FACULTY OF ENGINEERING AND BUILT ENVIRONMENT
DEPARTMENT OF CONSTRUCTION ECONOMICS AND MANAGEMENT

CAUSES AND EFFECTS OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SOUTH AFRICA

CON5023Z MINOR DISSERTATION

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR A MASTER OF SCIENCE DEGREE IN PROJECT MANAGEMENT

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ABSTRACT

Delays in road construction projects in South Africa are a common phenomenon. This study aimed at identifying the causes and effects of such delays that are pertinent to South African conditions. The study used a deductive quantitative research approach that used a structured questionnaire developed through a comprehensive literature review on the subject under study and through a pilot evaluation by experts.

The structured questionnaire was sent to clients, consultants, contractors, and other external stakeholders involved in SANRAL projects. A total of 64 responses to the questionnaire was received. The data received was analysed using the Relative Importance Index (RII), Kruskal-Wallis Test and Chi-square test. The Cronbach's Alpha was used to measure reliability with the lowest alpha value of 0.827 indicating a high degree of reliability.

The RII indicated the top five overall causes of delays in South Africa road construction are: unrest by local communities, stoppages of work by construction mafia/ neighbouring communities/ wards, delays due to regulatory approval processes, poor engagement with local community, and lack of acceptance of project by community. The top five effects of delays that emerged from the survey are: time overruns, cost overruns, disputes and claims between contract parties, stress, and negative social impact/ bad reputation. The study further found that the top five delay minimising measures included: early engagement with the community, improved communication with community, improved management of subcontractors, effective strategic planning by contractor, and timeous payments to contractor and consultant.

The Kruskal-Wallis Test revealed that there was no statistically significant difference in the views of all project stakeholders on the five main causes of road construction project delays. There was no statistically significant difference in the views of all project stakeholders on the major effects of road construction project delays. The results of the Kruskal-Wallis test revealed that there is a statistically significant difference in the views of all project stakeholders on the delay minimising measures.

The study concludes that project delays occur on road construction projects in South Africa with the major contributor being external-related causes. The study proposed the following recommendations: early involvement of the community in the project

through the establishment of community liaison meetings and the establishment of a Public Liaison Committee (PLC), improved management and supervision by the contractor on site, improvement of decision making and approval by client, timeous payment to consultant and contractors by the client, and the contractor should employ improved strategic planning techniques.

Key words: Road projects, delays, effects, construction, South Africa

DEDICATION AND ACKNOWLEDGEMENTS

This academic achievement is dedicated to my wife, Zaheera and son Yahya.

I wish to praise Almighty God for affording me the strength and abilities throughout these challenging times to complete the academic work. Nothing can be achieved without the assistance of Almighty God.

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LIST OF ACRONYMS/ ABBREVIATIONS

Capex	Capital Expenditure
CPM	Critical Path Method
DOT	Department of Transport
GDP	Gross Domestic Product
Opex	Operational Expenditure
PM	Project Manager
PLC	Public Liaison Committee
PLO	Public Liaison Officer
RII	Relative Importance Index
RRM	Routine Road Maintenance
SANRAL	South African National Roads Agency Ltd.
SMME	Small Medium Micro-Enterprise

CHAPTER ONE: INTRODUCTION

1.1 Introduction to Research

The wealth of a country is judged by its infrastructure performance. For developing countries, road infrastructure is the heart of the economy (Kaliba, Muya and Mumba, 2009). It is a major influence in developing the country's socio-economic growth as it influences how citizens, goods, and services are accessed throughout the country. According to Tsikai (2016), transport plays a major role in the tourism industry which improves the economic growth of the country. When a country's transport system is efficient, it results in economic and social opportunities and benefits that have positive effects such as better accessibility to markets, employment, and additional investments in the country (Rodrigue and Notteboom, 2020). On the contrary, when the transport system is deficient, it results in economic cost, reduced opportunities, and a lower quality of life (Rodrigue and Notteboom, 2020). South Africa has a comprehensive road network that amounts to approximately 750 000km in length (Nkabinde, 2019), of which approximately 21 403km are constructed and managed by the South African National Roads Agency Limited (SANRAL, 2021).

The economic development of South Africa depends on reliable and sustainable road infrastructure to allow for the transportation of the country's produce from inland to the ports for export, commuting to work/shopping and tourism. Haseeb, Lu, Bibi, Dyian, and Rabbani (2011) argue that the construction industry and in particular, road construction, are key to the country's development and economic growth. Ivanova and Masarova (2013) claim that road infrastructure is a key prerequisite for social and economic development of the country and poor road infrastructure hinders foreign investments in the country.

