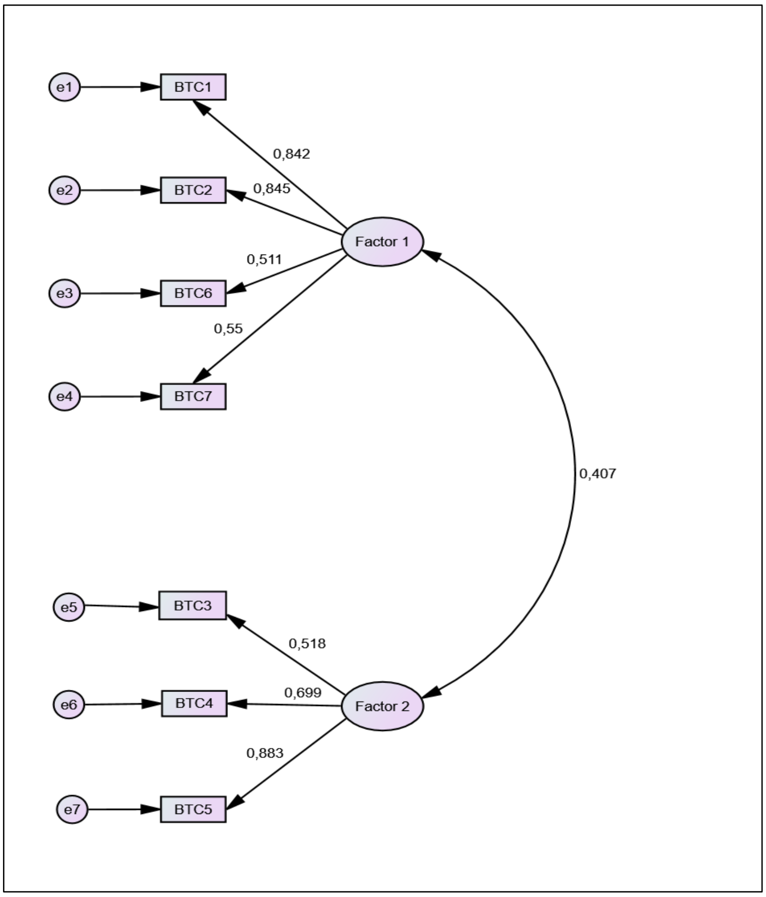

Figure 6.6: The path model for BTC

The association between the two factors reveals that factor 1 has a strong correlation score of 0.407 with factor 2, which signifies that the two factors have significant inter-dependence as essential underlying factors to mitigate the occurrence of contractual claims risk relating to BTC (Andrew, 2016).

6.6.5.6 KMO yest and Bartlett's sphericity test of main contractor's strategies

Table 6.93 presents the results of the KMO test and Bartlett's sphericity test for the data pertaining to main contractor's strategies (BTMC) in identifying the underlying strategies for contractual claims risk mitigation. The results show that the data are adequate and significant for the purpose of applying FA. The KMO test measure of sampling adequacy for the data in BTMC is 0.77 and the Bartlett's test of sphericity indicated that p=0.00.

Table 6.93: KMO test and Bartlett's sphericity test scores for BTMC

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
REPD	0.77	Approx. Chi-Square	158.57	Items are significant and adequate for FA
		df	15	
		Sig.	0.00	

6.6.5.7 Communality estimates of items in main contractor's strategies

The communality estimates displayed in Table 6.94 indicate that only two out of six items demonstrated good communality proportions. BTMC3 (increase work shifts to increase productivity) (0.56) and BTMC2 (efficient site management and supervision) (0.54) have the largest amount of variance close to 1.00 more than other items in BTMC. Thus, these two items are expected to produce a better path model, accounting for the largest proportion of loadings.

Table 6.94: Communalities of items in BTMC

Communality Proportions of Items in BTMC			
Code	**Item**	**Initial**	**Extraction**
BTMC1	Efficient construction planning by the main contractor	1.00	0.47
BTMC2	Efficient site management and supervision	1.00	0.54
BTMC3	Increase work shifts to increase productivity	1.00	0.56
BTMC4	Timely response to the consultant instructions	1.00	0.27
BTMC5	Efficient quality management system	1.00	0.32
BTMC6	Speed up the site activities by the use of the sub-contractors	1.00	0.31

6.6.5.8 Total variance of items explained in main contractor's strategies

The results derived from the analysis of the variance explained in items relating to BTMC are presented in Table 6.95. It shows that only one factor has an eigenvalue higher than 1.00, with the eigenvalues of the other factors being all lower than 1.00. Factor 1 had an eigenvalue of 2.48, explaining 41.35% of variance in data pertaining to BTMC. The graph in Appendix G shows that factor 1 is within the extraction point while other factors are directly below the extraction point. Therefore, factor 1 can be extracted as the underlying strategy for contractual claims risk mitigation in civil infrastructure projects because only this factor produces extractable loadings from the total variance accounted for in BTMC. The extraction of one factor affected the implementation of the factor rotation method in simplifying the results to generate pattern and structure matrices.

Table 6.95: Total variance of items explained in BTMC

Total Variance Explained in BTMC						
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.48	41.35	41.35	2.48	41.35	41.35
2	0.91	15.15	56.50			
3	0.81	13.48	69.99			
4	0.76	12.59	82.58			
5	0.54	9.01	91.58			
6	0.51	8.41	100.00			

6.6.5.9 Factor loadings of items in main contractor's strategies

Factor loading results of the items in BTMC are given in Table 6.96. The results show that all six items had strong loadings above 0.500 and converged on only one underlying factor. BTMC3 (increase work shifts to increase productivity) had the highest loading score of 0.751, followed by BTMC2 (efficient site management and supervision) (0.737), BTMC1 (efficient construction planning by the main contractor) (0.686), BTMC5 (efficient quality management system) (0.566), BTMC6 (speed up the site activities by the use of the sub-contractors) (0.557) and BTMC4 (timely response to the consultant instructions) with the lowest loading score of 0.520.

Table 6.96: Factor matrix of items in BTMC

Factor Loadings of Items in BTMC		
Code	Item	Factor Matrix
		Factor
BTMC1	Efficient construction planning by the main contractor	**0.686**
BTMC2	Efficient site management and supervision	**0.737**
BTMC3	Increase work shifts to increase productivity	**0.751**
BTMC4	Timely response to the consultant instructions	**0.520**
BTMC5	Efficient quality management system	**0.566**
BTMC6	Speed up the site activities by the use of the sub-contractors	**0.557**

The underlying factor represents operations, timeliness and planning strategies for contractors' as it improves construction operations, work ethics, efficient procurement system, cost and time planning for project execution.

6.6.5.10 KMO test and Bartlett's sphericity test of consultant's strategies

The sampling adequacy and significance of the data relating to BTCo are presented in Table 6.97. KMO test value of 0.71 and Bartlett's sphericity test value of p=0.00 were generated to establish the sufficiency and significance of the data in BTCo. The values indicate that the data are within the acceptable range.

Table 6.97: KMO test and Bartlett's sphericity test scores for consultant's strategies

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
REPD	0.71	Approx. Chi-Square	130.24	Items are significant and adequate for FA
		df	6	
		Sig.	0.00	

6.6.5.11 Communality estimates of items in consultant's strategies

The data presented in Table 6.98 represent the communality estimates of the items in BTCo. It can be seen that only one item has a communality proportion below 0.50, which signifies that a smaller amount of variance can be explained in BTCo4 (cooperating with the contractor) (0.37). Other items in BTCo such as BTCo1, BTCo2, & BTCo3 are expected to yield a better path model accounting for the largest proportion of loadings.

Table 6.98: Communalities of items in BTCo

Communality Proportions of Items in BTCo			
Code	**Item**	**Initial**	**Extraction**
BTCo1	Efficient internal approval	1.00	0.65
BTCo2	Efficient inspection system process	1.00	0.59
BTCo3	Timely response to contractor's inquiries	1.00	0.55
BTCo4	Cooperating with the contractor	1.00	0.37

6.6.5.12 Total variance of items explained in consultant's strategies

Table 6.99 shows the amount of variance explained in the data pertaining to BTCo indicating that factor 1 has an eigenvalue of 2.16, which explained 54.12% of variance in the data. Factors 2 – 4 had eigenvalues below the extraction point of less than 1.00, as shown in Appendix G. This indicates that only one factor yielded extractable loadings from the total variance accounted for in BTCo. It is therefore impossible to conduct the factor rotation procedure through the application of the Oblimin rotation method to generate pattern and structure matrices.

Table 6.99: Total variance of items explained in BTCo

Total Variance Explained in BTCo						
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.16	54.12	54.12	2.16	54.12	54.12
2	0.81	20.19	74.32			
3	0.59	14.92	89.24			
4	0.43	10.77	100.00			

6.6.5.13 Factor loadings of items in consultant's strategies

Table 6.100 presents the factor loading results relating to BTCo. The results indicate that that all four items are positively converged on the underlying factor. BTCo1 (efficient internal approval) has the strongest factor loadings of 0.804, followed by BTCo2 (efficient inspection system process) (0.773), BTCo3 (timely response to contractor's inquiries) (0.740), and BTCo4 (cooperating with the contractor) with the lowest factor loadings of 0.611.

The results show that all the four items are significant in identifying the underlying factor as a principal strategy for contractual claims risk mitigation with the underlying factors being *operations, timeliness and teamwork strategies for consultant* as that enhances swift release of approved memos and attention to queries, including inspection process and work collaboration.

Table 6.100: Factor matrix of items in (BTCo)

Factor Loadings of Items in Consultant's Strategies (BTCo)		
Code	**Item**	**Factor Matrix** **Factor**
BTCo1	Efficient internal approval	**0.804**
BTCo2	Efficient inspection system process	**0.773**
BTCo3	Timely response to contractor's inquiries	**0.740**
BTCo4	Cooperating with the contractor	**0.611**

6.6.5.14 KMO test and Bartlett's sphericity test of strategies for mitigation

The KMO test and Bartlett's test of sphericity conducted for SFM produced test scores of 0.77 and p=0.00 respectively, showing the suitability of the data for the application of FA (Yong and Pearce, 2013; Andrew, 2016; Civelek, 2018). The results show that the data is fit and adequate for dimensionality reduction (Table 6.101).

Table 6.101: KMO test and Bartlett's sphericity test scores for SFM

Code	KMO Test Measure of Sampling Adequacy	Bartlett's Test of sphericity		Observations
SFM	0.77	Approx. Chi-Square	252.45	Items are significant and adequate for FA
		df	45	
		Sig.	0.00	

6.6.5.15 Communality estimates of items in strategies for mitigation

The communality estimates of items in strategies for mitigation (SFM) were computed to demonstrate the number of variations that can be accounted for. Table 6.102 illustrates that nine out of the ten items have communality proportions above 0.40, but only four out of nine items have communality proportions close to 1.00 (Schumacker and Lomax, 2021). SFM10 (enabling stakeholders to identify, negotiate and achieve their objectives and interests to reduce claims) (0.72), SFM3 (understanding the area of stakeholders' interests) (0.65), SFM9 (predicting stakeholders' reaction for implementing the strategies) (0.64) and SFM4 (exploring stakeholders' needs and project constraints) (0.61) have a stronger likelihood of accounting for a high proportion of variance than any other items in SFM.

Table 6.102: Communalities of items in SFM

Community Proportions of Items in SFM			
Code	**Item**	**Initial**	**Extraction**
SFM1	Formulating a clear statement of project missions	1.00	0.43
SFM2	Identifying stakeholders properly	1.00	0.48
SFM3	Understanding the area of stakeholders' interests	1.00	**0.65**
SFM4	Exploring stakeholders' needs and project constraints	1.00	**0.61**
SFM5	Assessing stakeholders' behaviour; predicting the influence of stakeholders	1.00	0.39
SFM6	Analysing conflicts and coalitions among stakeholders	1.00	0.53
SFM7	Keeping and promoting a good relationship with stakeholders	1.00	0.43
SFM8	Formulating appropriate strategies to manage stakeholders	1.00	0.52
SFM9	Predicting stakeholders' reaction for implementing the strategies	1.00	**0.64**
SFM10	Enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims	1.00	**0.72**

6.6.5.16 Total variance of items explained in strategies for mitigation

The results of the total variance explained in the data pertaining to SFM are given in Table 6.103. The eigenvalues are as follows: factor 1 accounted for 2.90, factor 2 accounted for 1.44, and factor 3 accounted for 1.08. The eigenvalues generated by these three factors are all above 1.00, which signifies that only these three factors are suitable for extraction (Schumacker and Lomax, 2021). Factor 1 explained 30.00% of variance, 3.82% more than the sum of variance of by factors 2 and 3. This is graphically shown in (Appendix G), where only these three factors have eigenvalues directly above the inflection point, indicating that only the three factors produced extractable loadings from the total variance accounted for in SFM.

Table 6.103: Total variance of items explained in SFM

Total Variance Explained in SFM							
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**
1	2.90	28.97	28.97	2.90	28.97	28.97	2.43
2	1.44	14.40	43.36	1.44	14.40	43.36	1.92
3	1.08	10.75	54.11	1.08	10.75	54.11	1.63
4	0.87	8.65	62.76				
5	0.78	7.79	70.55				
6	0.70	7.04	77.59				
7	0.60	5.97	83.56				
8	0.57	5.73	89.29				
9	0.56	5.61	94.90				
10	0.51	5.10	100.00				

This is further elaborated by a sharp increase in the cumulative proportion of variance from factor 1 through to factor 3 and a slow increase from factor 4 – 10. In total, factor 1 to factor 3 accounted for a cumulative proportion of 54.11% (Schumacker and Lomax, 2021; Yong and Pearce, 2013; Osborne, 2015; Civelek, 2018). This validates the extraction of factors 1 – 3 as 'strategies' with the most explainable amounts of variation in the data pertaining to SFM.

Further observation shows that the distribution of variance across the underlying factors is weighted. As a result, rotation of the data variance amongst them was considered essential to circumvent the occurrence of multiple cross-loadings (Yong and Pearce, 2013; Ncube and Moroke, 2016; Civelek, 2018). Direct Oblimin testing with Kaiser Normalisation was applied to enhance explainable results (Meyers *et al.,* 2015; Osborne, 2015). The outcome indicates that the variation in the factor 1 is reduced by 0.47, while factors 2 and 3 are increased by 0.48 and 0.55 respectively.

6.6.5.17 Factor loadings of items in strategies for mitigation

Table 6.104 presents the results obtained after the rotation of the data variance amongst the three underlying factors. In the pattern matrix, there are a few cross-loadings on the three underlying factors, but only the significant loading scores were considered. Six items are positively loaded on factor 1, with four items being significant for model development. On factor 2, four items are negatively loaded but only two are significant for use, while on factor 3, three items are positively loaded but only two items are significant. On factor 1, SFM6 (analysing conflicts and coalitions among stakeholders) had the highest loading score of 0.737, followed by SFM5 (assessing stakeholders' behaviour, predicting the influence of stakeholders) (0.610). SFM8 (formulating appropriate strategies to manage stakeholders) (0.608), and SFM7 (keeping and promoting a good relationship with stakeholders) (0.546) that are positively converged.

Similarly, SFM3 (understanding the area of stakeholders' interests) (-0.814) and SFM4 (exploring stakeholders' needs and project constraints) (-0.766) are negatively converged on factor 2, while SFM10 (enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims) (0.839) and SFM9 (predicting stakeholders' reaction for implementing the strategies) (0.730) are positively combined on factor 3.

The structure matrix presents correlation scores between the items and the factors. Factor 1 is strongly correlated with SFM6 (analysing conflicts and coalitions among stakeholders) (0.728) and four other items. Factor 2 is strongly correlated with SFM3 (understanding the area of stakeholders' interests) (-0.794) and two other factors, while factor 3 is strongly correlated with SFM10 (enabling stakeholders to identify, negotiate and achieve their objectives and interests to reduce claims) (0.808) and SFM9 (predicting stakeholders' reaction for implementing the strategies) (0.774). This association established the significance of these strategies in mitigating the occurrence of construction problems in civil infrastructure projects (Osborne, 2015).

Table 6.104: Factor matrix, pattern matrix, and structure matrix of items in SFM

Factor Loadings of Items in SFM										
Code	**Items Loaded**	**Unrotated Loadings Result**			**Rotated Loadings Result**					
		Factor Matrix			**Pattern Matrix**			**Structure Matrix**		
		Factor 1	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**
SFM1	Formulating a clear statement of project missions	**0.549**			0.493	-0.328		**0.544**	-0.454	
SFM2	Identifying stakeholders properly	**0.642**			0.402	-0.471		**0.525**	**-0.573**	
SFM3	Understanding the area of stakeholders' interests	0.492	-0.462	0.440		**-0.814**			**-0.794**	
SFM4	Exploring stakeholders' needs and project constraints	**0.522**	**-0.505**			**-0.766**			**-0.781**	
SFM5	Assessing stakeholders' behaviour; predicting the influence of stakeholders	**0.536**		-0.317	**0.610**			**0.614**		
SFM6	Analysing conflicts and coalitions among stakeholders	**0.613**		-0.397	**0.737**			**0.728**		
SFM7	Keeping and promoting a good relationship with stakeholders	**0.565**			**0.546**			**0.588**		0.389
SFM8	Formulating appropriate strategies to manage stakeholders	**0.563**	0.403		**0.608**		0.318	**0.627**		0.435
SFM9	Predicting stakeholders' reaction for implementing the strategies	0.460	**0.615**				**0.730**	0.340		**0.774**
SFM10	Enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims	0.397	0.426	**0.616**			**0.839**			**0.808**

6.6.5.18 Path diagram for strategies for mitigation

The linear association between the three underlying factors identified in SFM are represented in the path model shown in Figure 6.7. In the model, four items are represented as endogenous variables on factor 1, two items each on factor 2 and factor 3. Factor 1 represents *'managing stakeholders' operations and involvement'* as it influences stakeholders' social relationship, stakeholders' cooperation and disputes, and sustaining relationship with stakeholders. Factor 2 represents '*estimating stakeholders' preferences'* as it influences stakeholders' interests, needs and project constraints in civil infrastructure projects, and factor 3 *'enhancing stakeholders' operation strategies'* as it influences empowerment of the stakeholders to attain goals to reduce claims.

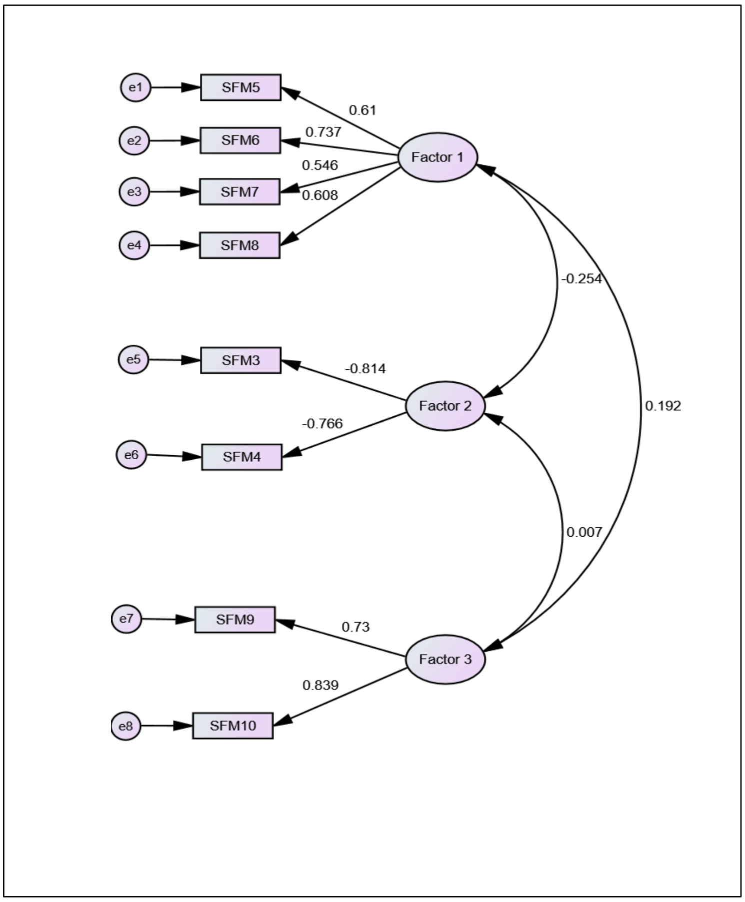

Figure 6.7: The path model for SFM

6.7 CHAPTER SUMMARY

This chapter presents the methods explored in this study. Accordingly, the research methodology behind this study, with philosophical views, and various techniques used for data collection and analysis were methodically explained to offer logical understanding of the findings. The study adopted a mixed methods technique for collation of applicable data through a survey exercise to enable procedural analysis of quantitative and qualitative data. Data analysis was subjected to descriptive statistical techniques, correlation analysis and PCA, amongst other statistical techniques used to analyse the quantitative survey. The factor loading results deduced from the FA were used to develop pathmodels that establish factors applicable to develop a PLS-SEM feasible to mitigate risk in the South African construction industry.

CHAPTER SEVEN

7. QUALITATIVE RESEARCH DATA COLLECTION, ANALYSIS AND DISCUSSION

7.1 INTRODUCTION

This chapter presents a qualitative research analysis of the open-ended data collected through open-ended interviewing of the selected participants (Creswell, 2009; Loraine Blaxter and Tight, 2010), who are stakeholders in the construction organisations registered with the CIDB in South Africa. The questions were formulated in accordance with the research objectives of this study to validate deductions and to confirm quantitative deductions in Chapter 6. The qualitative data were gathered as audio and written statements, and structured into applicable data for the purpose of satisfying the objectives of this study (Creswell, 1999; Creswell, 2009; Shava *et al.,* 2021).

7.2 QUESTION LAYOUT

Five qualitative (open-ended) questions with sub-questions were prepared to aid easy understanding and clarification of responses obtained from the respondents during face-to-face interviews (Hsieh and Shannon, 2005), These questions centred on areas relating to the findings obtained from the quantitative analysis, which included contractual claims risk in civil infrastructure project delivery (Objective 1), impacts of risks on civil infrastructure projects (Objective 2), and risk mitigation strategies in civil infrastructure projects (Objective 3) to determine the right operational framework for risk reduction in civil project (Objective 4). This layout assisted the participants to provide related answers to the questions.

7.3 PARTICIPANTS SELECTION AND INTERVIEW SCHEDULING

Participants were selected according to their level of experience as stakeholders in civil project execution. Seven participants from different construction companies in the Western Cape (Cape Town), Gauteng (Johannesburg and Pretoria), and KwaZulu Natal (Durban) within South Africa were interviewed, with interview duration and dates appropriately scheduled to avoid busy periods. These participants work in construction companies registered with CIDB at grade levels of 5-9. They have all partaken in the execution of civil infrastructure projects in South Africa. Three construction companies located in Cape Town were considered, with two other construction companies located in Johannesburg, one construction company each in

Table 7.1: Background information of participants

Participants	Geographic Area of Operation	Core Operations	CIDB Grade Level	CIDB Class of Works	Value Range of Project	Years of Experience	Position
Participant A	All nine provinces in South Africa	Road and bridge construction	Grade 6	Civil Engineering (CE)	R100 – R500 million	10 years	Project manager
Participant B	All nine provinces in South Africa	Building construction	Grade 9	General Building (GB)	R20 – R50 million	15 years	Risk manager
Participant C	All nine provinces in South Africa	Sustainable building construction	Grade 7	General Building (GB)	R10 – R30 million	8 years	Quantity surveyor
Participant D	Operates largely in two provinces (Western Cape and Gauteng)	Water engineering and sewage disposal line construction	Grade 5	Civil Engineering (CE)	R50 – R100 million	13 years	Project manager
Participant E	All nine provinces in South Africa	Road and bridge reconstruction	Grade 6	Civil Engineering (CE)	R10 – 100 million	11 years	Quantity surveyor
Participant F	All nine provinces in South Africa	Road and bridge construction	Grade 8	Civil Engineering (CE)	R100 – 500 million	14 years	Project manager
Participant G	Operates largely in three provinces (KwaZulu Natal, Gauteng, and North West Provine)	Water engineering and sewage disposal line construction	Grade 6	Civil Engineering (CE)	R50 – 300 million	7 years	Risk manager

Pretoria and Durban respectively. The three participants in the Cape Town area were categorised as Participants A (project manager), B (risk manager) and C (quantity surveyor), while the two other participants in Johannesburg area were classified as Organisation D (project manager) and E (quantity surveyor), with one participant each in Pretoria and Durban categorised as Organisation F (project manager) and G (risk manager) as shown in Table 7.1. An audio voice recorder, was to record the interviews and a voice transcriber, was used to transcribe the audio voice into useable qualitative data.

7.4 COLLECTION OF RESPONSES

Interview instructions were presented to the participants to ensure that standard procedures were instituted from one interview to another (Creswell, 2009). The data was analysed using content analysis procedures to highlight important statements that appropriately discussed the objectives of the study (Hsieh and Shannon, 2005; Creswell, 2009) and to facilitate detailed evaluation of the data (Hsieh and Shannon, 2005; Creswell, 2009).