In line with the South African government priorities and the medium-term strategic framework, the 2020 National Budget prioritised spending on social and economic infrastructure which included roads and transportation development. Public-sector infrastructure spending over the medium-term period is estimated at R815 billion, of which R308.3 billion (37.8 %) is allocated to transport and logistics (National Treasury, 2020). SANRAL is allocated approximately R64.6 billion (20.97%) of the budget allocated to transport and logistics. This investment aims to improve the transport network and enhance mobility while reducing travel costs and increasing regional

trade (National Treasury, 2020). The substantial allocation to infrastructure development is not surprising as infrastructure development is essential for social and economic growth. It is through infrastructure and the construction industry that society achieves its goals of rural and urban development (Enhassi, Al- Hallaq, and Mohammed., 2006).

The word delay in the construction industry refers to a specified task not occurring as planned in the construction programme (Pickavance, 2005). Delays are defined as the late completion of work as opposed to the agreed contract schedule; they are events that impact the project's completion date (Vijekar and Ugle, 2015). Construction delays are categorised into four types: non-excusable delays, excusable non-compensable delays, excusable compensable delays, and concurrent delays (Kikwasi, 2012).

Delays and disruptions in completing projects are a risk to developing the country's economy and affecting service delivery to its citizens. Any form of delay on a project is a major risk to the country's development and could potentially threaten the economy. Divya and Ramya (2015), argue that project delays negatively impact projects resulting in over schedule, reduction in productivity, increased cost, contract termination and continue to pose significant challenges to developing countries. This is especially true for developing countries like South Africa, where financial resources are limited and critical sectors like health, education and housing need to be prioritised.

1.2 Background to the Study

Project delays in the road construction industry are becoming more common with SANRAL reporting a significant increase in construction delays on several major projects in the 2018/19 financial year (SANRAL, 2019). Two critical problems on any construction project are time overruns (delays) and cost overruns, which negatively impact the country’s economic growth (Shah, 2016).

There are many reasons for project delays and disruptions. The most common factors that result in project delays are lack of proper planning, changes in designs, changes in site conditions, shortages of materials and unpredictable weather conditions (Mansfield, Ugwu and Doran, 1994). Mahamid, Bruland and Dmaidi, (2012) identify the political situation and awarding of tenders to the lowest bidder as causes of delays

in construction projects. The awarding of tenders to the lowest bidder leads to a problem when the lowest bidder is usually the least qualified and least capable to complete the project and has the fewest resources to execute the project (Mahamid et al., 2012). Tsegay and Luo (2017) identify significant causes of project delays as corruption, inflation of construction material or lack of quality material, unavailability of site utilities, late delivery of design documents and drawings, delays in the release of project's budget and poor project planning and management (Tsegay and Luo, 2017).

The effects of construction delays impact all project stakeholders and the country's economic and social development (Twana, 2015). The delay has adverse effects on both client and contractor either in the form of additional expense or loss of revenue. In a study by Sambasivan and Soon (2007), the authors ranked the response of effects of project delays in terms of their frequency. The authors revealed time and cost overruns on the project as the most frequent responses received (Sambasivan and Soon, 2007). The cost overrun not only increases the delivery cost of the project, turning a profitable project into a loss, but also impacts taxpayers not receiving value from government delayed projects. The effects of delays not only impact the stakeholders of the project, but the effects pass onto the construction industry as a whole and subsequently to the economy of the country (Nega, 2008). Cost overruns, due to project delays, prevent the planned increase in infrastructure and service delivery of the country that negatively affects the national growth of the country (Arditi and Yasamis, 1998).

Unlike the causes of project delays that can be geographically isolated, the effects of the delays are universal in nature (Twana, 2015). The effects of project delays include, but are not limited to, wastage of resources, cost overruns, reduction in profits, stress, tension, disputes and anxiety amongst stakeholders, negative reputation, and a loss of opportunity due to resources being utilised in delayed projects (Kamanga and Steyn, 2013). Project delays can lead to disputes and claims that may require arbitration to be resolved. Aibinu and Jagboro (2002) identify six effects of delays in construction projects in Nigeria that include cost overruns, time overruns, disputes and claims, arbitration, abandonment of the project and litigation. This is supported by Sambasivan and Soon (2007) who identify the same six effects of project delays in a study of construction projects in Malaysia.

Another effect of delays is the total abandonment of the project. According to Saleh, Abdelnaser and Abdul Hamid Kadir (2009), construction delays lead to a loss of interest by project stakeholders, loss of resources and a negative reputation. The abandonment of the project has other negative consequences in the loss of employment, loss of revenue, slow down of economic activities and the loss of foreign investment into the country (Twana, 2015).