7.5 CASE STUDY ASSESSMENT

7.5.1 Participant A

7.5.1.1 Subject 1: Contractual claims risk in project delivery

The section provides qualitative understanding on understanding of the perceived factors that Participant A considered causing contractual claims risk during project delivery. The project manager noted that lack of common goals amongst the stakeholders could cause extension of time, cost increases due to variations, conflict in design procedures, etc. Pertaining to the above subject, the participant stated that:

> From my personal understanding, the inability of the stakeholders to have common goals during civil infrastructure in design, development, and execution of project caused contractual claims risk such as extension of project delivery time, increase in construction cost, conflict in design procedure, and variations in work order, etc.

These responses validate the strong correlation existing between change of work scope and design by the client as two associated risks influenced by variations in cost of materials, time and extension of project delivery (see subsection 6.4.1) (Ramanathan et al., 2012; Baloyi and Agumba, 2014; Adekunle and Ajibola W, 2015; Rauzana, 2016).

Participant A also observed ineffective procurement technique as another causal factor for contractual risk. The participant claimed that this particular factor could encourage inadequate human resources and unrealistic projections of productivity by the project teams during project execution. The project manager further noted that unethical handling of a contract project ahead of a civil project execution could heighten the occurrence of human health risks, procurement issues, contract risk claims, and poor use of resources. The above statement substantiates the finding noted in subsection 6.5.1 concerning the effect of construction site health and safety practices risk, and managerial risk pertaining to contractual claims risk in civil infrastructure projects.

7.5.1.2 Subject 2: Impacts of risks on stakeholders during projects

In addition to identifying the factors causing contractual claims risk, Participant A quantified the impact of these risks in civil infrastructure projects by affirming that they influence the progress of construction due to construction materials allocation, estimated time for projects, construction outputs, and project planning. The participant declared that project delivery time, cost and quality of production are strongly affected. This is reinforced by the quantitative the observation in subsection 6.5.5.13, which established that delay claims, extension of time claims, change of work order claims, etc., are frequently occurring contractual claims risks caused by either the stakeholders or project teams. The project manager also stressed that unethical handling of contract projects has an influence on the workers' performance, work principles, safety rules, decision-making, and welfare of the construction operators, financial provision, and resources distribution, because they are determinant factors in the performance of the project. In part, this consolidates the quantitative discussion in subsection 6.5.4, where unethical activity was noted as part of the problems encouraging unnecessary delays, change of work scope, project fund mishandling, etc., during construction projects.

7.5.1.3 Subject 3: Risk mitigation strategies in civil infrastructure projects

Upon the impact of the contractual claims risk identified by Participant A, suggestions were made that construction operators should mitigate contractual claims risks emerging from lack of common goal amongst stakeholders during construction because of poor communication and neglect of interests. This statement affirms the importance of communication (Famiyeh *et al.,* 2017) and information sharing amongst parties involved in project delivery, as identified in subsection 6.4.7.23. The participant also advised construction firms to consider cognisance technique in identifying, transferring, and monitoring the occurrence of contractual claims risk effectively. The opinion given reinforces the quantitative findings obtained in subsection 6.6.5.14, which established that stakeholders must be properly aware of risk occurrence through effective identification, transfer and monitoring of risks. Participant A gave a clear view on the significance of considering a professional approach in managing contract preparation. The project manager stated that:

> On the contractual claims risk impact aspect, in my opinion, I will urge construction organisations to strategically consider professional approach of handling the preparation of contract project in order to avert the emergence of poor financial and resources planning, weak principles, low performance and erroneous decisions.

7.5.1.4 Subject 4: Development of a model for risk mitigation in civil infrastructure projects

Participant A specified on the need to develop a model for risk mitigation in civil infrastructure projects. The participant noted that in a situation where contractual claims risk occurrence is considered inevitable, it is essential to develop a framework that encourages smooth interaction among project stakeholders and project teams to attain effective collaborative efforts and teamwork to mitigate contractual claims risk occurrence at large.

7.5.2 Participant B

7.5.2.1 Subject 1: Contractual claims risk in project delivery

Participant B, with significant experience in risk management, identified inadequate contract planning and occurrence of conflict in project delivery as one of the significant causes of variations that facilitate the occurrence of contractual claims risk in all areas of construction works. The participant further highlighted that inadequate contract planning and occurrence of conflict in project delivery alone could cause unplanned project delay and extension of time (Acharya *et al.,* 2006); changes in the scope of work; unauthorised changes in project design; poor procurement of construction materials; decline in quality of materials, standard of design, and working conditions; poor payment plan across construction departments; disputes and poor communication amongst project stakeholders, etc. This statement is substantiated with findings obtained in subsection 6.4.7.4, where it was cited that operations and project design difficulties are determinants of client's dominance and project team inefficiency.

7.5.2.2 Subject 2: Impacts of risks on stakeholders during projects

Participant B explicated that inadequate contract planning and occurrence of conflict in project delivery have direct impacts on the quality of a project, workforce procurement, estimated time for project delivery, welfare of the workers, consultation and supply chain processes, and materials procurement:

> If you look closely at these contractual claims risk causes, you will understand that they have direct impact on the delivery quality of a project, workforce procurement, materials

> procurement, estimated time for project delivery, including workers' welfare, consultation and supply chain processes.

The above statement confirmed to some degree the need to sanction the construction engineers and managers to make appropriate decisions on the mitigation strategies that could curtail the impact of the two identified factors (Egbelakin *et al.,* 2015). The risk manager emphatically stated that these factors could also influence communication, workflow and scope of work during a construction project (subsections 6.4.7.26 and 6.5.5.17).

7.5.2.3 Subject 3: Risk mitigation strategies in civil infrastructure projects

Participant B pointed out the importance of cultivating the flow of communication amongst stakeholders to mitigate the occurrence or impact of inadequate contract planning and occurrence of conflict in project delivery. The participant stressed further that this particular strategy is adequate to mitigate contractual claims risks in all areas of construction works in civil infrastructure projects:

> Improvement of the flow of communication amongst stakeholders can be part of the strategies to use to strengthen the reduction of contractual claims risk across all areas of construction works during civil infrastructure projects.

The participant further indicated that alignment of contract interests by ensuring that flow of communication regularly enhances the consultation of contract awareness across all parties involved could deter omissions in contract agreements. The risk manager's view ratifies the quantitative finding that communication improvement could adequately reduce the occurrence of contractual claims risk in civil infrastructure project (Babaeian Jelodar *et al.,* 2021; Bryson, 2004) (subsection 6.4.6). The participant further emphasised that stakeholders should always reach a sustainable agreement on the deliverables before commencing a civil project to avoid unnecessary contractual claims risk during civil infrastructure project execution (Ansary and Renault, 2018). Participant B also highlighted that it is important to carry out a thorough study on the appropriate techniques for risk mitigation, with the motive of establishing a remedial solution to enhance timely delivery of civil infrastructure project.

7.5.2.4 Subject 4: Development of a model for risk mitigation

Participant B emphasised the importance of developing an operational model for contractual claims risk mitigation that may arise from contract integration among the three major stakeholders (client, consultant, and contractor). The participant expected the model to enhance timely delivery of civil infrastructure project.

7.5.3 Participant C

7.5.3.1 Subject 1: Contractual claims risk in project delivery

Participant C, a professional quantity surveyor with involvement in many large budget civil infrastructure projects in South Africa, affirmed that cost estimation issues are a predictable problem that causes contractual claims risk. The participant associated the instigating ability of this factor with cost increases, extension of projects, changes in design, erroneous interpretation of clients' design interests, including contractual conflicts between clients and contractors in civil projects. The quantity surveyor asserted that policies on cost, quality, and ethics are poorly practised on various construction sites in South Africa (Atkinson, 1999; Emuze and Smallwood, 2011). Participant C further ascertained that cost increase of construction materials could cause delay in project delivery by influencing a firm's performance (Adekunle and Ajibola, 2015; Rauzana, 2016). Participant C further identified inapplicable contractual processes as a factor that causes poor cost evaluation of projects, change of work scope and variation order, lack of adequate skilled labour, poor mobilisation process, lack of proper procurement, and design adjustment during production.

7.5.3.2 Subject 2: Impacts of risks on stakeholders

Participant C stated that the identified factors have great influence on project delivery and cost performance by the stakeholders in South Africa. The participant drew attention to project abandonment and legal issues that emerge from poor planning costs for project implementation. These responses affirm the significant impact of poor planning in civil project delivery as emphasised in subsection 6.4.7.22 by Kusakci *et al. (*2017) and Luo et al. (2020). The quantity surveyor noted that the occurrence of inapplicable contractual processes influences budgeted cost and time for project completion, project requirements, workers' performance, resource distribution, and project quality due to irregular payment and poor skills. Participant C further stressed that any contractual claims risk impact occurring from an imbalance in contract interpretation could escalate to contract issues such as litigation, conflict, financial implications, contract cancellation, and project prolongation.

7.5.3.3 Subject 3: Risk mitigation strategies in civil infrastructure projects

Participant C suggested that construction organisations could consider the implementation of appropriate planning of project cost between clients and consultants, and proper management of stakeholders' interests and information. The quantity surveyor stated that the consideration of these mitigation strategies could deter the emergence of contractual claims risks from financial planning, cost and time estimations, procurement systems, and design requirements. The participant described stakeholders' interest as one of the most effective and applicable mitigation strategies that could efficiently curtail risk impact in civil infrastructure projects, as well as the causal factors (Bryson, 2004). Therefore, the implementation of these strategies could deter imminent occurrence of project delays (Akogbe *et al.,* 2013).

7.5.3.4 Subject 4: Development of a model for risk mitigation

Participant C also added that lack of proper investigation of contractual claims risk in South Africa requires the formulation of an operational framework that could curb recurrence of contractual claims risk. The participant claimed that this framework could improve budget planning, project planning, contract development, project execution, and stakeholders' relationships. The quantity surveyor further claimed that the framework could also discourage the occurrence of contract information errors, insensitive implementation of practices, and slow information flow between parties (Bowen *et al.,* 2007) as quantitatively indicated in subsection 6.4.7.23. Participant C explained further that the operational framework would restructure every aspect of construction operation during project execution and promote continuity on the construction site. This demonstrates the significance of implementing an adequate framework to ward off the recurrence of contractual claims risk in civil infrastructure projects.

7.5.4 Participant D

7.5.4.1 Subject 1: Contractual claims risk in project delivery

Participant D, as a project manager, has demonstrated vast experience over the years in construction management. The participant pointed out that poor contract handling, poor planning, substandard estimation processes, cost variation of materials, cost of labour acquisition, changes in construction design, and adjustment in scope of work as challenges promoting contractual risks during civil project execution in South Africa. The project manager also noted that these issues have made contractors demand various contractual claims such as extension of time, financial implication, delay, extra work, variation order, and contract ambiguity claims due to the disparities occurring along the process. This shows the failure of the stakeholders or involved parties to adopt the right procedure of cost analysis and their failure to raise productivity because of an inadequate number of workers, poor handling of construction sites, and cash flow forecast.

7.5.4.2 Subject 2: Impact of risks on stakeholders during projects

According to Participant D, the impact of these causal factors could significantly diminish the progress of a construction project across all departments due to new initiatives for the purchase of new construction materials. The participant claimed that the impact of these issues could also be a challenge as result of poor drafting of contracts, unforeseen environmental issues, lack of funds, variations in cost and design, and lack of a communicative work environment. However, they also influenced the delivery of project within the stipulated budgeted cost and time. This statement is quantitatively supported in the results discussed in subsection 6.5.5.17. Further explanation indicated that the impact caused by variations in construction design simultaneously influenced the purchasing of new construction materials, perhaps, at high prices and increased the scope of work, presumed factors that could instigate contractual claims risk in civil infrastructure project delivery.

7.5.4.3 Subject 3: Risk mitigation strategies in civil infrastructure projects

Participant D established a cogent reason for construction firms to consult stakeholders regularly, with the intention of conveying adequate techniques to project development and planning, cost of production, materials and labour. The participant clearly asserted that this specific mitigation strategy could avert the occurrence of contractual claims risk. The participant established that stakeholders should always be involved at all times, with the purpose of avoiding the variances amongst projects team during construction operations. The project manager further noted that the interests of stakeholders could also be of importance for managing contractual claims risk occurrence. In essence, identifying interests of stakeholders could foster efficient integration of project ideas to avoid any occurrence of related contractual claims risk that may result from miscommunication – from client's interests to consultants' interpretation, from consultants' interpretation to contractor's implementation, and from contractors' implementation to the project teams' realisation.

7.5.4.4 Subject 4: Development of a model for risk mitigation

Participant D noted that many construction industries in South Africa lack a framework to enhance the process of completing civil infrastructure projects. The participant further stated that a simplified framework is critical for contractual claims risk mitigation by curtailing poor handling of the contract, poor construction planning, cost variation of materials, cost of labour acquisition, changes in construction design, adjustment in work scope, delays in project delivery, and lack of standard estimation process to improve and sustain the production process.

7.5.5 Participant E

7.5.5.1 Subject 1: Contractual claims risk in project delivery

Participant E is a quantity surveyor, with 11 years of experience in land surveying and development of the bill of quantities for many construction projects. The participant identified poor contract management, unfulfilled contract agreements, harsh government policies, clients' excessive demands, poor project planning, inadequate resources, wrong estimation of cost and time, and inadequate procurement systems as factors causing contractual claims risk in construction production. The quantity surveyor emphasised the importance of cost and time estimation during the execution of a civil project. The participant explained that the disparity between cost estimation and cost increases has an impact on the project duration. Participant E commented that other issues such as erratic power supply that has caused many construction companies to lower their productivity rate. This effects the cost of construction materials, implementation of difficult designs, and environmental safety.

7.5.5.2 Subject 2: Impacts of risks on stakeholders during projects

Participant E said that different forms of contractual claims risk do occur when executing civil infrastructure projects but can also be avoided if essential steps are duly implemented. The participant simply described contractual claims risk as a risk encountered in the process of implementing a construction project, which could be caused by harsh government policies, poor contract management issues, unfulfilled contract agreements, unstable power supply, poor project planning, clients' excessive demands, and inadequate resources with their significant impacts on project delivery, litigation, construction production rate, work ethics, quality of work, time of delivery, workers' payment, and attitude of workers. The participant stressed that a procurement system not adequately processed in accordance with a client's interests or financial capacity, would lead to recurring issues of contractual claims risk during the execution of civil infrastructure projects, from contract and design procurement to materials and equipment procurement, as well extend to labour procurement and guiding procurement.

7.5.5.3 Subject 3: Risk mitigation strategies in civil infrastructure projects

On risk mitigation strategies, Participant E added that the appropriate answer to contractual claims risk mitigation to construction industries is to consider the efficacy of the project stakeholders because of their ability to offer clarity on the basic procedures needed to initiate before a project could be executed. The participant stressed that stakeholders always understood the requirements for any planned projects. In view of this, the quantity surveyor said that client and consultant should consolidate their project interests with the contractor's project interests to discourage any possible occurrence of complexity (risks) along the construction process. The participant noted that client and consultant should be able to establish a workable environment for the contractor to facilitate adequate control over the performance project teams to attain efficient construction production and accountability to avert contractual disputes amongst the construction operators. This demonstrates the significance of considering the interests of the stakeholders as the leading strategy for deterring and mitigating contractual claims risk because the participant perceives these interests as the consensus of the construction operations and the linkage between cultural differences. This could also enhance the economic and environmental impact of the civil infrastructure projects before they commence.

7.5.5.4 Subject 4: Development of a model for risk mitigation in civil infrastructure projects

Participant E suggested the development of a predictive model that could handle mitigation of contractual claims risk as it would predict risk occurrence along the construction process to avoid or manage all forms of project delivery delays during projects.

7.5.6 Participant F

7.5.6.1 Subject 1: Contractual claims risk in project delivery

Participant F acquired his project management skills over 7 years, within 14 years of experience in the construction environment around South Africa. Participant F noted that many factors caused contractual claims during project execution. One of these factors is the environmental situation of the construction site, which could provoke contract infringement. The participant said that environmental challenges during project execution are not under the control of the stakeholders because they are external. However, in some cases, contract adjustment could be initiated to restructure the budgeted cost and time for project execution. Participant F further identified other factors that could cause contractual claims risk in project execution as lack of participation by stakeholders, poor preparation of the contract, inadequate procurement of workers, poor budget planning, including various types of variations – cost of construction materials, work orders, and civil infrastructure design. These factors influence the capacity of a contractor, and other stakeholders to perform optimally. The participant added that these factors could also frustrate efficient delivery of projects.

7.5.6.2 Subject 2: Impacts of risks on stakeholders during projects

Participant F also offered a clear opinion on the impact of these factors on project execution. The participant cited that the environmental situation, lack of participation by stakeholders, poor preparation of contracts, inadequate procurement of workers, poor budget planning, cost of construction materials, work orders, and civil infrastructure design lower construction productivity, exposed workers to environmental and health risks, including their impact on the procurement system, use of resources, performance of contractors, and project delivery schedule. The project manager said that the the impact of all this is project delivery delays. This issue could be accompanied by poor preparation of contracts, lack of participation by stakeholders, and inadequate procuring of workers. Participant F laid emphasis on the strong implication of poor procurement systems used by the construction industry calling the procurement system a production process initiator. The project manager also disclosed the importance of procedural data in the procurement process, most especially, during the bidding process. This impact extends to the procurement of skilled labours and materials, construction design, and improved output rate.

7.5.6.3 Subject 3: Risk mitigation strategies in civil infrastructure projects

Participant F clearly stated the impact of the factors causing contractual claims risk during civil infrastructure projectssaying that it would be of great benefit if the clients and consultants could always affect a relief control clause in the contract for environmental disasters during project execution. This should be driven by integrating and communicating the principles of the stakeholders to the project teams. The implementation of these risk mitigation strategies will enhance adequate mitigation of contractual claims risk if every member implements the same project ideas. Further understanding shows that proper observational procedure would aid an effective way of managing contractual claims risk during project execution. Therefore, the stakeholders are expected to be part of the observation team that could effectively acquire data to identify and communicate their interest to the parties managing the project. This simply means that the principles of the stakeholders would be communicated to the members to circumvent any occurrence of contractual claims riskand will aid easy communication between the stakeholders and project teams.

7.5.6.4 Subject 4: Development of a model for risk mitigation in civil infrastructure projects

Participant F declared that it is important for the construction industry to consider implementing a simplified framework that could incorporate observational behaviours of the stakeholders to generate a contractual claims risk-detecting patterns during the project.

7.5.7 Participant G

7.5.7.1 Subject 1: Contractual Claims Risk in Project Delivery

Participant G is a risk manager with experience in contractual claims risk management who highlighted some principal causes of contractual claims risk that disrupt the progress of a construction project. The risk manager emphasised that project delays are unavoidable, but they can be managed. The participant identified contract mishandling, wrong cost estimation, materials wastage, plants transportation, shortage of materials and labour, poor acquisition system, construction site management, labour, plants and equipment maintenance, and changes in cost of materials as factors causing contractual claims risk in construction projects. The identified factors show the association between the cost increase due to variations and project delivery time. Participant G also identified unethical practices as one of the principal causes of contractual claims risk adding that poor inter-reaction and inefficient organisation amongst the stakeholders could also cause contractual claims risk during construction project execution (Coleman *et al.,* 2020).

7.5.7.2 Subject 2: Impacts of Risks on Stakeholders During Projects

Participant G noted that ethical conduct of the project team, project execution, production efficiency, supply of construction materials, possession of construction site, and communication among the stakeholders are influenced by the factors highlighted in subject 1. The risk manager extended the impact of these factors on the relationship between the construction operators and distribution of quality information (Coleman *et al.,* 2020). In addition, assessment of technical information to enhance the procurement method could also be affected by inadequate communication and coordination amongst stakeholders, including conflict between stakeholders and project team, (Adeyemi and Masalila, 2016). The participant also stated that contract-bidding process could also be affected and information sharing could also be slow down in the process (Adeyemo and Amade, 2016). This statement strengthens the qualitative findings discussed in subsection 6.4.7.26.

7.5.7.3 Subject 3: Risk mitigation strategies in civil infrastructure projects

On the risk mitigation strategies, Participant G stated that one of the most critical measures in contractual claims risk is communication. The risk manager claimed that an effective communication is critical among stakeholders to alleviate and complement other approaches to contractual risk mitigation (Adeyemi and Masalila, 2016; Famiyeh *et al.,* 2017). Participant G advised that the stakeholders and the project team should collaborate by controlling potential occurrence of contractual claims risk to discourage any contractual delays, by purposefully aiming at formulating the simplest approach to risks documentation to enhance project delivery. Free flow of information amongst stakeholders and attainment of stakeholders' expectations could then stand a chance of remedying imminent occurrence of contractual claims issues (Famiyeh *et al.,* 2017), particularly by avoiding conflict issues and encouraging stakeholders' involvement in all planning stages of civil infrastructure projects. In support of this, subsection 6.6.5.14 quantitatively established that a decent relationship should be stimulated amongst stakeholders to strengthen the existence of effective communication.

7.5.7.4 Subject 4: Development of a model for risk mitigation in civil infrastructure projects

Like other participants, Participant G also suggested the development of a model for mitigation of contractual claims risk in civil infrastructure projects and stated that the model should be adequate to mitigate contractual claims risk occurrence due of oversights, negligence, and poor communications amongst the construction operators to attain timely delivery of civil projects. The risk mitigation model should also be capable of investigating, identifying, and managing the occurrence of contractual claims risk across all areas of construction practices, with the purpose of attaining timely delivery of civil infrastructure project.

7.5.8 Tabular synopsis of the qualitative findings

From the interviews conducted, the seven participants made valuable contributions to affirming the research objectives of this study by qualitatively observing the contractual claims risk in project delivery, impacts of these risks on the stakeholders, and the mitigation strategies for risk occurrence in civil infrastructure projects. Theyidentified principal factors that require strategic techniques critical to the improvement of project delivery. The qualitative interviews conducted with each participant are summarised in Table 7.2.

All the seven participants confirmed the development a (predictive) framework as a paradigm for improving production processes in the area of planning, scheduling, procurement, cost budgeting, and project delivery.

Table 7.2: Summary of the qualitative interviews conducted with the participants from seven different organisations based on case study analyses

Case study	Factors causing contractual claims risk in civil infrastructure project delivery (Objective 1)	Impact of contractual claims risk occurrence in civil infrastructure projects (Objective 2)	Risk mitigation strategies in civil infrastructure projects (Objective 3)	Development of a model for risk mitigation in civil infrastructure projects (Objective 4)
Participant A	From my personal understanding, the inability of the stakeholders to have common goals during civil infrastructure in design, development, and execution of project caused contractual claims risk such as extension of project delivery time, increase in construction cost, conflict in design procedure, and variations in work order, etc.	These contractual claims risks influence the progress of construction work through project-estimated time, construction materials allocation, construction outputs, and project planning.	More so, pertaining to this impact, it will be of great advantage to the construction operators to mitigate contractual claims risks that could emerge from failure of stakeholders to have common goals during construction due to [neglect] of interests and poor communication.	In this type of situation, there is a need to develop a framework that incorporate smooth interaction among project stakeholders and project teams to attain effective collaboration and teamwork for managing contractual claims risk occurrence at large.
	Clearly, an ineffective procurement method is another contractual claims risk initiator that could encourage inadequate human resources and unrealistic productivity by the project teams during project implementation.	The occurrence of contractual claims has a strong effect on the project delivery time, cost of production, and quality of production.	I will advise that construction companies adopt proper awareness technique to identify, transfer, and monitor contractual claims risk occurrence effectively.	
	I also believe that unethical handling of a contract project before the execution of a civil project considerably triggers such contractual claims risks as human health risk, procurement issues, and poor use of resources.	The impact of the contractual claims risk caused by unethical handling of a contract project is very sensitive due to project performance, which affects workers' performance, work principles, decision-making, safety rules, and well-being of the construction operators, with provision of finance and distribution of resources affected.	On the contractual claims risk impact aspect, in my personal opinion, I will urge construction organisations to strategically consider a professional approach to handling the preparation of a contract project in order to avert the emergence of poor financial and resources planning, weak principles, low performance and erroneous decisions.	

Table 7.2 continues.

Participant B	From Participant B's viewpoint, inadequate contract planning and occurrence of conflict during project delivery significantly contributed to the cause of variations that motivate the occurrence of contractual claims risk across all areas of construction works. These specific factors cause unplanned project delay and extension of time, changes in the scope of work, unauthorised changes in project design, declining standard of design, poor procurement of construction materials, declining quality of materials supplied, poor payment plan across construction departments, decline in working conditions, disputes occurrence between project stakeholders, poor communication amongst project stakeholders, etc.	If you look closely at these contractual claims risk causes, you will understand that they have direct impacts on the delivery quality of a project, workforce procurement, materials procurement, estimated time for project delivery, including workers' welfare, consultation and supply chain processes.	Improvement of the flow of communication amongst stakeholders can be part of the strategies to use to strengthen the reduction of contractual claims risk across all areas of construction works during civil infrastructure projects. In this case, an additional strategy to consider by stakeholders is alignment of contract interests by communicating its awareness across all parties involved to discourage exclusions along contract agreement.	Clearly, it is imperative to develop an operative paradigm for contractual claims risk mitigation that may arise from contract integration among the three main stakeholders (client, consultant, and contractor). This paradigm will enhance timely delivery of civil infrastructure projects.
Participant C	Based on Participant C's experience, cost estimation issue is a conventional problem that has relatively caused contractual claims risk, cost increase, extension of projects, changes in design, erroneous interpretation of clients' design interests, and contractual conflicts between clients and contractors in civil projects.	The impact of these factors on a civil project is critical because they have great influence on the project delivery and cost performance by the stakeholders because of project abandonment and legal issues that arise from the poor planning cost for the project implementation.	Appropriate planning of a project cost between clients and consultants, and proper management of stakeholders' interests and information could help in discouraging contractual claims risk emerging from financial planning, cost and time estimation, procurement system, and design requirements.	Lack of proper investigation of contractual claims risk in South Africa requires an operational framework to curb recurrence of contractual claims risk as it eases budget planning, project planning, project execution, contract development and stakeholders' relationships.
	Participant C further identified inapplicable contractual processes as a factor causing contractual claims risk, such as poor cost evaluation of a project, change of work scope and variation order, design adjustment during production, lack of adequate skilled labour, poor mobilisation process, and lack of proper procurement.	In addition, these contractual claims risks have an impact on the budgeted cost and time for project completion, project requirement, project quality, resource distribution, and workers' performance due to irregular payment and poor skills.		

Table 7.2 continues.

Participant D	Participant D identified poor contract handling, poor planning, substandard estimation process, cost variation of materials, cost of labour acquisition, changes in construction design, and adjustment in scope of work as challenges causing contractual risks during civil project execution in South Africa. These issues have caused many contractors to demand extension of time claims, financial implication claims, extra work claims, variation order claims, delay claims and contract ambiguity claims due to the disparities occurring along the process.	According to Participant D, the occurrence of these challenges will significantly cause the progress of a project to stagnate because of new initiatives for the purchasing of new materials – causing the abandonment of the old materials, as well as affecting the productivity rate and promoting the reallocation of obligations.	In Participant D's view, the applicable strategy for contractual claims risk mitigation in this situation will be to ensure regular consultations amongst stakeholders in order to convey the best approach to project design and planning, materials and labour procurement, and cost of production.	Develop a simplified framework to mitigate contractual claims risk by improving and sustaining production process to attain effective construction planning, work scheduling, material procurement, cost and time estimation, and project delivery.
Participant E	Participant E identified harsh government policies, poor contract management issues, unfulfilled contract agreement, clients' excessive demands, unstable power supply, poor project planning, inadequate resources (finance, equipment, materials and labour), wrong estimation of cost and time, and inadequate procurement systems as factors causing contractual claims risk in civil infrastructure projects.	These factors will have impact on the project delivery, construction production rate, work ethics, quality of work, time of delivery, litigation, workers' payment, and attitude of workers to work.	The client and consultant should align their project interests with the contractor's project interests to ward off any probable occurrence of complexity (risks) along the construction process. In addition, client and consultant have much more influence on a project than a contractor. Therefore, they should be able to establish a workable environment for the contractor, so that he/she would be able to exercise adequate control over the performance of the project teams for efficient construction production and accountability to avert any probable occurrence of contractual disputes among the construction operators.	Participant E advised the adoption of a predictive model that will mitigate contractual claims risk along the construction process to avoid or manage all forms of project delivery delays during civil infrastructure projects.

Table 7.2 continues

Participant F	Many factors cause contractual claims during project execution. One of these factors is the environmental situation of the construction site – which could provoke contract infringement. Other factors that could cause contractual claims risk in project execution are lack of participation by stakeholders, poor preparation of contract, inadequate procuring of workers, poor budget planning, including various types of variations – cost of construction materials, work orders, and civil infrastructure design.	These causative factors could lower the construction productivity, while exposing the workers to environmental and health risks, including their impact on the procurement system, use of resources, performance of contractors, and project delivery schedule.	It will be very considerate of both the clients and consultants to always effect a relief control clause in the civil contract for environmental disasters during construction projects, and integrating and communicating the principles of the stakeholders to the project teams. This will enhance adequate mitigation of contractual claims risk if every member [implements] the same project ideas.	It is crucial for construction industries to consider implementing a simplified framework that incorporate observational behaviours of the stakeholders to generate a risk-detecting pattern along the civil production process.
Participant G	Project delays are unavoidable, but they can be managed ... issues like contract mishandling, wrong cost estimation for a project, changes in cost of materials, labour, plants and equipment maintenance, plant transportation, shortage of materials and labour, poor acquisition system, construction site management, and materials wastage cause contractual claims risk in construction projects.	These issues have effect on the ethical conduct of the project team, project execution, production efficiency, supply of construction materials, possession of construction site, communication among the stakeholders, and in some cases, it could have an impact on the relationship between the construction operators.	It is imperative for the stakeholders and project team to collaborate by managing potential occurrence of contractual claims risk to deter delays that may affect construction activities by purposefully aiming at formulating the simplest approach to risks documentation during civil project execution to enhance project delivery.	Based on the suggested strategy, formulate a model to mitigate contractual claims risk occurrence because of oversights, negligence, and poor communications amongst the construction operators to attain timely delivery of civil projects.

7.6 CHAPTER SUMMARY

This chapter presented the analyses of qualitative interviews conducted with seven research participants who work with different construction companies located within South Africa. In Cape Town, three participants in three different organisations were interviewed to extract relevant information to validate the quantitative findings discussed in Chapter 6, two participants in two different organisations in Johannesburg, and one participant each in Pretoria and Durban. These participants also participated in the quantitative survey during the preliminary stage of data collection. The findings obtained in this chapter offer a better understanding of the findings obtained in the quantitative analysis section by validating the underlying variables and the observed variables required to drive the development of the SEM in Chapter 8 of the study.

CHAPTER EIGHT

8. THE ESTABLISHMENT OF A RISK MITIGATION MODEL IN CIVIL INFRASTRUCTURE PROJECTS

8.1 INTRODUCTION

In this chapter the establishment of a risk mitigation model required to govern contractual claims risk occurrence in civil infrastructure projects is discussed. It incorporates the study objectives to implement the principle of the study constructs. The identified causes and impact of contractual claims risk, and applicable strategies for risk mitigation were quantitatively classified and estimated in Chapter 6 to deduce and discuss the significance of the measured variables using both descriptive and inferential statistics. From the quantitative analysis, the causal relationship between these variables, with respect to their corresponding latent variables as conceptually explained in Chapter 6, were carefully determined. As part of this analysis, experienced construction managers qualitatively supported the findings relating to the conceptual establishment of the causal relationship in Chapter 7 to validate the findings deduced in Chapter 6.

It is argued that the use of structural equation modelling (SEM) technique would depict a significant reason for a construction organisation to circumvent the occurrence of contractual claims risk to achieve project delivery within the budgeted cost and time. The estimation build-up to the application of SEM involved the reduction of variables (items), determination of the underlying (latent) variables (factors), as well as specifying and evaluating the causal relationship hypotheses between them (Grace, 2022). SEM can be viewed as an intermix of factor analysis and path analysis (regression) used mostly in behavioural studies (Hox and Bechger, 1999; Gefen *et al.,* 2000; Gefen *et al.,* 2011), to establish the structural relationships between the latent constructs, and the linear relationship of the observed items with the latent constructs (Gefen *et al.,* 2000; Gefen *et al.,* 2011; Andrew, 2016; Türegün, 2019). Thus, these constructs were developed into integrated models in SEM, which are identified as measurement and structural models. According to Gefen, et al (2011; 2000), the combination of these two stages specifies factor analysis and hypothesis testing, including measurement errors of the measured variables and path analysis as significant parts of SEM model.

8.2 IMPLEMENTATION OF STRUCTURAL EQUATION MODEL

SEM is categorised as a single- and multi-level analysis that can execute various statistical analyses, which include multivariate analysis of covariance, multi-groups, multiple regression, generate prediction models, path model analysis, exploratory factor analysis, and confirmatory factor analysis (Andrew, 2016), as noted in subsection 5.5.3. Moreover, in many multivariate studies, SEM was performed to establish covariance of variables and constructs, by determining the structure of the latent constructs and the associations (Ncube and Moroke, 2016). In other word, SEM offers more understanding of the mathematical associations existing between observable variables and latent variables (Andrew, 2016).

The non-parametric statistic application of SEM demonstrates the significance of identifying the measurement model from the structural model as a technique for the estimation of a mutually dependent series of hypothesised, interdependent, and multiple path equations (Hair *et al.,* 2010; Andrew, 2016). SEM was implemented in this study using PLS-Smart to establish the required processes and subsequently automated model checking to ensure appropriate results (Grace, 2021; Grace, 2022). The application of this software was based on the multivariate nature of the technical data explored, which involved the categorisation of the modelling as variance-based partial least square-structural equation modelling (PLS-SEM). PLS-SEM was considered applicable in this study with the significance of identifying the observed variables (indicators) as reflectors of the latent variables (Hair *et al.,* 2021; Türegün, 2019; Hair *et al.,* 2022). Technically, PLS-SEM observes and deduces the results of a path model (Türegün, 2019). In addition, it improves the approach to data requirements and data quality to attain better model predictions (Putra, 2022). The technical purpose of employing PLS-SEM has made the statistical technique an appropriate approach for both confirmatory and exploratory analyses (Türegün, 2019).

SmartPLS4 (version 4.1.0.0) software was used to develop the model into two integrated parts (measurement parts and structural parts) to demonstrate the relationship and hypotheses that were to be tested amongst the variables (Basbeth *et al.,* 2018). The measurement parts contained the development of the measurement model, which represented the relationship between the latent variables and the indicators. The structural parts contained the development of the structural model, which demonstrates the relationship between the constructs. Generally, the combination of these constructs presents a path model that illustrates the prediction results of the model (Hair *et al.,* 2021; Hair *et al.,* 2022). The combination of the measurement and structural models of the measurement and structural models entails both numerical and diagrammatic illustrations of their corresponding path coefficients (β), which constitute such parameters as coefficients, loadings, weights, direct and indirect effects (Andrew, 2016). These parameters offer clear understanding of the development of structural relationship between the latent constructs for predicting a relational causality.

Other studies of contractual claims risk in civil infrastructural projects have applied several statistical approaches, such as linear and multiple regressions to formulate various applicable statistical models to resolve the issue of risk occurrence during project execution. However, PLS-SEM, as a multivariate technique, is used for developing an applicable mitigation model for risk management (Kassem, 2022; Tran and Huang, 2022; Alhammadi *et al.,* 2024). The PLS-SEM technique is well known for its ability to refine and develop theoretical models by demonstrating the association between the latent and measurement variables (Hair *et al.,* 2010; Hair *et al.,* 2011; Hair et al., 2021).

8.3 MODEL FITTING AND ANALYSIS USING PLS-SEM

In many areas of research, PLS-SEM is considered a technique that offers better clarity on the multivariate analysis of variables, with the objective of acquiring applicable structural equation model results (Hair *et al.,* 2011). However, PLS-SEM involves observations that require clear understanding before the model is developed. Relative to this, PLS-SEM is known for its strong statistical potential to produce complex model results regardless of the sample size, for example, 100 observations (Hair *et al.,* 2011; Elbanna *et al.,* 2013; Tran and Huang, 2022: 54;). According to Elbanna *et al.* (2013), a good PLS-SEM result can be achieved regardless of the sample size by exercising the basic assumption that 'the sample size must be a minimum of 10 times the number of path relationships leading to endogenous construct'. The strong motive behind the development of the model is to establish the association between the identified risk mitigation factors that are fit for the development of effective risk mitigation strategies requiredby reducing the contractual claims risk occurrence during project delivery.

8.3.1 Variables selection for the risk mitigation model

The variable selection procedure established in this study for the risk mitigation model was based on the quantitative data analysis outcomes derived in the Chapter 6, along with the qualitative evaluations discussed in Chapter 7. The selection procedure was initiated by assessing the variance contribution levels of the variables for better clarity on their performance of significance for their individual constructs (see Table 8.1). In Chapter 6, the descriptive statistics depicted that all the variables (items) were significant because they all indicated no less than 3.00 MV. However, not all the variables gave better proportions; therefore, the dimensionality of the variables was reduced through the application of FA by ensuring sampling adequacy. This approach gave a better depiction of the variables and simplified the identification of the latent factors.

Table 8.1: Theoretical model of latent variables extracted

Latent variable constructs	Measurement variables	
Factors causing contractual claims risk in civil infrastructure project delivery **(FCC)**	**Client-related causes**	
	CRCF1	Operations and design difficulties
	CRCF2	Inefficient planning
	Contractor-related causes	
	CoRCF1	Poor procurement and production planning
	CoRCF2	Poor site management
	CoRCF3	Lack of proficient management
	CoRCF4	Poor approach to inventory
	Consultant-related causes	
	CsRCF	Operations impediment and inexperience
	External causes	
	ExCF	External circumstances beyond stakeholders' control
	Finance-related	
	FiRF	Impact of rigid government policies
	Contractual risk factors	
	CRFF1	Poor contract structure
	CRFF2	Approach to contract requisition
	CRFF3	Poor conflict management and information sharing
	CRFF4	Poor performance and contract preparation
Impacts of risks occurrence in civil infrastructure projects **(IRO)**	**Risk occurrence**	
	RkOF	Risk-causative impacts
	Risk effects on project delivery	
	REPDF	Risk associative impacts on project realisation
	Risk associated with risk-causative	
	RARCVF1	Incompetent and unethical stakeholders
	RARCVF2	Poor contract development
	RARCVF3	Poor reportage and obsolete technical systems
	RARCVF4	Poor handling of construction policies
	Frequency occurrence of contractual claims	
	FOCCF1	Project delays and payment issues
	FOCCF2	Construction site occurrence
	FOCCF3	Illegal refusal of deposits and claims payment
	FOCCF4	Payment deficits and work variation
	FOCCF5	Unclear contract and dayworks deficits
Essential strategies to mitigate risk in civil infrastructure projects **(SMR)**	**Client's strategies**	
	BTCF1	Finance, duration and procurement
	BTCF2	Contract allocation and operational structures
	Main contractor's strategies	
	BTMCF	Operations, timeliness and planning strategies for contractors
	Consultant's strategies	
	BTCoF	Operations, timeliness and teamwork strategies for consultant
	Strategies for mitigation	
	SFMF1	Managing stakeholders' operations and involvement
	SFMF2	Estimating stakeholders' preferences
	SFMF3	Enhancing stakeholders' operations strategies

The variables were selected in accordance with their loading contributions to their respective latent factors. A preliminary selection was conducted, wherein cross-loading variables within a cut-off of 0.500 on latent factors were considered along with variables that have strong loadings. The variables were combined by computing the average of each latent factor using a transformation process in SPSS (version 23) software as a technique of producing fewer variables (indicators). The technique yielded a set of indicators adequate for PLS-SEM analysis. The results derived from the combination of variables (strong loadings) and cross-loading variables resulted in a model that could not be used due to the poor performance of the cross-loadings, and the difficulty of attaining plausible findings (Dragan and Topolšek, 2014; Garson, 2016: 74, 230).

The final selection approach considered only the strong loadings on each latent factor, with significant model performance qualities (Garson, 2016; Costello and Osborne, 2019; Schumacker and Lomax, 2021). The selected variables are shown in Table 8.1, with the exclusion of cross-loading variables based on the deductions given above. The table illustrates the latent variable constructs in connection with the measurement variables according to the selection principles for PLS-SEM (Dragan and Topolšek, 2014; Henseler *et al.,* 2016; Garson, 2016; Tabachnick and Fidell, 2017; Costello and Osborne, 2019; Schumacker and Lomax, 2021).

The first latent variable considers the factors causing contractual claims risk in civil infrastructure project delivery. This latent variable comprises six related measurement variables of identifying the causal factors of contractual claims risk in civil infrastructure project delivery, with each of them having corresponding measurement variables. The first concept is client-related causes, with two corresponding measurement variables. The second concept is contractor-related causes, which produced four corresponding measurement variables. Also, the third (consultant-related causes), fourth (external causes), and fifth (financial related) concepts equally produced only one corresponding measurement variable each, while the sixth concept, contractual risk factors, generated four corresponding measurement variables.

The second latent variable considers the impacts of risks occurrence in civil infrastructure projects. The latent variable involves four related constructs that measured the influence of risks occurrence in civil infrastructure projects. The first (risk occurrence) and second (risk effects on project delivery) concepts produced only one corresponding measurement variable. Third concept produced four corresponding measurement variables, whereas the fourth concept, frequency occurrence of contractual claims, generated five corresponding measurement variables.

Similarly, the third latent variable observes the essential strategies to mitigate risk in civil infrastructure projects. This latent variable incorporates four related constructs that identified appropriate strategies that could mitigate risk in civil infrastructure projects. The first concept, client's strategies, produced two measurement variables, while both the second (main contractor's strategies) and third (consultant's strategies) concepts, equally, produced one measurement variable each. The fourth concept, strategies for mitigation, produced three concepts.

8.3.2 Measurement Model Results Assessment

The measurement model represents the PLS-SEM exploration of the associations between the reflective constructs and their respective indicators (Hair *et al.,* 2022; Tran and Huang, 2022: 53, 54). This part of the model is ascertained using PLS-Smart (version 4.1.0.0) software to illustrate the findings obtained from the PLS-SEM analysis of the relationship between the factors causing contractual claims risk (FCC), impact of the risk occurrence (IRO), and applicable strategies to mitigate risk (SMR). In essence, the software offers a clear establishment of the potential causal relationship between the latent constructs (variables) and their respective indicators, as well as dependences between the endogenous and exogenous constructs to generate adequate predictive models. In the process, a proper development of the structural relationships between the latent constructs was performed as a form of association required to generate the reflective measurement model results. During the process, the appropriate connectivity between the latent constructs, including the allocation of indicators to their respective constructs, changed the colour of the model from red to blue.

Earlier in Chapter 7, a confirmatory factory analysis was performed to ascertain the appropriateness of the measuring items for identifying the best performing variables for the purpose of the PLS-SEM analysis (Tran and Huang, 2022). The deployment of the PLS-SEM analysis is based on some set criteria for the convergent validity and discriminant validity tests to ascertain the extent of the applicability level of the descriptive items. The convergent validity and discriminant validity assessments of the measurement model determine if the measuring items perfectly measure the same or distinct concepts of establishing potential model performance rates. PLS-SEM calculates the individual item reliability (factor loadings), composite reliability (CR), average variance extracted (AVE), cross-loading, and variable correlation (root square of AVE) for the measurement model part (Hair *et al.,* 2022; Tran and Huang, 2022). According to previous studies, variables with minimum factor loadings of 0.700 can be retained for further analysis (Costello and Osborne, 2019; Osborne, 2015; O'Rourke and Hatcher, 2013; Acharya *et al.,* 2006; Gliem and Gliem, 2003). In this study, a minimum of 0.500 was considered the cutoff for factor loading because this is an acceptable baseline in factor analysis according to (Dragan and Topolšek, 2014; Osborne, 2015; Costello and Osborne, 2019). All variables selected for the development of the model were well above a threshold baseline of 0.500 (Costello and Osborne, 2019), and no variables were classified as nonperforming.

Table 8.2 presents the PLS-SEM calculations of the measurement model, wherein the consistency strength of the items was carefully observed to deduce their relationship with their respective latent constructs. The convergent validity could be observed in that the multiple items consistently measured the same constructs except for FCC, with an average value slightly less than 0.500. This means that FCC explains a lower proportion of variability of its measurement, but the latent variable yielded acceptable internal consistency well above a minimum level of 0.700 (; Hair *et al.,* 2011; Elbanna *et al.,* 2013; Hair *et al.,* 2013; Dragan and Topolšek, 2014; Janadari *et al.,* 2016; Kassem, 2022; Hair *et al.,* 2022), to complement the extent to which multiple items, perhaps, measure the same reflective constructs. This signifies that all the items consistently load on their corresponding latent factor, which further indicates that they interrelatedly depend on the same factor (Dragan and Topolšek, 2014). The results establish that the measuring items are adequately suitable for PLS-SEM analysis as per the acceptable reliability level.

Table 8.2: Latent variables inter construct correlation and reliability measure

Latent variables	AVE	Composite Reliability (CR)	Coefficient of Determination (R^2)	Cronbach's Alpha (α)	FCC	IRO	SMR
Factors causing contractual claims risk in civil infrastructure project delivery (FCC)	0,384	0,889		0,876	1		
Impacts of risks occurrence in civil infrastructure projects (IRO)	0,507	0,917	0,206	0,903	0,454	1	
Essential strategies to mitigate risk in civil infrastructure projects (SMR)	0,538	0,861	0,411	0,857	0,459	0,607	1

The discriminant validity findings depict that the measuring items adequately associate with their individual latent construct more than other constructs. This is substantiated by items having loadings (in bold) greater than the cross-loadings in Table 8.3, with an indication that they load strongly on the latent constructs from a lower boundary of 0.531 to an upper boundary of 0.803. A related result is depicted in a section of Table 8.2, with the observation that the inter-construct correlations (square root of AVE) between the three constructs indicate that they share a high amount of variance with their items (indicators) more than the amount shared with other constructs (Chin, 1998; Elbanna *et al.,* 2013; Hair *et al.,* 2022;). This signifies that these items associate more strongly with their peculiar factor than they do with other factors (Elbanna *et al.,* 2013; Dragan and Topolšek, 2014; Hair *et al.,* 2022; Tran and Huang, 2022) and hypothetically measured the constructs they are supposed to measure. For this reason, it can be said that the model is adequate to explain the relationship between the three constructs.

Table 8.3: Factor loadings (bold) and cross-loadings for measurement model

Variables measured	Factors causing contractual claims risk in civil infrastructure project delivery (FCC)	Impacts of risks occurrence in civil infrastructure projects (IRO)	Essential strategies to mitigate risk in civil infrastructure projects (SMR)
CRCF1	**0,531**	0,227	0,049
CRCF2	**0,636**	0,317	0,231
CoRCF1	**0,679**	0,289	0,185
CoRCF2	**0,663**	0,188	0,145
CoRCF3	**0,746**	0,250	0,161
CoRCF4	**0,612**	0,282	0,159
CsRCF	**0,611**	0,139	0,191
ExCF	**0,618**	0,388	0,546
FiRF	**0,546**	0,383	0,513
CRFF1	**0,617**	0,214	0,228
CRFF2	**0,595**	0,189	0,205
CRFF3	**0,596**	0,201	0,230
CRFF4	**0,573**	0,215	0,093
RARCVF1	0,259	**0,699**	0,341
RARCVF2	0,226	**0,686**	0,343
RARCVF3	0,193	**0,711**	0,298
RARCVF4	0,243	**0,760**	0,346
REPDF	0,287	**0,539**	0,283
RkOF	0,546	**0,622**	0,313
FOCCF1	0,158	**0,660**	0,250
FOCCF2	0,371	**0,764**	0,558
FOCCF3	0,382	**0,771**	0,569
FOCCF4	0,352	**0,797**	0,549
FOCCF5	0,343	**0,781**	0,603
BTCF1	0,302	0,567	**0,684**
BTCF2	0,321	0,333	**0,699**
BTCoF	0,340	0,557	**0,755**
BTMCF	0,362	0,349	**0,735**
SFMF1	0,380	0,386	**0,803**
SFMF2	0,272	0,425	**0,720**
SFMF3	0,383	0,411	**0,731**

8.3.3 Structural model results assessment

The extent of the consistency and interrelation between the indicators (variables) and their respective latent factors were determined, as shown in both Table 8.2 and Table 8.3, to establish the structural relationship between the latent constructs (latent variables) (Dragan and Topolšek, 2014; Hair *et al.,* 2021). Based on the aim of validating the statistical significance existing between the three constructs, tests such as coefficient of determination (R^2), path coefficient (hypothesis testing: t-values and p-values statistics), and effect size (f^2) were conducted. These tests are important to estimate the performance of the structural model, as well as attaining adequate model validation.

The proportions of variance account for in the latent constructs were adequately determined to deduce the path coefficients (β), f^2, R^2, and t-statistics by implementing the PLS-algorithm procedure. The PLS estimates for β and f^2 are presented in (Table 8.4), while the estimates for R^2 and t-statistics are shown in Figure 8.1 and Figure 8.2 respectively. The β estimates demonstrate the effective connectivity between the three latent constructs (Putra, 2022). The path estimates are assessed to establish the effect of one latent construct on the other latent constructs to determine their predictive ability (Putra, 2022). This is graphically depicted in the model shown in Figure 8.2 as contributions (effects) of one latent variable on the predictive ability of the other latent variable.