From the above literature one can infer that project delays have a negative impact on project cost and quality. Sunjka and Jacobs (2013) identify poor quality of completed projects as an effect of project delays due to workers rushing to make up for lost time to avoid cost overruns.

The South African government is focused on job creation through infrastructure development, and this is supported by the government's intention to unlock R1 trillion in infrastructure projects over the next couple of years (South African Government, 2020). At the 2020 State of the Nation Address, President Ramaphosa called on both public and private sectors to invest in infrastructure development projects that will stimulate the country's economy (Businesstech, 2020). This was followed by the transport minister's commitment to use road infrastructure development as a key contributor to job creation (Businesstech, 2020). The government aims to create more than 60 000 jobs for labour intensive maintenance and construction of municipal infrastructure and road projects (Nkgweng, 2020). The Preferential Procurement Regulation framework prescribed by National Treasury on 01 April 2017 specifies that 30% of government projects must be sub-contracted to SMMEs to allow for job creation and skill development within local communities. This gave rise to the introduction of a "construction mafia" into the industry (Cokayne, 2018), where agents of radical economic transformation see the construction industry as an opportunity to gain economic benefit through violent disruptions (Donnell, 2019). This has affected the construction sector at a time where major contractors are filing for business rescue. More than 60 SANRAL projects were affected by disruptions by armed gangs demanding a stake of at least 30% in the project in the 2018/19 financial year (Donnell, 2019). This accounts for almost a quarter of the agency's projects.

In South Africa, while urban land and most commercial farms are formally surveyed, peri-urban and rural land is occupied by people who follow traditional law. This means

that the land users are not recognised as legal landowners. Instead, traditional knowledge and tribal laws are used to allocate land rights and define property boundaries (Hull, Sehume, Sibiya, Sothafile, and Whittal, 2016). This results in project delays due to negotiations with landowners and tribal leaders to agree on people and property relocations, grave relocations, relocation ceremonies and compensation to landowners. This delay is common in SANRAL projects and an example of this delay was seen in a project for the upgrading of National Route 1, Section 17 between Holfontein and Kroonstad, where the project was delayed due to land acquisition that included a delay in the land owner willing to sell, delay in finalising the expropriation process, the landowner withdrawing once the contractor was on site, delay due to identification and relocation of graves and delay in compensation to families (Nene, 2019). This type of delay may occur in other countries but is a common issue in South Africa that is not investigated.

Although studies like those of Sambasivan and Soon (2007), Kamanga and Steyn (2013), and Divya and Ramya (2015), amongst other studies, have been conducted in different parts of the world on this subject, limited research has been conducted on the causes and effects of delays in road construction projects in South Africa and its unique environment. Because of the uniqueness of each project and its environment, the causes of delays may vary from region to region and country to country. It should also be noted that there is limited knowledge of project delays in South Africa and SANRAL commissioned projects, and current literature does not address the issues discussed above.

Therefore, to develop a better framework to address the delays in completing road construction projects in South Africa, a study is required that focuses on road construction projects and the causes of delays in South Africa, and their effects on the project being completed within schedule. This research examines the main causes and effects of delays on South African road construction projects from the view of SANRAL Project managers, consultants, contractors, and others involved in the project, and recommends strategies to mitigate these delays.

1.3 Statement of the Problem

The classic criterion for measuring project success is the measure of the performance of the project against its main design parameters: the project schedule, budget, scope, and quality. Delays in construction projects are a common problem that negatively impacts the project's performance and has an adverse ripple-effect on the project's budget, scope, and quality. The impact of delays is more significant in developing countries due to the limited financial resources used to fund public projects. In developing countries like South Africa, the performance of the construction industry influences both economic and social conditions. Road construction projects in South Africa are almost always experiencing delays, and as a result, they are never completed on time.

Road construction and in particular, highway construction is a complex process often due to the project's everchanging environment and the many uncertainties the project endures during the construction phase. Delays occur in all construction projects; however, the magnitude, causes and effects of the delays vary significantly from project to project and country to country. Although there is published literature on causes and effects of construction delays and road construction projects, research was conducted internationally, and very little is published in South Africa, and on SANRAL commissioned projects. This leaves a gap for further investigation that would comprehensively address the factors that contribute to road construction delays in South Africa.

This study aims to find out the causes and effects of delays in South Africa Road construction projects towards identifying measures that can minimise project delays.

1.4 Research Question

The following question guides the research:

Which of the related causes of delay, external or internal, are the most significant contributor to construction project delays in South Africa?

1.5 Research Hypothesis

External-related causes of delays are more significant contributors to construction project delays in South Africa than client, consultant, and contractor related causes.