Table 8.4: Path coefficients of the latent variables

Path Coefficients Matrix			
Latent variables	**FCC**	**IRO**	**SMR**
Factors causing contractual claims risk in civil infrastructure project delivery **(FCC)**		0.454	0.231
Impacts of risks occurrence in civil infrastructure projects **(IRO)**			0.503
Essential strategies to mitigate risk in civil infrastructure projects **(SMR)**			
Effect Size (f^2) Matrix			
Latent variables	**FCC**	**IRO**	**SMR**
Factors causing contractual claims risk in civil infrastructure project delivery **(FCC)**		0.260	0.072
Impacts of risks occurrence in civil infrastructure projects **(IRO)**			0.340
Essential strategies to mitigate risk in civil infrastructure projects **(SMR)**			

In Figure 8.1, the PLS path model shows the relationships existing amongst the three constructs. According to Hair *et al.* (2011), Garson (2016), and Hair *et al.* (2021) path coefficients are generally between -1 and +1, with a negative coefficient closer to -1 specifying strong negative relationships and a positive coefficient closer to +1 specifying strong positive relationships. The significance relationships can be interpreted in a similar way to effect size, f^2 as presented in Table 8.5.

Table 8.5: Effect size (f^2) index criteria

Effect Size (f^2) Value	Effect Size (f^2) Criteria
Above 0.35	Large effect size
Between 0.15 to 0.35	Medium effect size
Between 0.02 to 0.15	Low effect size
Less than 0.02	Lowest effect size

(Adapted from Bido and Da Silva, 2019; Ncube and Moroke, 2016; Janadari *et al.,* 2016; Hair *et al.,* 2013; Chin, 1998; Cohen, 1988)

Also, positive, medium to large, direct effects are observed between the three constructs as the values all approach +1 (Hair *et al.,* 2011). The PLS path results are strengthened by using other important statistical tests to validate the significance and relevance of the structural model relationships. These are included as part of the parameters that depict the reliability and validity of individual paths (Fan *et al.,* 2016; Hoyle, 2009). They also provide overall fitness details of the PLS path model (Fan *et al.,* 2016; Hoyle, 2009).

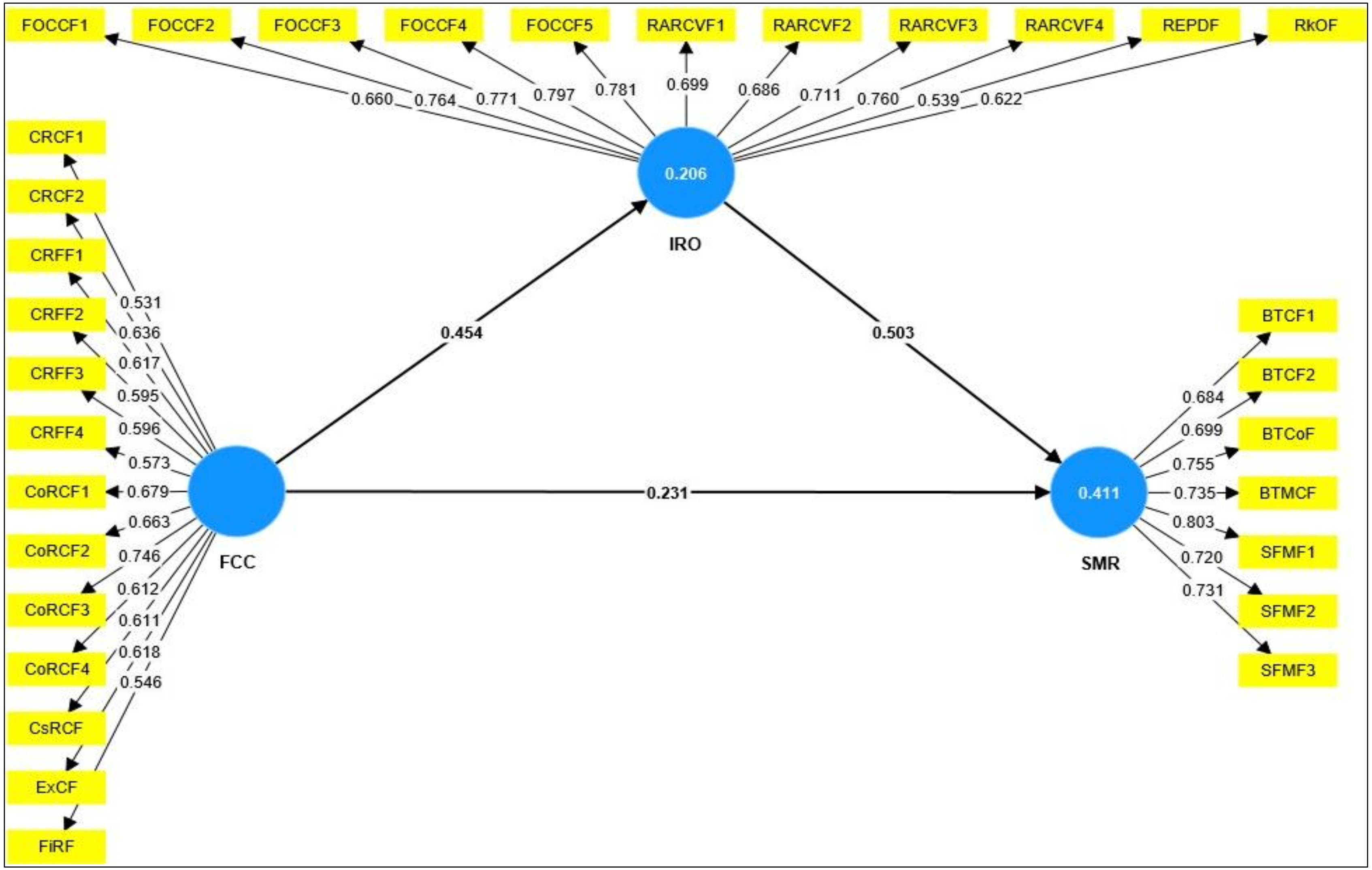

Figure 8.1: Structural model with path coefficients and coefficients of determination (R^2) values

The values pertaining to effect size (f^2) in Table 8.4 demonstrate a similar interpretation of the magnitude of β discussed above. The estimates of f^2 consolidate findings deduced from β of the structural model by observing the magnitude of contributions (effects) of the constructs to each other. Additionally, f^2 contributes more to R^2 (Hair *et al.,* 2014), in terms of weight of the coefficient as any change in R^2 affects the relative effect of size of the exogenous latent construct over the two endogenous latent constructs identified in the structural model (Figure 8.1). This offers further explanation on the strength of contributions (effects) of a latent construct for the predictive ability of other latent constructs. Related to this the order of significance of the strength of contribution in the structural model does not differ when comparing f^2 effect sizes and magnitude of β (Ringle *et al.,* 2019; Janadari *et al.,* 2016). Thus, based on f^2 values depicted in Table 8.4, it can be observed that the values had an identical rank order of effect sizes to the rank order exhibited by β (Hair *et al.,* 2021).

R-squared a function of the number of predictor constructs (Ringle *et al.,* 2019; Hair *et al.,* 2022), was measured to establish the combined effect of an exogenous latent construct over the two endogenous latent constructs by examining the explanatory power of the structural model (Hair *et al.*, 2014; Janadari *et al.,* 2016; Hair *et al.,* 2022). R-squared produces the proportion of variance accounted for in each endogenous latent construct in the model (Hair *et al.,* 2012; Hair *et al.,* 2022; Putra, 2022). According to Hair *et al.* (2012; 2014; 2022), R^2 should be interpreted based on the context of a study. In many studies, different thresholds of R^2 values were considered in different contexts. The effect of exogenous variables on the endogenous variables ranges from 0 to 1, where 1 represents complete predictive accuracy (explanatory power) (Hair *et al.,* 2022).

Explicably, Falk and Miller (1992) stated that R^2 values as low as 0.10 can be adequate to explain a substantial amount of variance for endogenous latent constructs by the exogenous latent construct (Hair *et al.,* 2021; Hair *et al.,* 2011). Otherwise, any R^2 values less than 0.10 can only account for an insufficient amount of variance for endogenous constructs (Falk and Miller, 1992; Hair *et al.,* 2011). However, R^2 thresholds vary across different research contexts as cited by Cohen (1988), Chin (1998), and Hair et al. (2011; 2013). In this study, R^2 values obtained are greater than 0.1 a as affirmed by Falk and Miller (1992) because a substantial amount of variance is explained in endogenous latent constructs that are predicted by the other latent constructs in the model.

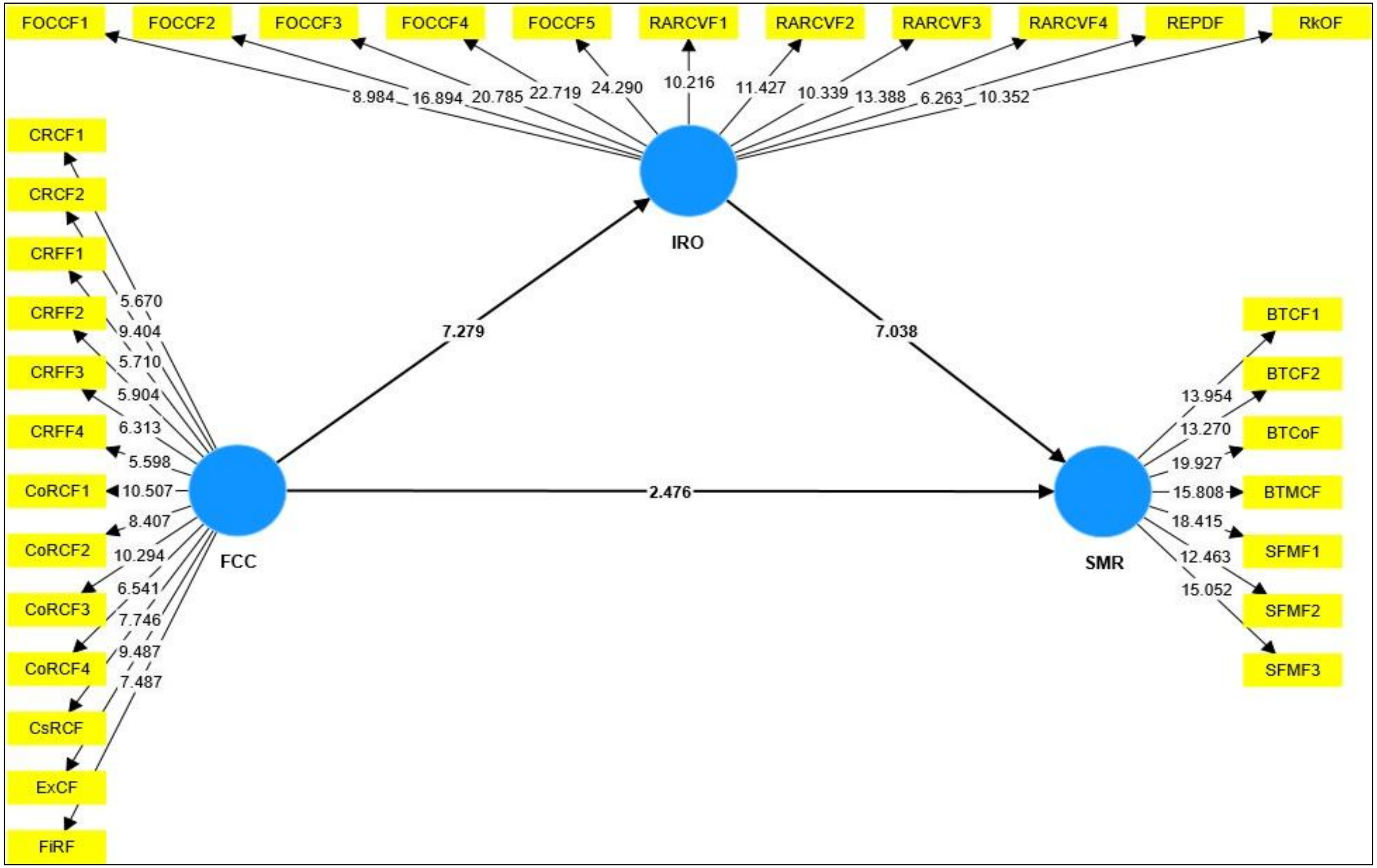

Figure 8.2: Structural model with hypothesis test statistics (t-statistics)

As part of the PLS-SEM analysis, a bootstrapping technique was performed in PLS-Smart to test the significance of β demonstrated by the relationship between the latent constructs (Ncube and Moroke, 2016; Janadari *et al.,* 2016). The bootstrapping was performed on 500 subsamples drawn from the primary dataset, based on random observations, to assess the PLS path model (Ncube and Moroke, 2016). The results derived from the bootstrapping are displayed in Figure 8.2 to demonstrate the hypothesis test statistics of β in the structural model to draw appropriate conclusions on the significance of β. Pertaining to the application of the bootstrapping procedure, a two-tailed assessment test was performed to determine if the relationship between the constructs was statistically significant in each direction. Related to the assessment test, the common assumptions to t-tests are shown in Table 8.6.

Table 8.6: Statistical assumptions for construct hypothetical evaluation. Structural model with hypothesis test statistics (t-statistics)

Significance Level	Critical Value	Significance Value
$\alpha = 0.10$	$t > 1.645$	$p \leq 0.10$
$\alpha = 0.05$	$t > 1.960$	$p \leq 0.05$
$\alpha = 0.01$	$t > 2.576$	$p \leq 0.01$

Adapted from Hair et al. (2011); Yahaya et al. (2019)

In this study, a significance level of 5% ($\alpha = 0.05$) was assumed at a critical value $t > 1.960$ ($p \leq 0.05$) cut-off point to either reject or accept each proposed hypothesis as a process of confirming the significance of the path coefficients because the study sample size is close to 170 (Hair *et al.,* 2011; Janadari *et al.,* 2016; Hair *et al.,* 2021;Tran and Huang, 2022; Hair *et al.,* 2022). Table 8.7 presents the hypothetical results indicating the significance of the dependence amongst the three constructs.

Table 8.7: Significance of the relationship between the latent constructs

Constructs model	T statistics		P values
FCC → IRO	7.279		0.000
FCC → SMR	2.476		0.014
IRO → SMR	7.038		0.000

8.3.4 Structural model validation

In the path diagrams presented in section 8.3.3, a descriptive illustration of the parameters that demonstrate the relational association between the latent constructs are presented. This particular part of the PLS-SEM was developed to provide a better account of the predictive ability of R^2 and the strength of the path effect of the independent variable on the dependent variable (Rahman and Al-Emad, 2018). The structural model specifically constitutes the existence of endogenous latent constructs (factors to be predicted) and exogenous latent constructs (factors with some degree of effect on the dependent variable). The structural path of the model estimates the relationship of the endogenous latent constructs with exogenous latent constructs (Rahman and Al-Emad, 2018) while in some cases, an endogenous latent construct could also become an exogenous latent construct (Civelek, 2018). Dependent variables are characterised as endogenous variables (regression path arrows go into the variables) in PLS-SEM (Rahman and Al-Emad, 2018; Civelek, 2018), because they are variables accounted for by other variables (Civelek, 2018). It can also be described as a variable affected by other variables in the path model (Hair *et al.,* 2022). On the other hand, the independent variables are characterised as exogenous variables (regression path arrows exit the variables) in PLS-SEM (Rahman and Al-Emad, 2018; Civelek, 2018), because they are variables that are not affected by other variables.

From the diagrammatic illustration in section 8.3.3, as shown in Figure 8.1 and Figure 8.2, the structural model comprises three latent constructs (FCC, IRO, and SMR), with each one having no less than six indicators representing the measurement part of the model. In the path diagrams, FCC *(factors causing contractual claims risk in civil infrastructure project delivery)* is observed as the exogenous variable, which shows that the variable is not influenced by IRO and SMR in the structural model. IRO *(impacts of risks occurrence in civil infrastructure projects)* and SMR *(essential strategies to mitigate risk in civil infrastructure projects)* are observed as two endogenous variables, which shows that the two variables are influenced by FCC. Based on the linear regression combinations effect of the model, as cited in Hair *et al*. (2011), the path model demonstrates latent causal dependences between the endogenous variables and exogenous variable.

The illustrative diagram for the casual dependence between the latent variables is displayed in Figure 8.3. The causality diagram simplifies the linear regression paths linking the three latent constructs together by denoting the path effect directions between them as presented in Table 8.8.

Table 8.8: Illustration of the path effect directions between the three latent constructs

Path Effect Direction	Causal Dependence of Constructs
Pxy	FCC (factors causing contractual claims risk in civil infrastructure project delivery) → IRO (impacts of risks occurrence in civil infrastructure projects).
Pyz	IRO (impacts of risks occurrence in civil infrastructure projects) → SMR (essential strategies to mitigate risk in civil infrastructure projects).
Pxz	FCC (factors causing contractual claims risk in civil infrastructure project delivery) → SMR (essential strategies to mitigate risk in civil infrastructure projects).

The above path linkages aided a basic configuration of the PLS-SEM path equations specified below. The linear relationship between these latent constructs is explained in PLS-SEM path equations written below. The PLS-SEM path equations depict the causal dependences between the latent constructs, including the hypothetical interpretation of the predictive strength of the model. The equations for the structural model are written as follow:

FCC = FCC + 0 (Exogenous variable)……………………………………………..…. Equation 1

IRO = $\beta_1 \cdot$ FCC + ε_1……………………………………………………….........Equation 2

SMR = $\beta_2 \cdot$ IRO + $\beta_3 \cdot$ FCC + ε_2………………………………………………….....Equation 3

From the above equations, β_1 denotes the path coefficient between FCC and IRO, β_2 the path coefficient between IRO and SMR, β_3 the path coefficient between FCC and SMR, ε_1 represents the error terms *(unexplained variance in IRO by FCC with the ability to predict),* and ε_2 represents the error terms *(unexplained variance in SMR by IRO and FCC with the ability to predict).* The variables on the left-hand side of the above equations are dependent variables, while those on the right-hand side are independent variables.

In IRO = $\beta_1 \cdot$ FCC + ε_1, IRO was a dependent variable but became an independent variable in SMR = $\beta_2 \cdot$ IRO + $\beta_3 \cdot$ FCC + ε_2, and FCC remains independent throughout the equations because it is an exogenous variable.

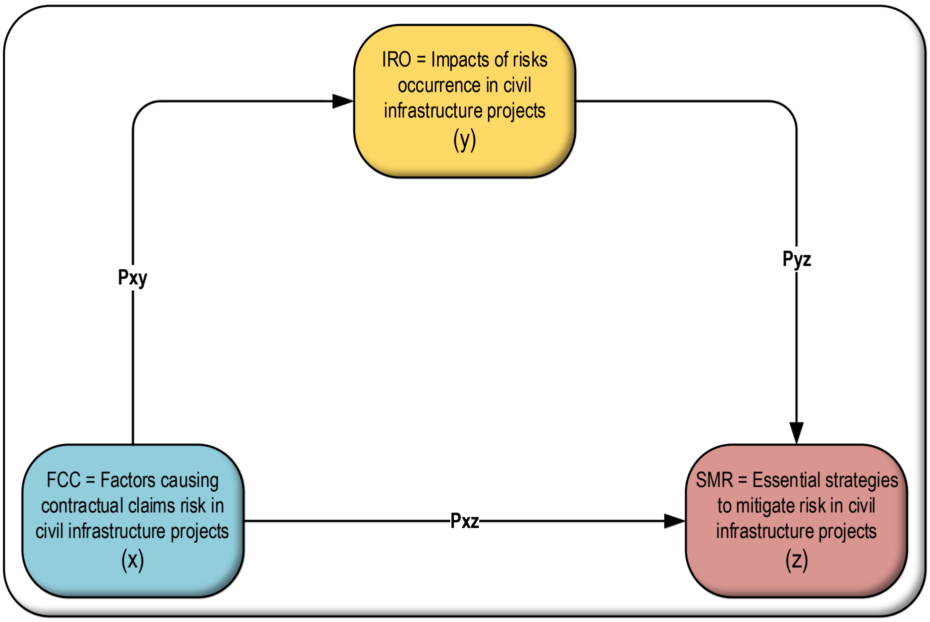

Figure 8.3: Simplified casual dependence diagram defining the latent factors of the risk mitigation approach to govern the contractual claims risk occurrence in civil infrastructure projects in South Africa

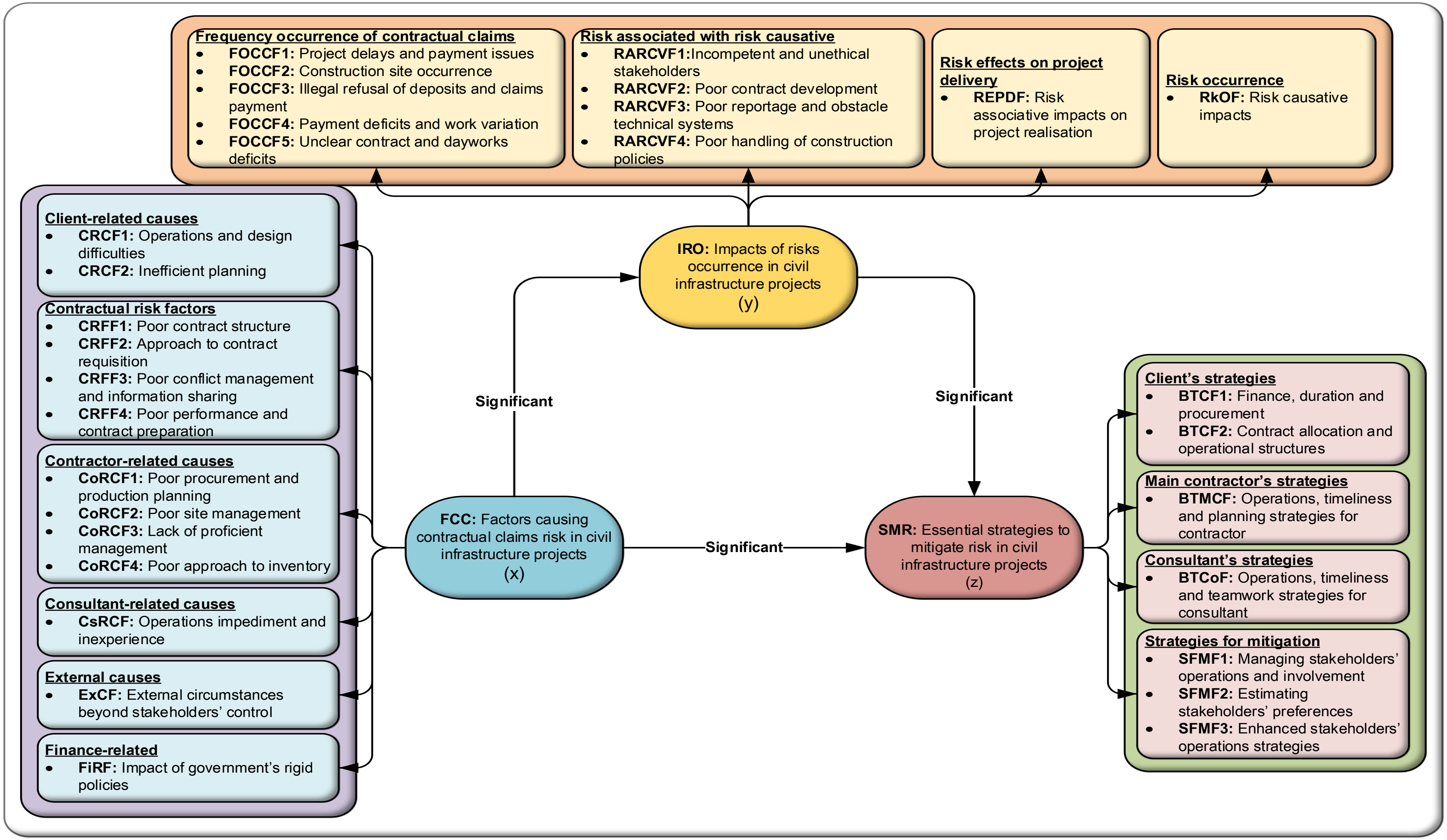

Figure 8.4: Risk mitigation model to govern the contractual claims risk occurrence in civil infrastructure projects in South Africa

A broader diagrammatic illustration of Figure 8.3 is presented in Figure 8.4 to show the risk mitigation model established in governing the contractual claims risk occurrence during project execution. The diagram depicts the latent variables and the indicators that constitute the development of the PLS-SEM in accordance with their relational effects on each other.

8.3.5 Model Assessment

In the PLS model, the extent of performance and ability to contribute significant predictions were assessed in the measurement and structural models to pave the way for overall model assessment. PLS estimated parameters, such as R^2, f^2 and path coefficient, are significant in determining the robustness of the model to attain the objective of mitigating the occurrence of contractual claims risk. Performance estimation of the PLS model was performed to give account of the fitness of the model by computing the goodness of fit (GoF) of the model. According to Nazir and Qureshi (2023), the GoF of a model is estimated to determine the overall performance estimation and predictive power of the model. In some studies, GoF is defined as the geometric mean of both average variance extracted (AVE) and the average of R^2 for all endogenous latent variables (Henseler *et al.,* 2016; Rahman and Al-Emad, 2018; Kassem, 2022; Nazir and Qureshi, 2023). The following equation was applied to estimate the overall fitness of the PLS model.

$$GoF = \sqrt{\overline{R^2} \times \overline{AVE}} \quad \text{………………………………………… 6}$$

Adapted from Nazir and Qureshi (2023); Kassem (2022); Rahman and Al-Emad (2018)

A GoF value of 0.38 was determined by finding the square root of the mean of both R^2 and AVE values depicted in Table 8.2. According to the threshold categories, the value falls within a GoF threshold of ‘determination’, which confirms that the entire PLS model is effective in explaining the relationships between the causes, impact, and strategies developed for the risk mitigation of contractual claims of civil infrastructure projects. The value determined from Equation 6 must satisfy the GoF criteria as shown in Table 8.9:

Table 8.9: Array of GoF standard measurements

Goodness of Fit (GoF) Value	Goodness of Fit (GoF) Index
GoF greater than 0.36	Good fit
GoF between 0.25 to 0.36	Medium fit
GoF between 0.1 to 0.25	Small fit
GoF less than 0.1	No fit

Adapted from Nazir and Qureshi (2023); Kassem (2022); Rahman and Al-Emad (2018)

8.4 MODEL RESULTS AND FINDINGS DISCUSSION

The PLS model results indicate that factors causing contractual claims risk in civil infrastructure project delivery (FCC) has a direct effect on the impact of risk occurrence in civil infrastructure projects (IRO). FCC explained a large (45.4%) proportion of variance in IRO, which signifies the strong influence of the exogenous latent construct (FCC) as a strong predictor of IRO. This finding is strengthened by a predictive ability of 20.6% (R^2 = 0.206) pertaining to the contribution threshold of FCC to IRO. In other words, factors encouraging contractual claims risk are responsible for more than 20.0% of the variation in the impact of the risk on civil infrastructure project delivery in South Africa.

These impacts are consolidated by the significant contribution of reflective indicators in FCC such as operations and design difficulties, inefficient planning, poor procurement and production planning, poor site management, poor approach to inventory, operations impediments and inexperience, external circumstances beyond stakeholders' control, including impact of rigid government policies, poor contract structure, approach to contract requisition, poor conflict management and information sharing, and poor performance and contract preparation. Based on the contributions of the reflective indicators on the predictive power of FCC, the relationship between FCC and IRO is statistically significant at $t = 7.279$; $p < 0.05$. To strengthen the above points, Hiyassat *et al.* (2022), in a study conducted on risk allocation in the public sector, identified related factors such as poorly tailored contract forms, change in design, and poor design as significant risks influencing construction projects. In the same study, they further cited inefficient planning, government corruption, and poor performance and management as other significant risks influencing construction projects (El-Sayegh, 2008; El-Sayegh and Mansour, 2015; Hiyassat *et al.,* 2022). Kassem (2022) clearly stated the cause-and-effect relationship between causes of risks in construction projects as it results in conflicts and cost and time overruns which supports the hypothetical relationship between FCC and IRO.

The model results also show that FCC and IRO have direct effects on SMR. FCC explained a medium proportion (23.1%) of variance in SMR, and a large proportion (50.3%) of variance by IRO in the endogenous variable. This signifies that IRO *(became an exogenous latent construct)* and is highly significant in predicting SMR consequently due to its large proportion of variance explained more than FCC *(exogenous latent construct)* as another predictor of SMR. This is reinforced by an indication that both FCC and IRO have a predictive power of 41.1% (R^2 = 0.411) pertaining to their contribution's threshold to SMR which implies that factors encouraging contractual claims risk occurrence and their impacts on civil infrastructure project delivery accounts for more than 40% of the variation in essential strategies to mitigate risk.

Table 8.10: Summary of the hypothetical significance of the structural model findings on hypothesised paths in the PLS-SEM model

Path label	Path relationship	t-statistic	Corresponding hypothesised path	Observation on hypothesis
Pxy	FCC (factors causing contractual claims risk in civil infrastructure project delivery) → IRO (impacts of risks occurrence in civil infrastructure projects)	Significant	**Hypothesis $_1$ (H_1):** A significant affiliation exists between factors causing contractual claims risk in civil infrastructure project delivery and impacts of risk occurrence in civil infrastructure projects.	Supported
Pyz	IRO (impacts of risks occurrence in civil infrastructure projects) → SMR (essential strategies to mitigate risk in civil infrastructure projects)	Significant	**Hypothesis $_2$ (H_2):** A significant association exists between essential strategies to mitigate risk in civil infrastructure projects and impacts of risks occurrence in civil infrastructure projects.	Supported
Pxz	FCC (factors causing contractual claims risk in civil infrastructure project delivery) →SMR (essential strategies to mitigate risk in civil infrastructure projects)	Significant	**Hypothesis $_3$ (H_3):** There is a significant relationship between essential strategies to mitigate risk in civil infrastructure projects and factors causing contractual claims risk in civil infrastructure project delivery.	Supported

Concerning the practical significance of IRO in the model, observation indicates that reflective indicators such as risk associative impacts on project realisation, incompetent and unethical stakeholders, poor contract development, poor reportage and obsolete technical systems, poor handling of construction policies, project delays and payment issues, construction site incidents, illegal refusal of deposits and claims payment, payment deficits and work variation, and unclear contract and dayworks deficits significantly contributed to the predictive power of IRO. Related to the above, the relationship between IRO and SMR is statistically significant at $t = 7.038$; $p < 0.05$.

Similarly pertaining to the potential causal relationship between the latent construct and their respective indicators, the impacts of FCC on SMR and its reflective indicators, such as finance, duration and procurement, contract allocation and operational structures, operations, timeliness and teamwork strategies for consultants, managing stakeholders' operations and involvement, estimating stakeholders' preferences, and enhancing stakeholders' operations strategies are significantly influenced by the contribution of the reflective indicators to the predictive power of FCC., The relationship between FCC and SMR is statistically significant at $t = 2.476$; $p < 0.05$.

From the structural model findings, it is evident that FCC, IRO and SMR depicts positive medium to large significant relationships, including the positive large significant relationship between FCC and IRO. The risk mitigation model yielded R^2 values well above 10.0%, from medium to strong predictive abilities that confirmed the fitness of the model at a goodness of fit greater than 0.36. The overall estimate of these findings demonstrates that the model is adequately effective to explain the relationship between the three constructs. Based on these findings, it can be established that this model validated the hypothetical proposition of the study that a significant relationship exists between the three constructs, that is, from FCC to IRO, FCC to SMR, and IRO to SMR as shown in Table 8.10.

8.5 PLS MODEL IMPLEMENTATION

Based on the PLS-SEM description noted by Janadaris (2016), PLS-SEM is applied to conceptualise theories in empirical research to exploit the predictive capability of latent variables in a model. This technique is increasingly applied across scientific studies and other related researches to estimate multivariate data (Janadari *et al.,* 2016; Henseler *et al.,* 2016; Civelek, 2018). Due to the strong statistical power of PLS-SEM, the multivariate technique is mostly adopted to process multivariate data with a large and complex model. PLS-SEM was used in this study to optimise the predictive power of the model developed by estimating the path coefficients (β), coefficients of determination, and effect sizes. It is also used because this study is prediction-orientated, as the study objectives are theory development and prediction (Hair *et al.,* 2011; Hair *et al.,* 2022;). The development of the PLS-SEM model follows the conceptual model discussed in Chapter 3 to assess the relationships between the three constructs.

8.6 CHAPTER SUMMARY

In this chapter the robustness of the risk mitigation model developed from the application of PLS-SEM to conceptualise the model constructs given in Chapter 3 is described. The process presented deductive findings pertaining to the assessment of the path model using PLS algorithms. The measurement aspect of the PLS model extensively illustrated that the indicators and the latent constructs are adequately related and suitable to explain the relationship between the three latent constructs. This part of the PLS model exhibited adequate validity and reliability qualities to demonstrate the applicability strength of the model. Following the deductive finding in the measurement model, the statistical significances between the latent constructs were confirmed through acceptable path coefficient (β) thresholds, effect sizes (f^2), coefficient of determination (R^2), and t-values as determining parameters for model performance. The model also demonstrated positive β above 20.0%, medium to large dependency effects between the latent constructs, which are all significant at $t > 1.960$ ($p \leq 0.05$). The effect size (f^2) exhibited low to medium strength of contributions between the constructs, wherein more than 10.0% acceptable amounts of variance were substantially explained in the endogenous latent constructs of the path model. The threshold of the GoF value derived indicates that the model is quite?? efficient in explaining the interdependence between the contractual claims risk factors, impact of the risk factors, and risk mitigation strategies in civil infrastructure projects. The efficiency of the PLS model established that the PLS-SEM yielded a predictive ability of more than 60.0% for the exogenous latent constructs. Based on this, the model is satisfactorily applicable for any comprehensive underlying principle for partial least square-structural equation model (PLS-SEM).

CHAPTER NINE

9. SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

9.1 INTRODUCTION

An overview of the study is presented in this chapter which includes the the study objectives using the literature review determine the relevance of the findings deduced. The literature review offered clarity and understanding of the contractual claims risk impeding project delivery within the budgeted cost and time, as well as facilitating the identification of the factors that cause the risks occurrence during civil infrastructure projects. This enabled application of variables suitable for the development of the research tools and risk mitigation model for construction project delivery. The findings obtained provide applicable study conclusions and recommendations, as well as proposed topics for future research.

9.2 ASSESSMENT OF THE RESEARCH AIM AND OBJECTIVES

The aim of the study was to develop an effective risk mitigation model to address contractual claims risk and to enhance the delivery of civil infrastructure projects in South Africa.

The objectives of the study were as follows:

- To identify the factors causing contractual claims risk in civil infrastructure project delivery,
- To ascertain the impacts of risks occurrence in civil infrastructure projects,
- To determine essential strategies to mitigate risks in civil infrastructure projects, and
- To develop and validate a risk mitigation model to address contractual claims risk and enhance the delivery of civil infrastructure projects in South Africa.

The appropriate measurement approach to the development of the research constructs was determined to facilitate the realisation of the study objectives. Adequate technical approaches were adopted to initiate the collection and exploration of the data. A sequential mixed method was adopted to enable the use of closed-ended and open-ended questionnaires for the observed data. The findings deduced from the application of the approaches are summerised in subsequent sections of this chapter.

9.2.1 Factors causing contractual claims risk in civil infrastructure project delivery

The first objective of the study was to examine the factors causing contractual claims risk in civil infrastructure project delivery in South Africa. Based on the literature reviewed in Chapters 2 and 3, it was observed that construction operations in South Africa are facing contractual claim challenges that continually impose risks on the delivery of civil infrastructure projects. The occurrence of the risks causes mishandling of resources often resulting in court proceedings, which incur contractual claims, project losses, tensions, delays and disputes between parties. From the literature reviewed the significance of ensuring complete delivery of projects within efficient budgeted cost, time and quality performance was established.

Several risks related factors were identified that cause contractual claims risk in civil infrastructure project delivery pertaining to financial, technical, organisational, and environmental issues. Variables associated with the client-related causes, contractor-related causes, consultant-related causes, external causes, finance-related, and contractual risk factors were determined. Eight variables were established with client-related causes, seventeen with contractor-related causes, six with consultant-related causes, five each with external causes and finance-related respectively, and eleven contractual risk factors.

The respondents' views identified the risk related causes, which were all descriptively analysed and subjected to inferential statistical analysis, using FA as the primary focus for using the data extraction technique was to reduce the dimension of the variables. The FA technique grouped the variables into component-factors and renamed them properly. From the findings, client-related factors' dimensions were reduced and categorised into two component-factors:

- Operations and design difficulties, and
- Inefficient planning.

The contractor-related factor dimensions were reduced and categorised into four component-factors as:

- Poor procurement and production planning,
- Poor site management,
- Lack of proficient management, and
- Poor approach to inventory.

Additional findings from the analysis of the respondents' views showed that consultant-related factor dimensions were reduced and grouped into one component-factor identified as 'operations impediment and inexperience'. External factors dimensions were narrowed down and classified into one component-factor identified as 'external circumstances beyond stakeholders' control'. Finance-related dimensions were also reduced and grouped into one component-factor named 'impact of rigid government policies.

Furthermore, based on the findings obtained from the analysed views of the respondents, contractual risk factor dimensions were narrowed down and categorised into four component-factors identified as:

- Poor contract structure,
- Approach to contract requisition,
- Poor conflict management and information sharing, and
- Poor performance and contract preparation.

The identified component-factors were integrated as indicators into the risk mitigation model developed for this study to manage the contractual claims risk occurrence in civil infrastructure projects and presented in Chapter 6.

9.2.2 Impacts of risks occurrence in civil infrastructure projects

The second objective of the study was to identify the impacts of risk occurrence in civil infrastructure projects. The literature reviewed highlighted the following: variables related to risk occurrence, risk effects on project delivery, risk associated with risk-causative impacts, and frequency occurrence of contractual claims. Five variables each were established with risk occurrence and risk effects on project delivery, eleven variables with risk associated with risk-causative impacts, and eighteen variables were established with frequency occurrence of contractual claims.

Many risk-related impacts were determined and appropriately analysed by employing descriptive and inferential statistical analyses, which utilised FA as the primary focus for data reduction technique. Findings from the analysis of the respondents' perceptions on the risk occurrence dimension established were reduced and classified into one component-factor identified as 'risk-causative impacts. Also, risk effects on project delivery dimensions were narrowed down and grouped into one component-factor defined as 'risk associative impacts on project realisation'.

Further findings confirmed that risk associated with the risk-causative dimension were reduced and grouped into four component-factors as:

- Incompetent and unethical stakeholders,
- Poor contract development,
- Poor reportage and obsolete technical systems, and
- Poor handling of construction policies.

Following a similar approach, frequency occurrence of the contractual claims dimensions was narrowed down and classified into five component-factors as:

- Project delays and payment issues,
- Construction site occurrence,
- Illegal refusal of deposits and claims payment,
- Payment deficits and work variation, and
- Unclear contract and dayworks deficits.

The established component-factors related to the impacts of risks occurrence in terms of the respondents' perceptions analysed were incorporated as indicators into the risk mitigation model developed for this study in Chapter 8.

9.2.3 Essential strategies to mitigate risk in civil infrastructure projects

The third objective of the study was to determine the essential strategies to mitigate risk in civil infrastructure projects. The literature reviewed provided an explanation of the variables correlating with client strategies, main contractor strategies, consultant strategies, and strategies for risk mitigation. Seven variables were established correlating with client strategies, six variables with main contractor strategies, four variables with consultant strategies, and ten variables with risk mitigation strategies.

The respondents' opinions on applicable strategies to mitigate risk were analysed through descriptive and inferential statistical approaches, using FA as the principal focus for the data reduction process to narrow the dimension of the variables into applicable component-factors. Variables in client strategies were narrowed and grouped into two component-factors and renamed as:

- Finance, duration and procurement, and
- Contract allocation and operational structures.

The dimensions of the variables for the main contractor strategies were reduced and categorised into one component-factor identified as '*operations, timeliness and planning strategies for contractors',* while the consultant strategies dimension was also reduced and categorised into one component-factor, '*operations, timeliness and teamwork strategies for consultant'*.

Other findings deduced from the analysis of the respondents' opinions indicated that strategies for the mitigation dimension were reduced and categorised into three component-factors identified as:

- Managing stakeholders' operations and involvement,
- Estimating stakeholders' preferences, and
- Enhancing stakeholders' operations strategies.

The established component-factors for the essential strategies to mitigate risk during construction projects in South Africa were integrated as indicators into the risk mitigation model designed for this study in Chapter 8.

9.2.4 Develop an effective risk mitigation model to address contractual claims risk and to enhance the delivery of civil infrastructure projects in South Africa

The fourth objective was to test the efficiency and feasibility of the risk mitigation model. To attain this objective, the array of hypotheses given below was applied to investigate the relationship between the model constructs that influence the delivery of construction projects in South Africa:

- Hypothesis $_1$ (H_1): A significant affiliation exists between factors causing contractual claims risk in civil infrastructure project delivery and impacts of risk occurrence in civil infrastructure projects.
- Hypothesis $_2$ (H_2): A significant association exists between essential strategies to mitigate risk in civil infrastructure projects and impacts of risk occurrence in civil infrastructure projects.
- Hypothesis $_3$ (H_3): There is a significant relationship between essential strategies to mitigate risk in civil infrastructure projects and factors causing contractual claims risk in civil infrastructure project delivery.

These hypotheses signified the corresponding hypothesised paths between the model constructs. To test these, a structural model was established in Chapter 8 using PLS-Smart to determine the significance of their relationships. The structural model results for H_1 demonstrated that a strong, significant and positive relationship exists between the factors causing contractual claims risk in civil infrastructure project delivery and impacts of risk occurrence. This signifies that contract activities performed by construction stakeholders and extraordinary events that occur during a construction project cause contractual risks that significantly influence the operational activities that impede the delivery of a construction project. This shows that factors causing contractual claims risks in construction are a good predictor of the impact of risks occurrence during construction project execution.

The structural model results for H_2 showed that a strongly significant and positive relationship exists between the essential strategies to mitigate risk in civil infrastructure projects and the impacts of risk occurrence. This strong relationship denotes that the impacts of risks strongly predict the appropriate strategies essential to minimise contractual impediments that may occur during a construction project, which elucidates the dependency of the mitigation strategies on the influence of the contractual claims risk.

H_3, is critical in establishing the relationship between the factors causing contractual claims risk in civil projects and the essential strategies to mitigate risk. The relationship implies that contract activities performed by construction stakeholders, along with extraordinary events, serve as predictors for the appropriate strategies necessary in minimising the contractual problems affecting construction projects. This shows that mitigation strategies are dependent on the occurrence of the factors causing contractual claims risk.

9.3 CONCLUSION

This study presented, discussed, and validated the structural model for the mitigation of the challenges that continually impose contractual claims risk as construction works are becoming more competitive. The findings indicated that the relationship between the factors causing contractual claims risk and impacts of risk occurrence has significant predictive potential to influence the essential strategies to mitigate risks that occur consequently due to contracts that are affected by extraordinary activities during project execution.

The application of PLS-SEM to develop and validate a 'contractual claims risk mitigation model' to manage the occurrence of contractual claims risk was realised. PLS-SEM is a multi-dimensional modelling technique, with proven success in predicting performance of complex exploratory variables. This demonstrates the adequacy and validity of the model for the assessment of the successful delivery of a construction project due to appropriate contractual claims risk mitigation in the construction industry.

The study established what contractual claims risk entails in the construction industry; and that risk management procedures for adequate project performance are either not significantly understood or used to assess risk occurrence during construction projects. Indicators that function as the standard for measuring the contractual claims risk mitigation in civil infrastructure project delivery in the future were identified. The model can be used as the as follows to:

- Provide a solution based on the significant relationship that exists between the causes, impacts and strategies for contractual claims risk occurrence in civil infrastructure projects in South Africa,
- Promote risk mitigation mechanisms viable for cost control, performance improvement, and attainable delivery schedules in civil infrastructure projects based on appropriate identification and estimation of the association between the causes and impacts of contractual claims risk, and
- Provide an operational technique that can improve the efficiency of the strategies viable to improve finances, contracts, work allocation, operational structures, and to reduce conflicts.

9.4 CONTRIBUTIONS OF THIS RESEARCH

The main contribution of this study was the development of the model for the effective risk mitigation management of civil infrastructure projects, including its practical application in several areas that concern contractual claims risk in ensuring that projects are delivered within budgeted time and cost. The study established a logical method that involved various objectives of risk mitigation as well as incorporating various views to comprehend and institute conceptual knowledge on the challenges facing the delivery of civil infrastructure projects. Applicable findings were critically deduced from the integrated studies to foster improved measures viable to control the effects of recurrent risk on stakeholders in the construction of civil infrastructure projects. An effective strategy was established for improving the abilities of construction operators to reduce contractual claims in civil infrastructure projects.

Other contributions of this study are the application of the PLS-SEM approach to develop the structural model required to improve contractual claims risk mitigation concepts to attain quality project delivery. The significance of the model was established through hypothesis testing to ascertain its suitability. Robin (2012), Wentzel (2023) stated that PLS-SEM is a strong multivariate technique for research that aims to improve theories in management research because it offers various usage advantages. Minimal use of this technique in construction management research has been observed, particularly in inclusive research on risk management. This study has demonstrated the multivariate potential of the PLS-SEM approach to the analysis of risk management in modeling relationships of variables in construction management.

The study has contributed significantly to existing knowledge by introducing a structural model that presents indicators for construction organisations, construction professionals, risk managers, and government agencies to exploit both internal and external factors. The model established positive, significant relationships between research variables, highlighting the following:

- Those factors contributing to the occurrence of contractual claims risk during project delivery significantly influence the impacts of risk occurrence impeding the progress of in civil infrastructure projects,
- That essential strategies to mitigate risk impeding the project performance regarding minimising cost and time of construction in civil infrastructure projects are significantly influenced by the impacts of risk occurrence impeding construction progress, and
- That essential strategies to mitigate risk impeding the project performance in the aspect of minimising cost and time of construction in civil infrastructure projects are significantly

influenced by the factors contributing to the occurrence of contractual claims risk during project delivery.

9.5 LIMITATION OF THE RESEARCH

The research limitations were primarily attributed to the use of questionnaires for data collection. The questionnaires were administered to construction professionals within South Africa only, who were working at construction industry registered on the CIDB and SACQSP register between grades 3–9. Therefore, the results (findings) deduced are valid only within the South African context. The methodology, data analysis techniques, and the model can, however, be replicated for other countries. It was also difficult to secure interview dates with the selected construction professionals, as many of the professionals prioritised their work schedule over research participation.

9.6 RECOMMENDATIONS FOR FUTURE RESEARCH

Investigations on the development of an effective risk mitigation model are gradually becoming more relevant to construction management, also in the South African construction industry. Based on the findings and limitations of this study, the following are proposed as areas of research that could be explored:

- Further investigation could focus on how technology can play a part in minimising project losses through the development of a project cost, time, and performance framework to stabilise project delivery processes in South Africa.
- Research efforts should be channelled to developing an interactive framework that could enhance effective collaboration amongst project stakeholders and project teams as a process of promoting efficient project performance across various departments.
- Research should be focused on the need to develop an operational model to enhance timely delivery of civil infrastructure projects.
- More effort should be centred on developing a framework that could observe the behavioural characteristics of the stakeholders to generate a risk-detecting pattern along the civil production process.
- The reliability of the constructs incorporated in the risk mitigation model developed in this study could be investigated by exploring the constructs and their respective variables.

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APPENDIX A: STUDY QUESTIONNAIRE

Cape Peninsula University of Technology

Faculty of Engineering,
Department of Civil Engineering and Surveying,
Cape Peninsula University of Technology
Symphony way off Robert Sobukwe Road, Bellville, 7535.
E-mail: awadsaad203@gmail.com /214129667@mycput.ac.za
March 2023

Dear Sir/ Madam,

Questionnaire survey for a research title: Risk mitigation approach of contractual claims of civil infrastructure projects in South Africa

This study is a Doctoral research study in the Department of Civil Engineering at the Cape Peninsula University of Technology. The study focus is to develop an operational framework for mitigation of contractual claims risks on civil infrastructure projects.

This questionnaire is a significant part of the Doctoral research project, but without your kind and expert input, the goal of this research will not be realised. We do appreciate that the questionnaire will take approximately 10 - 15 minutes of your precious time.

Kindly accept our utmost assurance that all answers and information provided by you will not be disclosed to a third party and be treated with the utmost confidentiality and used for academic purposes only. We undertake that, all ethical considerations guiding research of this nature shall be strictly adhered to.

Should you have any question(s) or would like further information, please do not hesitate to contact the researcher on 074-802-8969 or email at awadsaad203@gmail.com / 214129667@mycput.ac.za

Thank you most sincerely for your valuable time to answer the questions and for your kind assistance.

Awad Saad Abdulla Saad
Doctoral Research Student
Tel (cell): 074-802-8969

APPENDIX B: CONSENT FORM

Department of Civil Engineering and Surveying,
Cape Peninsula University of Technology
Symphony way off Robert Sobukwe Road, Bellville, 7535.
E-mail: awadsaad203@gmail.com /214129667@mycput.ac.za
March 2023

CONSENT FORM

Title of the research project: Risk mitigation approach of contractual claims of civil infrastructure projects in South Africa

Name and position of the researcher;

Awad Saad Abdulla SAAD, DEng candidate, Civil Engineering Department, Cape Peninsula University of Technology

Please tick box

1. I confirm that I have read and understood the information the researcher is seeking in the above study and have the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without offering reasons. ☐
3. I agree to take part in this study ☐

Name of participant (optional)……………………..……………….Date …..……..………Signature ……………..……

Awad Saad Abdulla SAAD (researcher) ……………………..….Date …..……..…….. Signature ……………...…

Note: that all the information provided will be treated in the strictest confidence. The result will be presented in aggregate format and no individual disclosure will be made.