1.6 Research Aims and Objectives

This study aims to investigate the causes and effects of delays in road construction projects in South Africa and whether external-related causes of delays are more significant contributors to construction project delays in South Africa.

The specific objectives of the research are to:

1. Identify the most important delay causes in road construction projects commissioned by SANRAL from the viewpoint of the project stakeholders;
2. Determine the effects of the delays in road construction projects governed by SANRAL;
3. Find out whether external-related causes of delays are more significant contributors to construction project delays in South Africa than client, consultant, and contractor related causes, and
4. Recommend measures for minimising delays in road construction projects in South Africa.

1.7 Research Method

The research follows a quantitative research approach to obtain the views from all project stakeholders: the Client (SANRAL Project Managers), Consultants, Contractors and others involved in the project on the causes and effects of delays in road construction projects. The research was conducted using a questionnaire structured from a literature review analysis which focuses on the research question.

Random sampling is a probability sampling technique where the entire population has an equal probability of selection (Taherdoost, 2016). The SANRAL Project Managers, consultants and contractors involved in SANRAL projects were selected through random sampling techniques.

A questionnaire was developed to address the research objectives in two parts:

- Background information- the respondents' age, gender, qualification, years of experience, job profile in the road construction project and project background information; and
- The set of questions derived from the literature review to determine the perception of stakeholders on the causes and effects of delays on road construction projects and measures to minimise project delays that are aligned to the study's objectives.

Questionnaires were presented using the Likert Scale for responses and sent to all project stakeholders, and data collected was analysed quantitatively using statistical methods. Analysed results are presented in tables and graphically. Based on the results, conclusions and recommendations are presented.

1.8 Scope of the Study

This study focuses on analysing causes and effects of delays in South African road construction projects commissioned by SANRAL. The three major role players in South African road construction projects are assessed: the client (SANRAL Project Managers); consultants; and contractors, as well as other project stakeholders (public liaison officers), to identify the most common and frequently occurring delays in road construction projects.

SANRAL, a state-owned entity, is responsible for constructing and maintaining South Africa's expanding national road network. Being the national road authority, SANRAL operates in all nine provinces providing an in-depth analysis of their conditions. The organisation is also responsible for setting the construction and maintenance standards in the country. Focusing and investigating SANRAL projects allows for a holistic investigation into the causes and effects of delays on road construction projects in South Africa. Other road authorities can adopt identified delay mitigation strategies in the country. Once the most frequent delays are identified, measures will be recommended for reducing these delays on road construction projects.

1.9 Significance of the Study

Walker (1994), investigating construction time performance on projects in Australia, concludes that through improving construction productivity, the construction industry could play a vital role in promoting national competitiveness (Walker, 1994). This can increase the rate of growth of the country.

This study has significant importance in understanding the causes and effects of delays in road construction projects in South Africa. It will contribute to the body of knowledge by assisting stakeholders in delay identification and mitigating measures that will assist in ensuring that projects are completed within schedule, budget, and quality.

This study will assist policymakers such as SANRAL and the Department of Transport in formulating appropriate strategies that address and reduce road construction delays that can be adopted at a national level. The research will be the basis for future investigations in delays in road construction projects in South Africa.

1.10 Limitations of the Study

Due to the subjectivity and design of the research, there were limitations present. These were minimised as far as possible through planning.

One limitation was the unwillingness of consultants and contractors to participate in the research, impacting the sample size. The bias of results received through questionnaires from clients, consultants and contractors could be biased and pose a limitation. This could affect the outcome of the research.

Without an official database of SANRAL service providers, the entire population size for stakeholders that worked on SANRAL projects could not be determined.

Due to COVID-19, many individuals are working from home. This limits contact to email and calls only and does not allow for office visits encouraging participants to complete the survey.

1.11 Structure of the Research Report

This study consists of five distinct chapters.

In **Chapter 1**, the study is introduced. This comprises the study's background, statement of the research problem, research question, aim of the study, research objectives, research method, scope of the study, the significance of the research and limitations.

A critical review of existing relevant literature relating to this study's topic is provided in **Chapter 2**. This chapter addresses what research has been conducted on the topic and what gaps are present.

In **Chapter 3**, the methodological framework of the study is explained. This includes a description of the study area, research design and approach, sampling techniques, data collection, data analysis, validity, and reliability of the data.

Chapter 4 presents and discusses the analysis of the data obtained through the questionnaire survey using techniques discussed in the previous chapter.