SECTION A: General information. (Please Tick √ all appropriate option)

1	Position in organisation (Please specify) …………………………………………………………………………………………
2	Type (s) of project executed? (Please √ thick all that is applicable) Building ■ Roads and Bridges ■ Rail lines and infrastructure ■ Water Engineering and Sewage Disposal lines ■ Others (Please specify) ……………………………………………
3	Please give an indication of the size of organisation where you work in terms of CIDB rating? (Please specify) …………………………………………………………………………………………
4	Your regular client types? (Please √ tick all that is applicable): Public Sector ■ Private Sector ■
5	Kindly indicate the province where your organisation operates (please thick all that is applicable): Eastern Cape ■ Free State ■ Gauteng ■ KwaZulu-Natal ■ Limpopo ■ Mpumalanga ■ Northern Cape ■ North West ■ Western Cape ■

SECTION B: Particulars of civil project. (Tick √ the appropriate answer)

1	Kindly select the price range of Civil project your company is involved in the last 10 years: Less than R500 000 ■ R500 000 to R1million ■ above R1 million to R100 million ■ above R100 million to R500 million ■ above R500 million to R1 billion ■ above R1 billion ■
2	Kindly state the agreed project duration in the contract document for the project under consideration: (Please specify) ………………………………………
3	Was the project completed and deliver on the agreed date? Yes ■ No ■
4	If answer to the above question is No, kindly state the Duration at which the project was complete; ……

SECTION C: Causes of contractual claims risk and its significance for the delivery of civil infrastructure projects.

1. Kindly indicate the extent to which the listed variables contribute to the occurrence of contractual claims on civil infrastructure construction projects you have handled in the last five years. Kindly indicate by ticking the box for each of the variables appropriately, using the scale below.

Extremely unimportant	Not important	Slightly important	Important	Very important
1	2	3	4	5

Client-related causes	1	2	3	4	5

1	Delay in release of main contractor's claims by the client					
2	Contractor selection process					
3	Changes in design by the client due environmental issues					
4	Changes in the scope of the work by the client					
5	Delay in decision-making by the client					
6	Delays in taking possession of the site by the main contractors					
7	Poor communication and coordination between clients and the project team					
8	Client's financial problems					
Contractor-related causes		1	2	3	4	5
1	Main contractor's experience					
2	Main contractor poor cash-flow forecast					
3	Delay in supply of construction materials					
4	Inadequate site management by the main contractor					
5	Low productivity of the main contractor workforce					
6	Lack of skilled management team					
7	Insufficient number of workers					
8	Poor construction planning by the main contractor					
9	Delay in mobilization to project site by the main contractor					
10	Poor cost estimation by the main contractor					
11	Delay in getting licenses and approvals from the government by the main contractor					
12	Delayed salary payments to the main contractor's staff					
13	Lack of the incentives for the workers					
14	Shortage of equipment on site					
15	Disagreement between the main contractor and the consultant					
16	Lack of well-being facilities by the main contractor					
17	Inappropriate methods of construction.					

Consultant-related causes		1	2	3	4	5
1	Delay in approval of drawings by the consultants					
2	Delay in site inspection by the consultant					
3	Slow response by the consultant to contractor's enquiries					
4	Lack of experience by the consultant's staff					
5	Poor quality control by the consultant					
6	Misunderstanding of the client's requirements by the consultant					
External causes		1	2	3	4	5
1	Unpredictable soil conditions.					
2	Bad weather conditions (excessive rainfall, winter storm and high temperatures).					
3	Control by the government and restrictions on the site					
4	Civil disturbance					
5	Unforeseen site condition					
6	Price fluctuation					
Finance related		1	2	3	4	6
1	Financing difficulties of contractor					
2	Financing difficulties of owner					
3	Effects of global economy/unforeseeable financial and economic crises					
4	High interest on loan and overdraft to Contractor					
5	Change in government policy on prices of construction materials					

2. Kindly rate the extent to which the listed contractual risk factors contribute to contractual claims on civil infrastructure construction projects you have handled in the last five years. Kindly indicate by ticking the box for each of the variables appropriately, using the scale below.

Extremely insignificant	Not significant	Slightly significant	Significant	Very significant
1	2	3	4	5

	Contractual risk factors	1	2	3	4	5
1	Contract modifications					
2	Poor contract management					
3	Payment method during construction					
4	Inadequate definition of substantial completion					
5	Omission and errors in contract documents					
6	Legal disputes and Inappropriate method of dispute resolution					
7	Type of contract procurement method					
8	Slow information flow between parties					
9	Poor communication/coordination between consultants and other parties					
10	Lack of communicating the requirements by owner					
11	Poor communication and coordination by contractors with other parties					

<u>SECTION D:</u> Effect of risk on the construction of civil infrastructure projects.

Kindly rate the frequency of occurrence of the listed risks in construction of civil infrastructure projects. Kindly indicate by ticking the appropriate box, using the scale below.

Never	Rarely	Occasionally	Often	Always
1	2	3	4	5

	Risk occurrence	1	2	3	4	5
1	Risk associated with claims due errors and omissions in design					
2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)					
3	Construction risk associated with poor management by contractor's (managerial risk)					
4	Risk associated with consultant performance (consultant competencies skills)					
5	Construction site health and safety practices risk					

1. Kindly rate the effects of the listed risks on civil infrastructure projects delivery. Kindly indicate by ticking the appropriate box, using the scale below.

Extremely little influence	No influence	Slight influence	High influence	Very high influence
1	2	3	4	5

Risk effects on project delivery		1	2	3	4	5
1	Risk associated with claims due errors and omissions in design					
2	Time delay risk (risk due to delay in delivery of the project on or before the schedule date)					
3	Construction risk associated with poor management by contractors (managerial risk)					
4	Risk associated with consultant performance (consultant competencies skills)					
5	Construction site health and safety practices risk					

2. Kindly indicate the risk associated with the listed risk causative variables. Kindly indicate by ticking the appropriate box, using the scale below.

- Risk associated with claims due to errors and omissions in design (1)
- Time delay risk (2)
- Managerial risk (3)
- Risk associated with consultant performance (4)
- Construction site health and safety practices risk (5)

Risk causative variables		1	2	3	4	5
1	Occurrence of financial claims					
2	Claim causes delays in project delivery					
3	Overbearing influence of project stakeholders during project execution					
4	Lack of understanding of the contractual terms and conditions					
5	Frequent delays on-site due to site conditions, designer and user changes					
6	Lack of proper notification procedures					
7	Poor documentation and management practices during construction					

8	Formation of a standard form of contract					
9	Procurement Method (Awarding the bid to the lowest bidder)					
10	Adoption of new construction technology has great potential to improve productivity and decrease project duration					
11	Constant delay caused by litigation between owner and contractors, contract termination and loss of productivity					

SECTION E: Construction contractual claims in civil infrastructure projects

1. Kindly rate the frequency of occurrence of the listed construction claims on civil infrastructure projects. Kindly indicate by ticking the appropriate box, using the scale below.

Never	Rarely	Occasionally	Often	Always
1	2	3	4	5

Contractual claims		1	2	3	4	5
1	Delay claims					
2	Extension of time claims					
3	Disruption and loss of productivity claims					
4	Acceleration claims					
5	Prolongation claims					
6	Change in work order claims					
7	Damage claims					
8	Loss of profit claims					
9	Loss and expenses claims					
10	Payment-related Claims					
11	Wrongful withholding of deposits claims					
12	Variation order claims					
13	Extra work claims					
14	Non-performance clams					
15	Dayworks claims					
16	Contract ambiguity claims					

17	Different construction site condition claims					
18	Please specify other claims you have encountered but not captured in the above list ………					

2. Kindly indicate your agreement to the use of the listed strategies for mitigation of contractual claims. Kindly indicate by ticking the appropriate box, using the scale below.

Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
1	2	3	4	5

Strategies for mitigating						
By the client		1	2	3	4	5
1	Ensure availability of the funds					
2	Engage experienced contractors and consultant					
3	Award bids to the best contractor not to the lowest bidder					
4	Efficient contract management					
5	Efficient coordination with the other parties					
6	Develop a reliable procurement process					
7	Specify a realistic contract period for the contractor					
By the main contractor						
1	Efficient construction planning by the main contractor					
2	Efficient site management and supervision					
3	Increase work shifts to increase productivity					
4	Timely response to the consultant instructions					
5	Efficient quality management system					
6	Speed up the site activities by the use of the sub-contractors					
By the consultant						
1	Efficient internal approval					
2	Efficient inspection system process					
3	Timely response to contractor's inquiries					

4	Cooperating with the contractor					

SECTION F: Factors that affect stakeholders' interest during implementation of civil infrastructure projects.

1. Kindly indicate the level at which you agree with the effects of these factors on stakeholders' interest during civil project delivery. Kindly indicate by ticking the appropriate box, using the scale below.

Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
1	2	3	4	5

Strategies for mitigating		1	2	3	4	5
1	Formulating a clear statement of project missions					
2	Identifying stakeholders properly					
3	Understanding the area of stakeholders' interests					
4	Exploring stakeholders' needs and constraints to project					
5	Assessing stakeholders' behaviour; predicting the influence of stakeholders					
6	Analyzing conflicts and coalitions among stakeholders					
7	Keeping and promoting a good relationship with stakeholders					
8	Formulating appropriate strategies to manage stakeholders					
9	Predicting stakeholders' reaction for implementing the strategies					
10	Enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims					

SECTION G: Background of Respondent

Name of organisation (optional):	
Years of working experience: (please tick √ appropriate option) 0 -5 years ■ 6 – 10 ■ 11 – 15 ■ 16 – 20 ■ above 20 ■	
Address (optional):	
Telephone (optional):	E-mail (optional):

Thank you very much for participating in the survey

Awad Saad Abdulla Saad
Doctoral Research Student
Tel (cell): 074-802-8969

APPENDIX C: INTERVIEW INVITATION LETTER

Cape Peninsula
University of Technology

Department of Civil Engineering and Surveying,
Cape Peninsula University of Technology
Symphony way off Robert Sobukwe Road, Bellville, 7535.
E-mail: awadsaad203@gmail.com /214129667@mycput.ac.za
March 2023

Dear Sir/ Madam,

Letter of appreciation and request for interview appointment

I write to express our appreciation for finding time out of your busy schedule to respond to our research questionnaire survey. We also appreciate your readiness to be interviewed on the subject of the research as indicated in your response to our research questionnaire survey. Thank you very much.

To achieve robust findings, the research phase is divided into the "Quantitative and Qualitative Phase," both of which are designed to run separately. The 'quantitative' phase has already been concluded, revealing extensive facts in alignment with the research objectives. However, the 'qualitative' phase, through the use of structured face-to-face interviews, would further be utilised to confirm and give more explanation to the facts that have been exposed by the quantitative findings, ensuring the validity and reliability of the research outcomes.

I wish to request for an appointment for the research interview. Kindly specify a date and time that will be convenient for you between 5th April and 30th April 2023 through the email address provided in the signature.

Sir, I wish to state that the objectives of this research will not be realised without the valuable contribution from your vast experience in the construction industry.

I wish to state that all information you provided during and after the course of the interview shall be treated with all anonymity and confidentiality.

Thanks for the usual cooperation and anticipated support for innovation.

Awad Saad Abdulla Saad

(Doctoral Research Student)

Tel (cell): 074-802-8969

APPENDIX D: STRUCTURED INTERVIEW GUIDE: DEDUCTIONS AND QUESTIONS

Cape Peninsula University of Technology

Title; Risk mitigation approach of contractual claims of civil infrastructure projects in South Africa.

Qualitative Interview Guide

1. What factors are responsible for the cause of the underlisted challenges influencing your firm's performance in civil infrastructure project?
   - Cost increase as a result of variations.
   - Completion time of the civil project.
   - Extend the time of civil project delivery.
2. What impact do these challenges have on the civil infrastructure projects delivery?
   - Were there any incidences of contractual claims on the project?
   - How does the procurement method influence the contractual claims?
   - How were these claims resolved?
3. Kindly share your opinion on the significance of contractual risk civil in nfrastructure projects delivery
   - in terms of managerial capability of project consultant.
   - as it concerns mitigation strategies deployed for managing the risks.
4. How has the stakeholder's interest been considered during implementation of civil Infrastructure Projects?
   - How could stakeholders be identified?
   - what measures are put in place to engage stakeholders in management of contractual risk?
   - How does unethical practices during project execution by stakeholders influence project delivery?
5. What type of risk mitigation model would you recommend for your organisation to implement for contractual claims risk management in civil infrastructure projects?

Thanks for your co-operation and support for innovation

APPENDIX E: FACTOR CAUSING CONTRACTUAL CLAIMS RISK IN CIVIL INFRASTRUCTURE PROJECT DELIVERY

E1: Frequency distribution estimates of other items in client related causes (CRC)

Frequency Scores for Client-Related Causes (CRC)								
Point-Likert Scale	**Delay in decision-making by the client (CRC5)**				**Changes in the scope of the work by the client (CRC4)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	1	0.6	0.6	0.6
2 = Not important	6	3.6	3.6	3.6	4	2.4	2.4	3.0
3 = Slightly important	55	33.1	33.1	36.7	64	38.6	38.6	41.6
4 = Important	76	45.8	45.8	82.5	68	41.0	41.0	82.5
5 = Very important	29	17.5	17.5	**100.0**	29	17.5	17.5	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Poor communication and coordination between clients and the project team (CRC7)**				**Client's financial problems (CRC8)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	1	0.6	0.6	0.6	3	1.8	1.8	1.8
2 = Not important	8	4.8	4.8	5.4	6	3.6	3.6	5.4
3 = Slightly important	64	38.6	38.6	44.0	82	49.4	49.4	54.8
4 = Important	71	42.8	42.8	86.7	60	36.1	36.1	91.0
5 = Very important	22	13.3	13.3	**100.0**	15	9.0	9.0	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

E2: Frequency distribution estimates of other items in contractor-related causes (CoRC)

Frequency Scores for Contractor-Related Causes (CoRC)								
Likert scales	Inadequate site management by the main contractor (CoRC4)				Low productivity of the main contractor workforce (CoRC5)			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	1	0.6	0.6	0.6	1	0.6	0.6	0.6
2 = Not important	6	3.6	3.6	4.2	9	5.4	5.4	6.0
3 = Slightly important	77	46.4	46.4	50.6	80	48.2	48.2	54.2
4 = Important	70	42.2	42.2	92.8	59	35.5	35.5	89.8
5 = Very important	12	7.2	7.2	**100.0**	17	10.2	10.2	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Insufficient number of workers (CoRC7)**				**Delay in mobilisation to project site by the main contractor (CoRC9)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	2	1.2	1.2	1.2
2 = Not important	10	6.0	6.0	6.0	6	3.6	3.6	4.8
3 = Slightly important	74	44.6	44.6	50.6	82	49.4	49.4	54.2
4 = Important	73	44.0	44.0	94.6	67	40.4	40.4	94.6
5 = Very important	9	5.4	5.4	**100.0**	9	5.4	5.4	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Shortage of equipment on site (CoRC14)**				**Poor construction planning by the main contractor (CoRC8)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	1	0.6	0.6	0.6	1	0.6	0.6	0.6
2 = Not important	7	4.2	4.2	4.8	7	4.2	4.2	4.8
3 = Slightly important	85	51.2	51.2	56.0	90	54.2	54.2	59.0
4 = Important	63	38.0	38.0	94.0	53	31.9	31.9	91.0
5 = Very important	10	6.0	6.0	**100.0**	15	9.0	9.0	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

E2: continued.

Frequency Scores for Contractor-Related Causes (CoRC)								
Likert scales	Delayed salary payments to the main contractor's staff (CoRC12)				Delay in supply of construction materials (CoRC3)			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not important	6	3.6	3.6	3.6	5	3.0	3.0	3.0
3 = Slightly important	87	52.4	52.4	56.0	95	57.2	57.2	60.2
4 = Important	68	41.0	41.0	97.0	58	34.9	34.9	95.2
5 = Very important	5	3.0	3.0	**100.0**	8	4.8	4.8	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Poor cost estimation by the main contractor (CoRC10)**				**Lack of the incentives for the workers (CoRC13)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	1	0.6	0.6	0.6	1	0.6	0.6	0.6
2 = Not important	3	1.8	1.8	2.4	3	1.8	1.8	2.4
3 = Slightly important	96	57.8	57.8	60.2	101	60.8	60.8	63.3
4 = Important	59	35.5	35.5	95.8	54	32.5	32.5	95.8
5 = Very important	7	4.2	4.2	**100.0**	7	4.2	4.2	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Lack of well-being facilities by the main contractor (CoRC16)**				**Disagreement between the main contractor and the consultant (CoRC15)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely unimportant	1	0.6	0.6	0.6	2	1.2	1.2	1.2
2 = Not important	9	5.4	5.4	6.0	9	5.4	5.4	6.6
3 = Slightly important	91	54.8	54.8	60.8	92	55.4	55.4	62.0
4 = Important	57	34.3	34.3	95.2	57	34.3	34.3	96.4
5 = Very important	8	4.8	4.8	**100.0**	6	3.6	3.6	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Inappropriate methods of construction (CoRC17)**							
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**				
1 = Extremely unimportant	1	0.6	0.6	0.6				
2 = Not important	9	5.4	5.4	6.0				
3 = Slightly important	97	58.4	58.4	64.5				
4 = Important	52	31.3	31.3	95.8				
5 = Very important	7	4.2	4.2	**100.0**				
Overall total	**166**	**100.0**	**100.0**					

E3: Frequency distribution estimates of other items in consultant-related causes (CsRC)

Frequency Scores for Consultant-Related Causes (CsRC)								
Likert scales	Poor quality control by the consultant (CsRC5)				Misunderstanding of the client's requirements by the consultant (CsRC6)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Extremely unimportant	1	0.6	0.6	0.6	1	0.6	0.6	0.6
2 = Not important	3	1.8	1.8	2.4	5	3.0	3.0	3.6
3 = Slightly important	75	45.2	45.2	47.6	77	46.4	46.4	50.0
4 = Important	70	42.2	42.2	89.8	63	38.0	38.0	88.0
5 = Very important	17	10.2	10.2	**100.0**	20	12.0	12.0	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

E4: Frequency distribution estimates of other items in external causes (ExC)

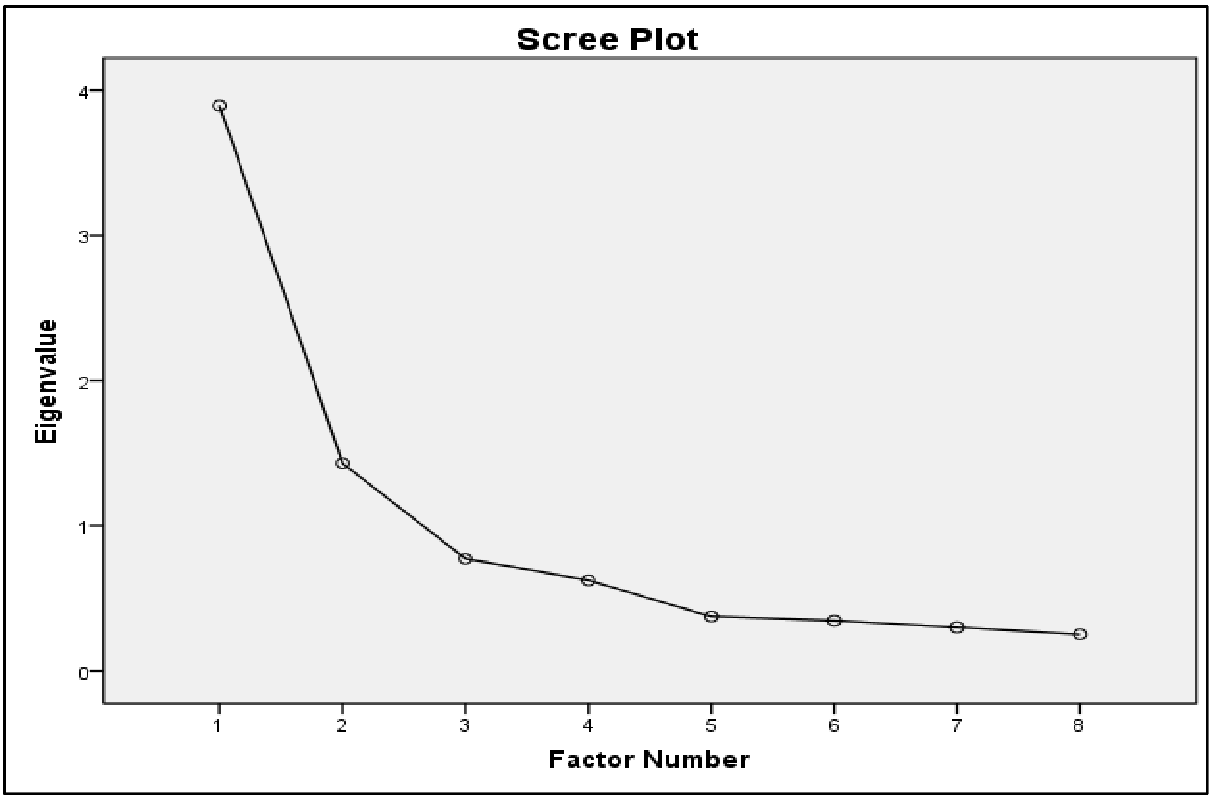
Frequency Scores for External Causes (ExC)								
Likert scales	Unforeseen site condition (ExC5)				Price fluctuation (ExC6)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Extremely unimportant	1	0.6	0.6	0.6	1	0.6	0.6	0.6
2 = Not important	16	9.6	9.6	10.2	16	9.6	9.6	10.2
3 = Slightly important	82	49.4	49.4	59.6	101	60.8	60.8	71.1
4 = Important	58	34.9	34.9	94.6	38	22.9	22.9	94.0
5 = Very important	9	5.4	5.4	**100.0**	10	6.0	6.0	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

E5: Frequency distribution estimates of other items in finance-related causes (FiR)

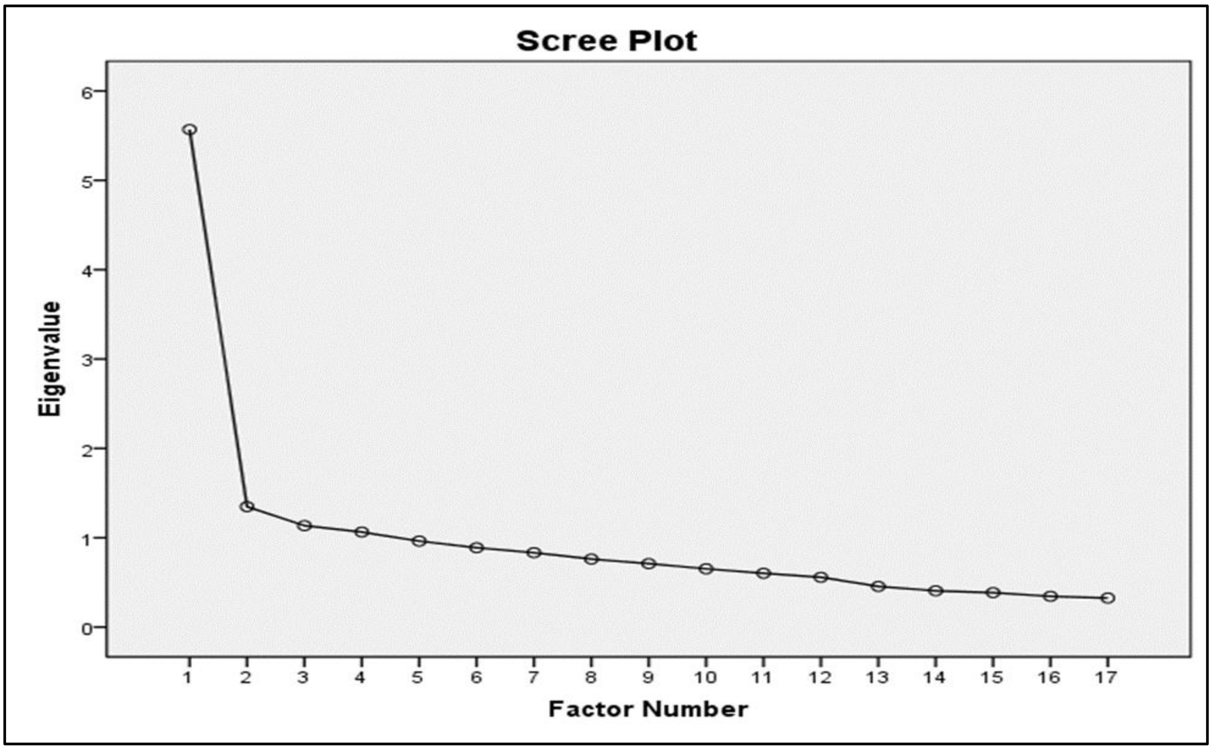
Frequency Scores for Finance-Related Causes (FiR)				
Likert scales	Change in government policy on prices of construction materials (FiR5)			
	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Extremely unimportant	0	0.0	0.0	0.0
2 = Not important	19	11.4	11.4	11.4
3 = Slightly important	90	54.2	54.2	65.7
4 = Important	46	27.7	27.7	93.4
5 = Very important	11	6.6	6.6	**100.0**
Overall total	**166**	**100.0**	**100.0**	

E6: Frequency distribution estimates of other items in contractual risk factors (CRF)

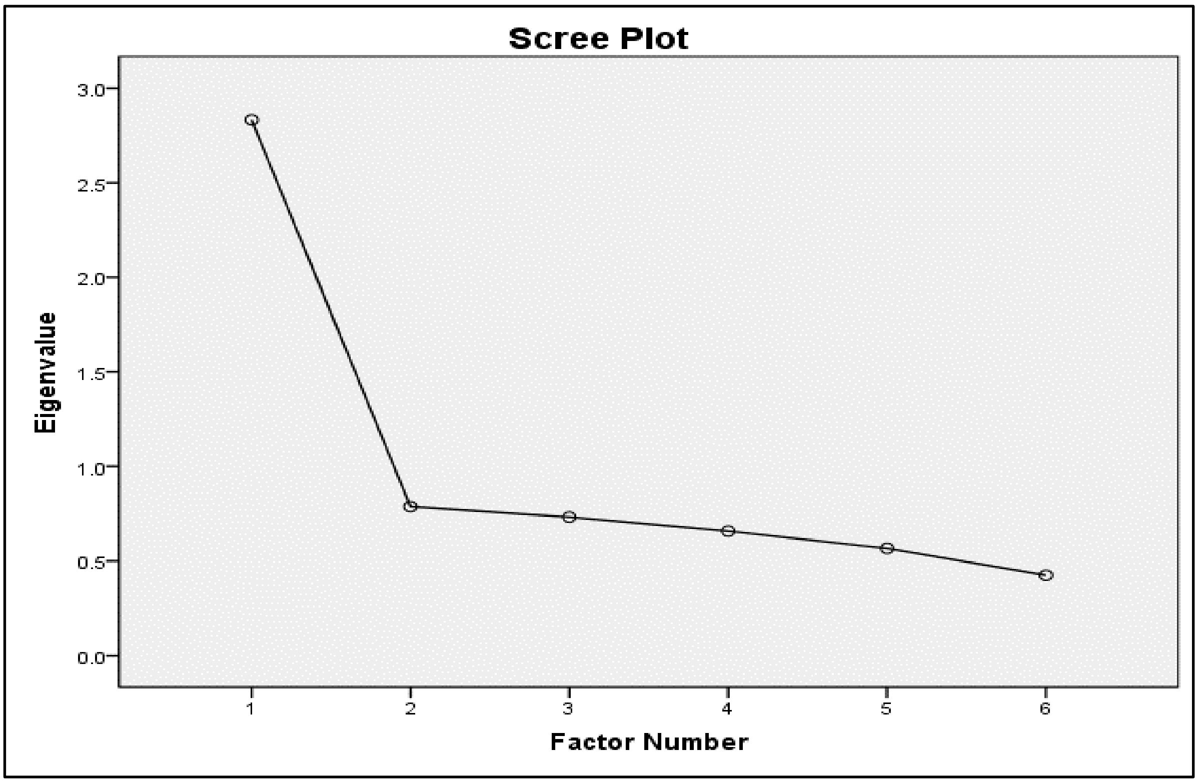
Frequency Scores for contractual risk factors								
Likert scales	Inadequate definition of substantial completion (CRF4)				Legal disputes and Inappropriate method of dispute resolution (CRF6)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Extremely insignificant	1	0.6	0.6	0.6	0	0.0	0.0	0.0
2 = Not significant	6	3.6	3.6	4.2	10	6.0	6.0	6.0
3 = Slightly significant	71	42.8	42.8	47.0	69	41.6	41.6	47.6
4 = Significant	65	39.2	39.2	86.1	75	45.2	45.2	92.8
5 = Very significant	23	13.9	13.9	**100.0**	12	7.2	7.2	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Poor communication/coordination between consultant and other parties (CRF11)**				**Slow information flow between parties (CRF8)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extremely insignificant	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Not significant	13	7.8	7.8	7.8	8	4.8	4.8	4.8
3 = Slightly significant	76	45.8	45.8	53.6	89	53.6	53.6	58.4
4 = Significant	61	36.7	36.7	90.4	53	31.9	31.9	90.4
5 = Very significant	16	9.6	9.6	**100.0**	16	9.6	9.6	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	



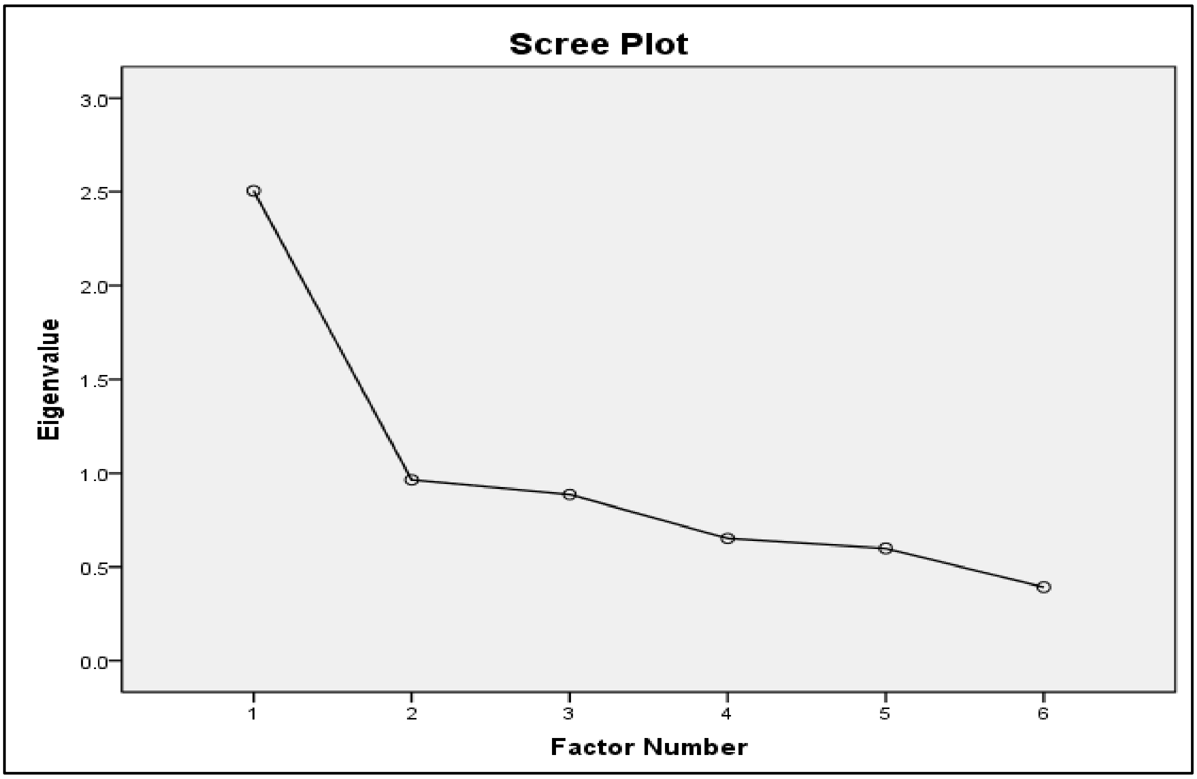
E7: Scree plot for factors extracted from CRC



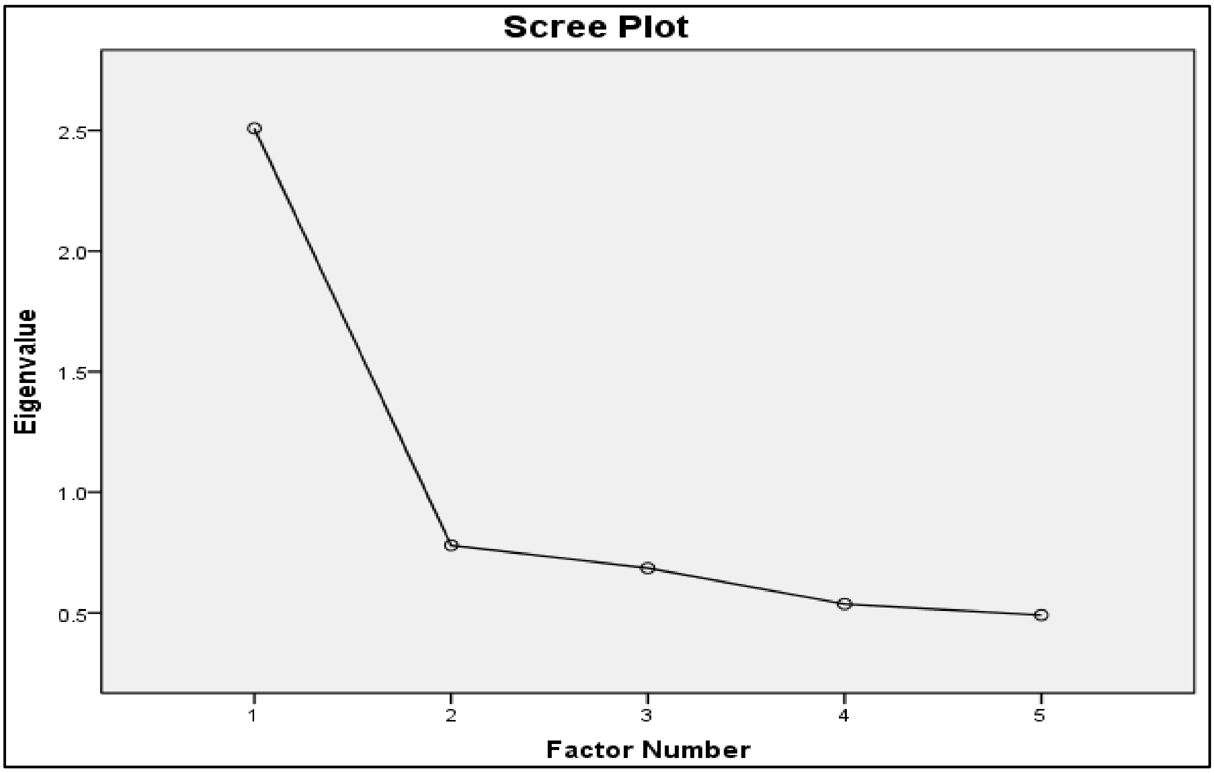
E8: Scree plot for factors extracted from CoRC



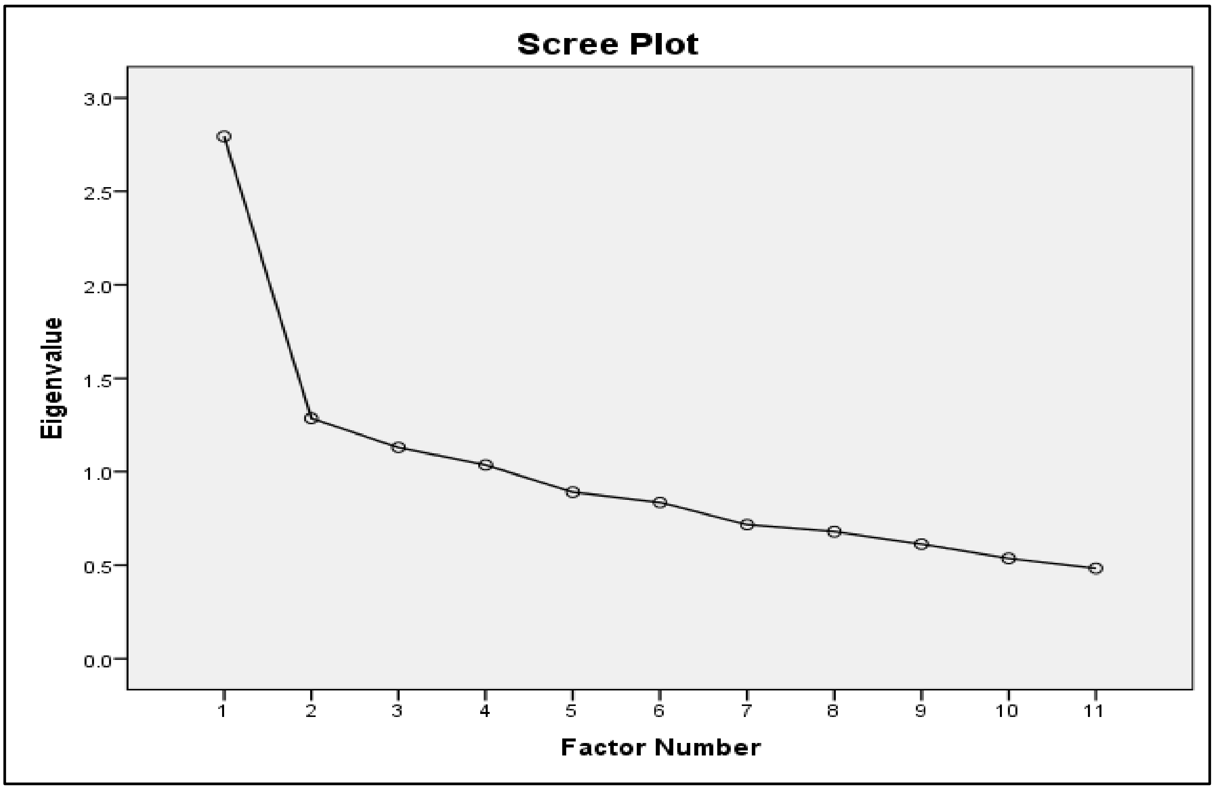
E9: Scree plot for factors extracted from CsRC



E10: Scree plot for factors extracted from ExC



E11: Scree plot for factors extracted from FiR



E12: Scree plot for factors extracted from CRF

APPENDIX F: IMPACTS OF RISKS OCCURRENCE IN CIVIL INFRASTRUCTURE PROJECTS

F1: Frequency distribution estimates of other items in risk occurrence (RkO)

Frequency Scores for Risk Occurrence (RkO)				
Likert scales	**Construction risk associated with poor management by contractor's (managerial risk) (RkO3)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0
2 = Rarely	4	2.4	2.4	2.4
3 = Occasionally	67	40.4	40.4	42.8
4 = Often	71	42.8	42.8	85.5
5 = Always	24	14.5	14.5	**100.0**
Overall total	**166**	**100.0**	**100.0**	

F2: Frequency distribution estimates of other items in REPD

Frequency Scores for REPD				
Likert scales	**Construction site health and safety practices risk (REPD5)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Extreme influence	3	1.8	1.8	1.8
2 = No influence	15	9.0	9.0	10.8
3 = Slight influence	92	55.4	55.4	66.3
4 = High influence	45	27.1	27.1	93.4
5 = Very high influence	11	6.6	6.6	**100.0**
Overall total	**166**	**100.0**	**100.0**	

F3: Frequency distribution estimates of other items in risk associated with underlisted RARCV

Frequency Scores for Risk Associated with Underlisted Risk-causative Variables (RARCV)								
Likert scales	**Frequent delays on-site due to site conditions, designer and user changes (RARCV5)**				**Procurement method (awarding the bid to the lowest bidder) (RARCV9)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Time delay risk	3	1.8	1.8	1.8	3	1.8	1.8	1.8
3 = Managerial risk	76	45.8	45.8	47.6	78	47.0	47.0	48.8
4 = Risk associated with consultant performance	70	42.2	42.2	89.8	74	44.6	44.6	93.4
5 = Construction site health and safety practices risk	17	10.2	10.2	**100.0**	11	6.6	6.6	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Lack of understanding of the contractual terms and conditions (RARCV4)**				**Formation of a standard form of contract (RARCV8)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Time delay risk	4	2.4	2.4	2.4	2	1.2	1.2	1.2
3 = Managerial risk	76	45.8	45.8	48.2	88	53.0	53.0	54.2
4 = Risk associated with consultant performance	76	45.8	45.8	94.0	60	36.1	36.1	90.4
5 = Construction site health and safety practices risk	10	6.0	6.0	**100.0**	16	9.6	9.6	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

F3: continued.

Frequency Scores for Risk Associated with Underlisted Risk-causative Variables (RARCV)								
Likert scales	Adoption of new construction technology has great potential to improve productivity and decrease project duration (RARCV10)				Poor documentation and management practices during construction (RARCV7)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Time delay risk	5	3.0	3.0	3.0	4	2.4	2.4	2.4
3 = Managerial risk	84	50.6	50.6	53.6	86	51.8	51.8	54.2
4 = Risk associated with consultant performance	68	41.0	41.0	94.6	67	40.4	40.4	94.6
5 = Construction site health and safety practices risk	9	5.4	5.4	**100.0**	9	5.4	5.4	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

Frequency Scores for Risk Associated with Underlisted Risk-causative Variables (RARCV)								
Likert scales	Lack of understanding of the contractual terms and conditions (RARCV4)				Formation of a standard form of contract (RARCV8)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Time delay risk	4	2.4	2.4	2.4	2	1.2	1.2	1.2
3 = Managerial risk	76	45.8	45.8	48.2	88	53.0	53.0	54.2
4 = Risk associated with consultant performance	76	45.8	45.8	94.0	60	36.1	36.1	90.4
5 = Construction site health and safety practices risk	10	6.0	6.0	**100.0**	16	9.6	9.6	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	Adoption of new construction technology has great potential to improve productivity and decrease project duration (RARCV10)				Poor documentation and management practices during construction (RARCV7)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Time delay risk	5	3.0	3.0	3.0	4	2.4	2.4	2.4
3 = Managerial risk	84	50.6	50.6	53.6	86	51.8	51.8	54.2
4 = Risk associated with consultant performance	68	41.0	41.0	94.6	67	40.4	40.4	94.6
5 = Construction site health and safety practices risk	9	5.4	5.4	**100.0**	9	5.4	5.4	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

F3: continued.

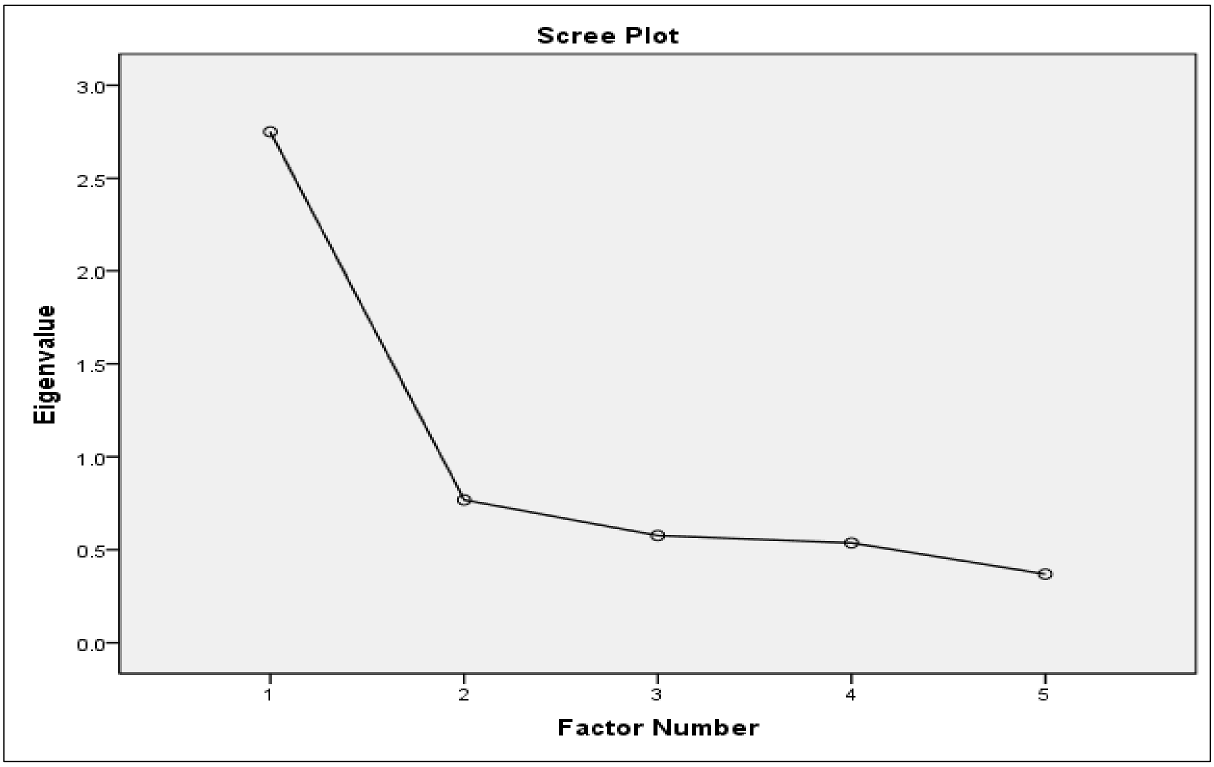
Frequency Scores for Risk associated with Underlisted Risk-causative Variables (RARCV)				
Likert scales	Constant delay caused by litigation between owner and contractors, contract termination and loss of productivity (RARCV11)			
	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Risk associated with claims due to errors and omissions in design	0	0.0	0.0	0.0
2 = Time delay risk	7	4.2	4.2	4.2
3 = Managerial risk	85	51.2	51.2	55.4
4 = Risk associated with consultant performance	61	36.7	36.7	92.2
5 = Construction site health and safety practices risk	13	7.8	7.8	**100.0**
Overall total	**166**	**100.0**	**100.0**	

F4: Frequency distribution estimates of other items in frequency occurrence of contractual claims

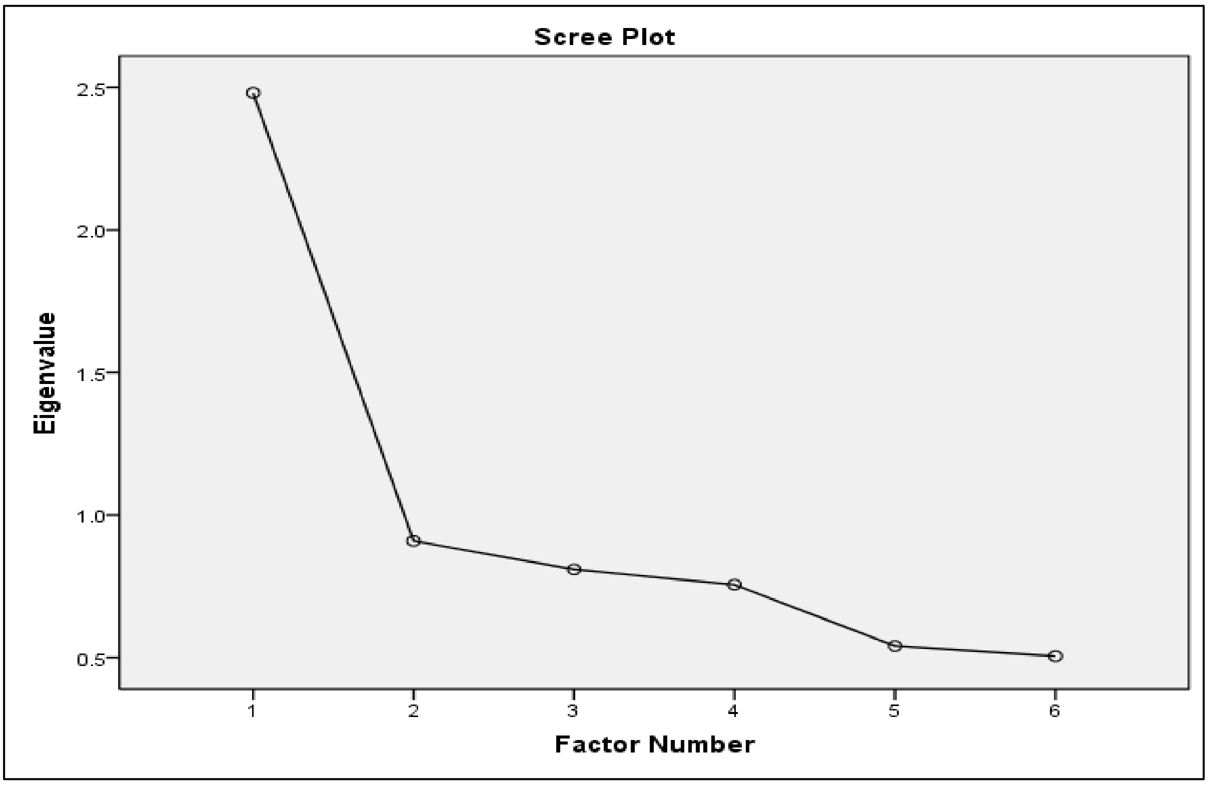
Frequency Scores for Occurrence of Construction Contractual Claims on Civil Infrastructure Projects (FOCC)								
Likert scales	Wrongful withholding of deposits claims (FOCC11)				Different construction site condition claims (FOCC17)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	0	0.0	0.0	0.0	1	0.6	0.6	0.6
3 = Occasionally	51	30.7	30.7	30.7	54	32.5	32.5	33.1
4 = Often	84	50.6	50.6	81.3	78	47.0	47.0	80.1
5 = Always	31	18.7	18.7	**100.0**	33	19.9	19.9	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	Change of work order claims (FOCC6)				Acceleration claims (FOCC4)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	3	1.8	1.8	1.8	1	0.6	0.6	0.6
3 = Occasionally	51	30.7	30.7	32.5	60	36.1	36.1	36.7
4 = Often	84	50.6	50.6	83.1	73	44.0	44.0	80.7
5 = Always	28	16.9	16.9	**100.0**	32	19.3	19.3	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

F4: continued.

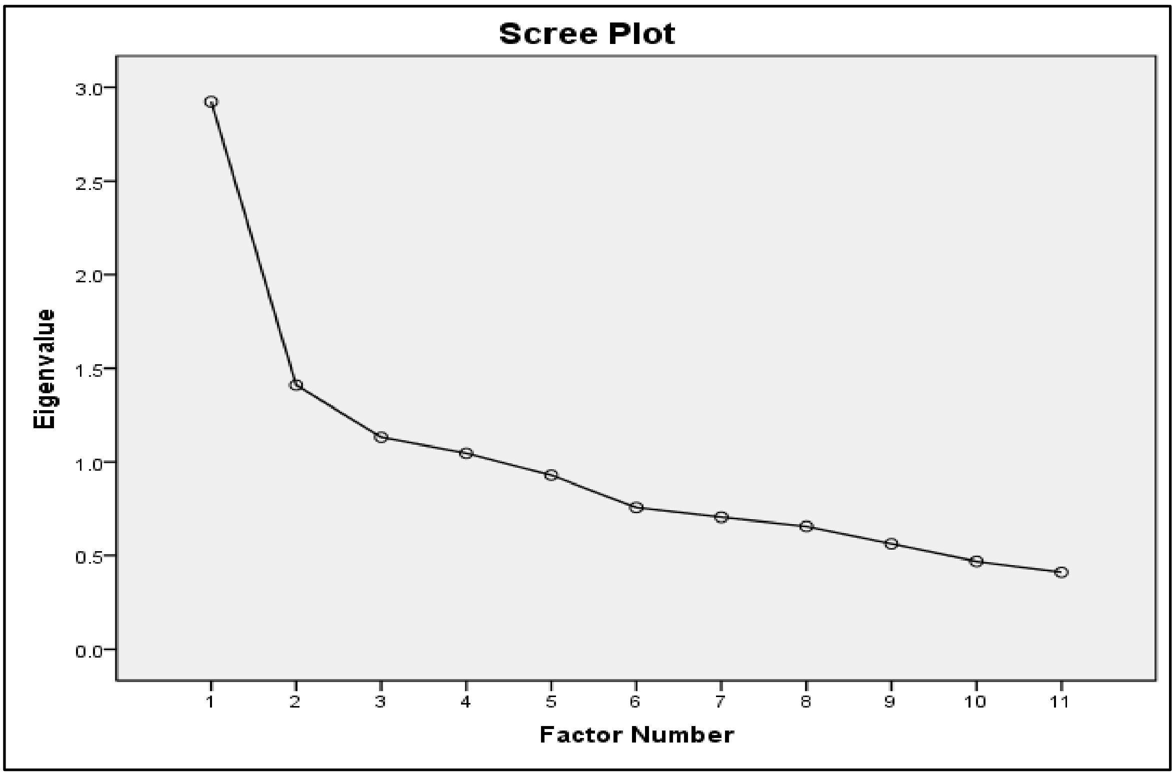
Frequency Scores for Occurrence of Construction Contractual Claims on Civil Infrastructure Projects (FOCC)								
Likert scales	**Dayworks claims (FOCC15)**				**Prolongation claims (FOCC5)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	4	2.4	2.4	2.4	2	1.2	1.2	1.2
3 = Occasionally	53	31.9	31.9	34.3	62	37.3	37.3	38.6
4 = Often	81	48.8	48.8	83.1	69	41.6	41.6	80.1
5 = Always	28	16.9	16.9	**100.0**	33	19.9	19.9	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Loss of profit claims (FOCC8)**				**Extra work claims (FOCC13)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	1	0.6	0.6	0.6	3	1.8	1.8	1.8
3 = Occasionally	67	40.4	40.4	41.0	60	36.1	36.1	38.0
4 = Often	64	38.6	38.6	79.5	73	44.0	44.0	81.9
5 = Always	34	20.5	20.5	**100.0**	30	18.1	18.1	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Others (FOCC18)**				**Contract ambiguity claims (FOCC16)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	4	2.4	2.4	2.4	2	1.2	1.2	1.2
3 = Occasionally	55	33.1	33.1	35.5	67	40.4	40.4	41.6
4 = Often	81	48.8	48.8	84.3	67	40.4	40.4	81.9
5 = Always	26	15.7	15.7	**100.0**	30	18.1	18.1	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Variation order claims (FOCC12)**				**Loss and expenses claim (FOCC9)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	2	1.2	1.2	1.2	1	0.6	0.6	0.6
3 = Occasionally	67	40.4	40.4	41.6	62	37.3	37.3	38.0
4 = Often	70	42.2	42.2	83.7	84	50.6	50.6	88.6
5 = Always	27	16.3	16.3	**100.0**	19	11.4	11.4	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	



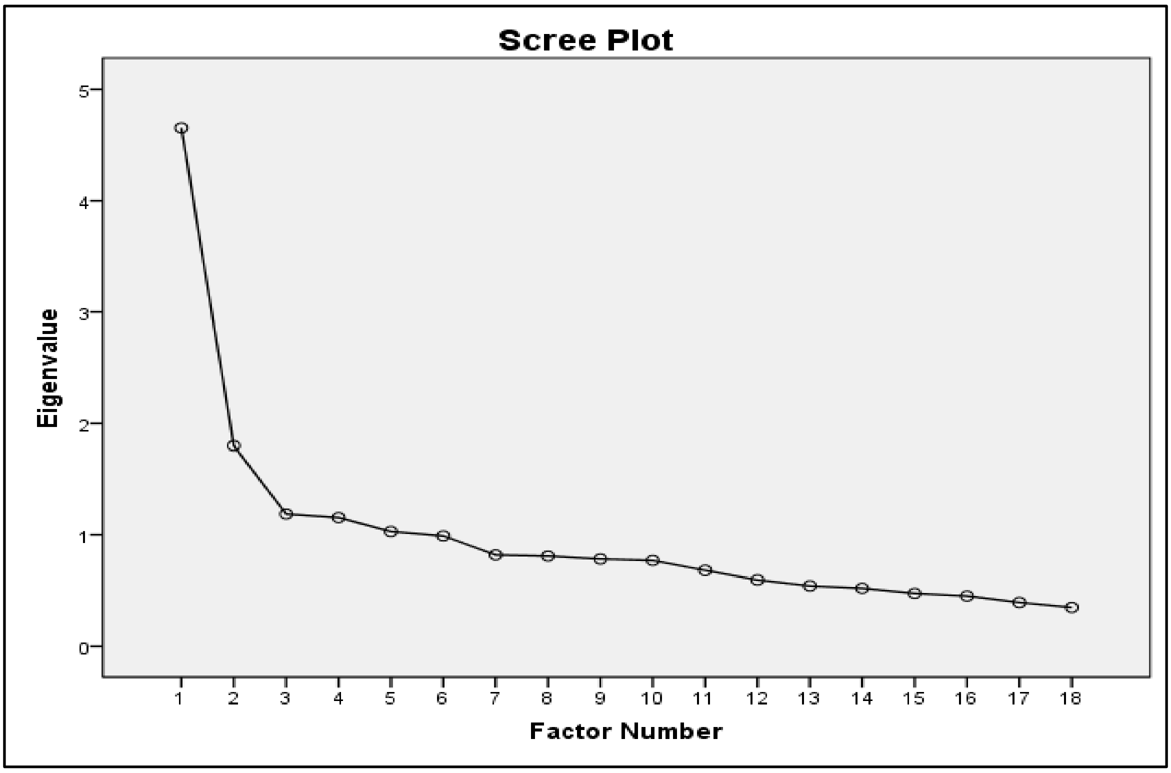
F5: Scree plot for factors extracted from RkO



F6: Scree plot for factors extracted from REPD



F7: Scree plot for factors extracted from RARCV



F8: Scree plot for factors extracted from FOCC

APPENDIX G: ESSENTIAL STRATEGIES TO MITIGATE RISK IN CIVIL INFRASTRUCTURE PROJECTS

G1: Frequency distribution estimates of other items in client strategies for contractual claims mitigation

Frequency Scores for Occurrence of Construction Contractual Claims on Civil Infrastructure Projects (FOCC)								
Likert scales	Non-performance claims (FOCC14)				Payment-related Claims (FOCC10)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Never	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Rarely	4	2.4	2.4	2.4	1	0.6	0.6	0.6
3 = Occasionally	64	38.6	38.6	41.0	67	40.4	40.4	41.0
4 = Often	71	42.8	42.8	83.7	74	44.6	44.6	85.5
5 = Always	27	16.3	16.3		24	14.5	14.5	
Overall total	**166**	**100.0**	**100.0**	**100.0**	**166**	**100.0**	**100.0**	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

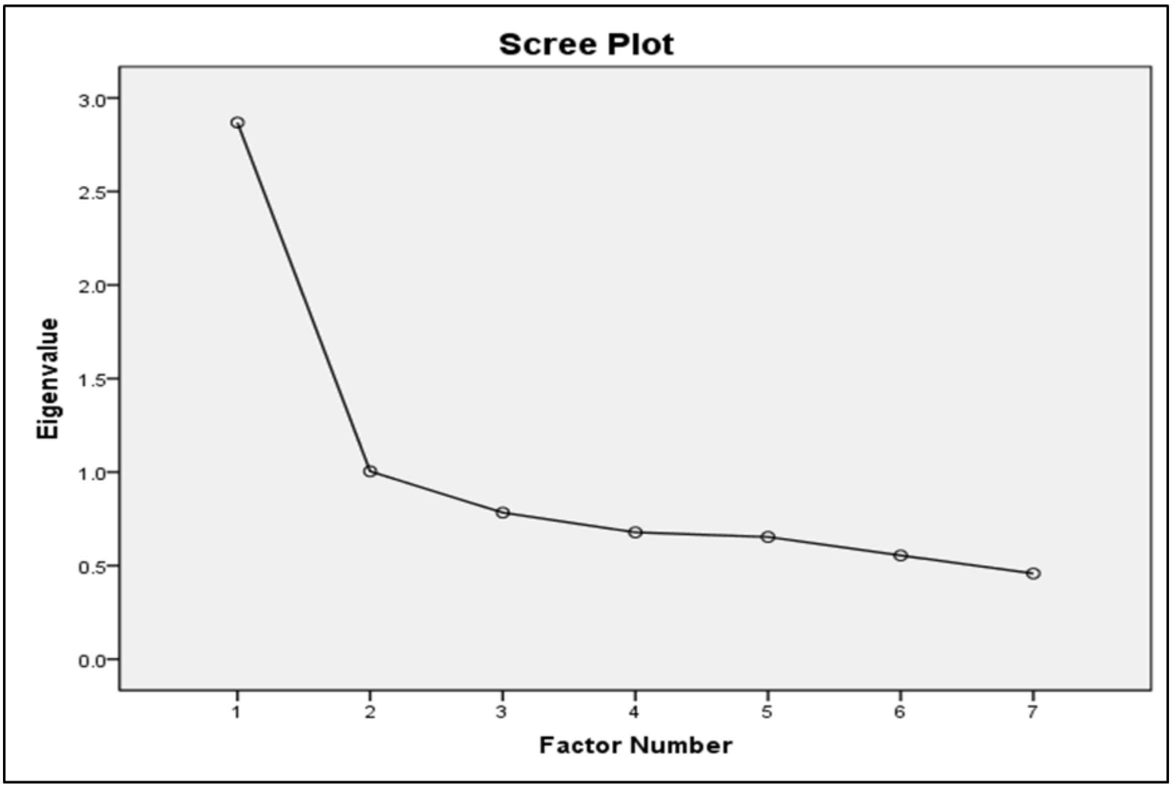
G2: Frequency distribution estimates of other items in main contractor's strategies for contractual claims mitigation

Frequency Scores for Main Contractor's Strategies for Contractual Claims Mitigation (BTMC)								
Likert scales	Timely response to the consultant instructions (BTMC4)				Speed up the site activities by the use of the sub-contractors (BTMC6)			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
1 = Strongly disagree	0	0.0	0.0	0.0	0	0.0	0.0	0.0
2 = Disagree	2	1.2	1.2	1.2	5	3.0	3.0	4.8
3 = Slightly agree	79	47.6	47.6	48.8	93	56.0	56.0	43.4
4 = Agree	71	42.8	42.8	91.6	55	33.1	33.1	89.8
5 = Strongly agree	14	8.4	8.4	**100.0**	13	7.8	7.8	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

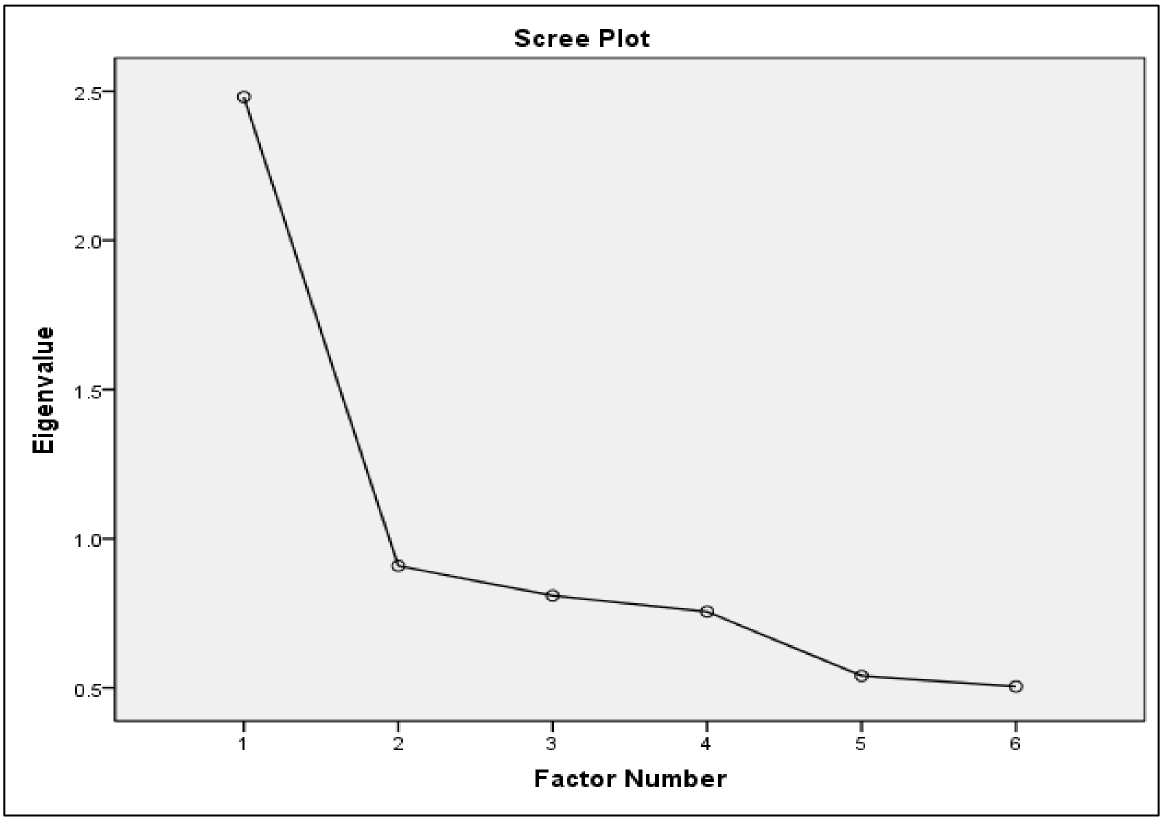
G3: Frequency distribution estimates of other items in strategies for mitigation

Frequency Scores for Strategies for Mitigation (SFM)								
Likert scales	**Assessing stakeholders' behaviour; predicting the influence of stakeholders (SFM5)**				**Predicting stakeholders' reaction for implementing the strategies (SFM9)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Strongly disagree	1	0.6	0.6	.6	0	0.0	0.0	0.0
2 = Disagree	4	2.4	2.4	3.0	2	1.2	1.2	1.2
3 = Slightly agree	48	28.9	28.9	31.9	68	41.0	41.0	42.2
4 = Agree	97	58.4	58.4	90.4	68	41.0	41.0	83.1
5 = Strongly agree	16	9.6	9.6	**100.0**	28	16.9	16.9	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	
Likert scales	**Keeping and promoting a good relationship with stakeholders (SFM7)**				**Analysing conflicts and coalitions among stakeholders (SFM6)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Strongly disagree	1	0.6	0.6	0.6	0	0.0	0.0	0.0
2 = Disagree	0	0.0	0.0	0.6	15	9.0	9.0	9.0
3 = Slightly agree	68	41.0	41.0	41.6	92	55.4	55.4	64.5
4 = Agree	76	45.8	45.8	87.3	51	30.7	30.7	95.2
5 = Strongly agree	21	12.7	12.7	**100.0**	8	4.8	4.8	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	

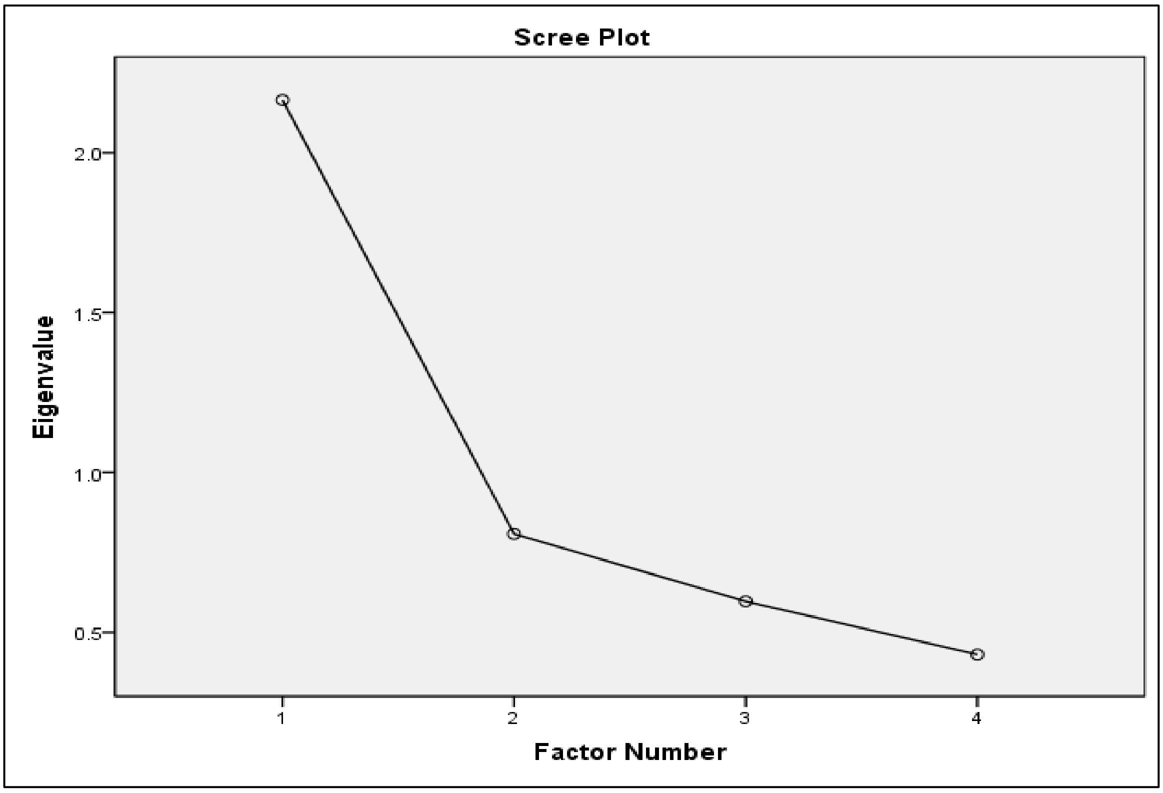
Frequency Scores for Strategies for Mitigation (SFM)								
Likert scales	**Formulating appropriate strategies to manage stakeholders (SFM8)**				**Enabling stakeholders to identify, negotiate and achieve their objectives and interests in order to reduce claims (SFM10)**			
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1 = Strongly disagree	1	0.6	0.6	0.6	0	0.0	0.0	0.0
2 = Disagree	4	2.4	2.4	3.0	7	4.2	4.2	4.2
3 = Slightly agree	73	44.0	44.0	47.0	74	44.6	44.6	48.8
4 = Agree	65	39.2	39.2	86.1	67	40.4	40.4	89.2
5 = Strongly agree	23	13.9	13.9	**100.0**	18	10.8	10.8	**100.0**
Overall total	**166**	**100.0**	**100.0**		**166**	**100.0**	**100.0**	



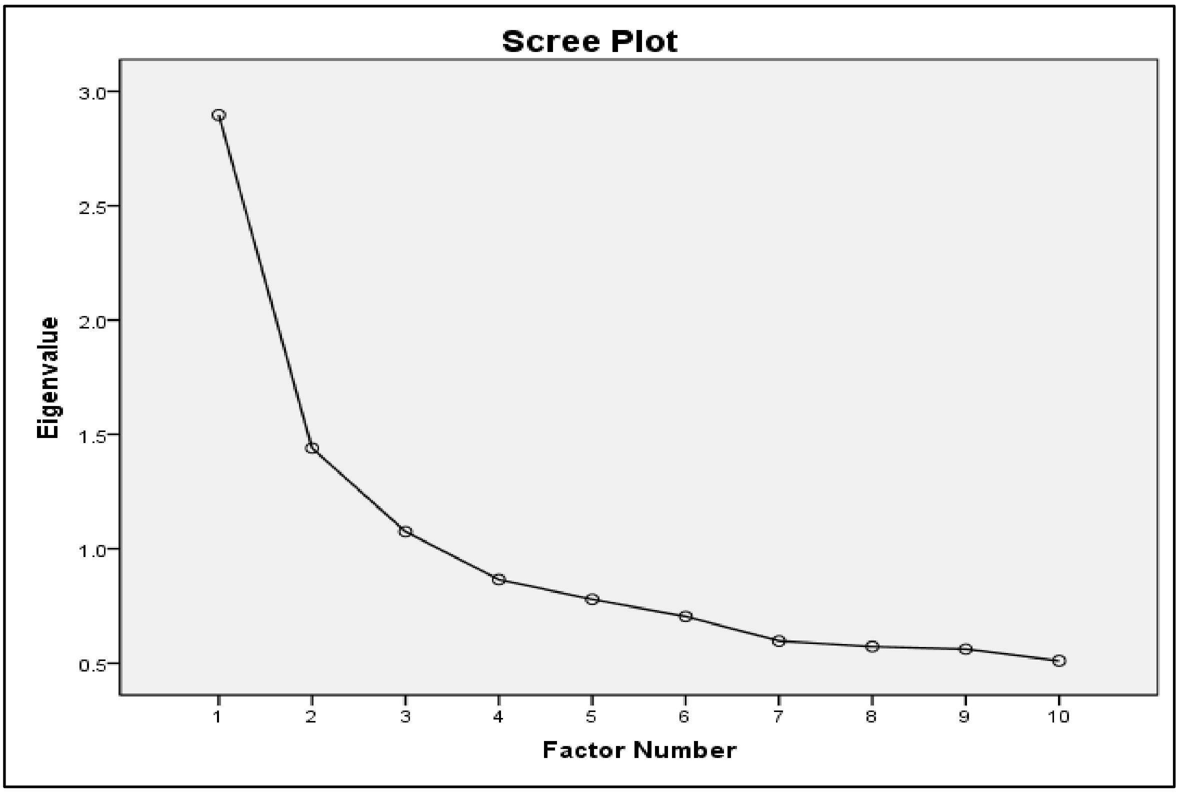
G4: Scree plot for factors extracted from BTC



G5: Scree plot for factors extracted from BTMC



G6: Scree plot for factors extracted from BTCo



G7: Scree plot for factors extracted from SFM

APPENDIX H: PAPER ONE – PUBLISHED (BUILDINGS MDPI)

Risk Mitigation Model to Address Contractual Claims Risk of Civil Infrastructure Projects in South Africa

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Abstract: *The risks due to contractual claims in the civil engineering construction industry in South Africa are a concern. Currently, there are no risk mitigation models available for managers to help reduce such risks. A theoretical risk mitigation model was developed from the literature and validated through partial least squares structural equation modelling (PLS-SEM), using primary questionnaire data obtained from 166 respondents drawn from a pool of South African construction industry professionals, including project directors, project managers, supervisors, consultants, and contractors. The descriptive results indicate the significant patterns, trends and distributions of the variables across the three constructs in the study. The PLS-SEM results indicate that factors causing contractual claims risk in civil infrastructure projects have a significant relation to the impact of risk occurrence on these projects, influencing the strategies to be implemented to mitigate such risks. The PLS-SEM results also indicate a significant direct relation between the factors causing the contractual claims risk and the strategies to be implemented to mitigate risks, thus implying that the holistic adaptation of the PLS-SEM (risk mitigation model) by construction industry professionals in South Africa should reduce contractual claims risk related to civil infrastructure projects. The findings serve as a valuable guide not only to construction industry professionals but also to government agencies such as the Department of Public Works and Infrastructure.*

Keywords: civil infrastructure projects; contractual claims risk; risk occurrence, South Africa