The final chapter, **Chapter 5**, presents a summary of the findings, the conclusion, and recommendations. This is followed by a full list of references used in the research and an appendix containing the questionnaire, raw data, and ethics approval.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter focuses on reviewing literature related to the topic under study, to develop a better understanding of the subject matter. A comprehensive literature review was conducted that included the reviewing of books, international journal articles, thesis papers, news articles, reports and conference proceedings all related to the topic under study, which is causes of delays and effects of delays in road construction projects. The review addresses types of road construction delays, the effects of such delays and mitigation measures that can be adopted to reduce delays. The result of the literature review ensured that any research gaps identified were addressed in the current study.

2.2 Overview of the Transport Sector in South Africa

A high-quality transportation network is critical for developing countries and a prerequisite for economic growth. A study by Marie and Davies (2008) identified inadequate infrastructure in South Africa as one of six constraints to growth in the country.

2.2.1 South Africa road network

South Africa has a road network of 750 000km long, the longest in Africa and tenth longest in the world (Department of Transport, Rebuplic of South Africa, 2020). The Department of Transport (DOT) is responsible for the legislation and policies for rail, air, sea, road and pipelines in the country. The South African National Roads Agency (SANRAL) is a crucial state-owned entity that is responsible for the upgrading, maintenance and strengthening of national roads in the country, approximately 21 403kms long. The provincial departments of transport are responsible for approximately 47 348 km of road whereas 51 682km is managed by municipalities. The route numbering system expresses ownership of the road with prefixes N, R and M for National, Provincial and Municipal roads respectively.

In South Africa, the government is the sole client for road construction projects. The causes of construction delays in developing countries are bound to differ from causes in developed countries where the responsibility of construction lies with the private

sector. According to Khair, Elhaj, Mohammed, and Mohammed (2016), it is difficult to generalise the causes and effects of road construction delays as well as delay minimising techniques due to the different role players responsible for the construction industry from country to country. It is therefore necessary to study country specific delays through the identification of delays in that country, its causes and effects from different perspectives and develop methodologies to minimise the delays particular to the country under study (Khair et al., 2016).

2.2.2 Importance of road infrastructure in South Africa Transport Industry

The South African transport infrastructure includes roads, railways, airports, and ports with a domestic GDP contribution of approximately 10-12% (Business for SA, 2020). In current conditions, road transport is the busiest mode of transport in the country with almost 90% of freight transported by road (GlobalAfrica Network, 2018). In a comparison of statistics collected by CTrack for the first quarter of the years 2020 and 2021, while air, rail and sea transport sectors declined, road freight increased by 1.8% (Ctrack and economists, 2021). This was a further improvement from the 3.1% increase in the second quarter of 2019 while rail improved by only 1% and sea and air showed declines of -3.5% and -0.4% respectively (Focus on Transport, 2019). As of July 2020, there were approximately 11.4 million vehicles registered on South Africa's National Traffic Information System (eNatis) of which approximately 65% were Light motor vehicles, 3.55% were passenger vehicles, 26% were freight vehicles (LDVS and HLV) and 5.45% others (eNatis, 2020).

The above is an indication of the key contribution of road infrastructure to the transport infrastructure GDP in South Africa and the importance of the development of road infrastructure in the country. The impact of delays in road infrastructure development are more significant in developing countries like South Africa where financial resources are limited. Any delays in the development of road infrastructure negatively impacts the country's economic growth (Shah, 2016).

2.3 Construction Project Delays

A construction delay can be defined as the untimely completion of construction work, or the project compared to the agreed contract schedule. A project delay is the situation when the actual completed construction work is slower than the planned

schedule (Hamzah, Khoiry, Arshad, Tawil, and Che Ani, 2011). In the road construction industry, construction delays occur because of prolongation of construction time due to disruptive events that hinder the construction workflow (Shebob, Dawood, Shah and Xu, 2012).

Despite the great technological advancements in the construction industry and improved understanding of project techniques by management, project delays are still a common phenomenon. Multiple studies have identified project delays as a major problem in the construction industry globally (Kaliba et al., 2009). According to Faridi and El- Sayegh (2006), construction delays are recurring problems that hurt the success of the project in terms of time, budgets, quality, and safety (Faridi and El-Sayegh, 2006). Aziz and Abdel- Hakam (2016) view a delay as the most common, complex, costly, and risky problem encountered in construction projects.

Project delays have a negative impact on all project stakeholders in terms of revenue loss, cash flow problems, adversarial relationship growth and negative reputation. According to Seboru (2015), project delays frustrate the development process of the project, result in an immeasurable cost implication to society and a loss of reputation of the parties involved in project execution (Seboru, 2015). Ahmed, Azhar, Kappagantula, and Gollapudi (2003) argue that delays have a negative effect on the client, consultant, and contractor which leads to mistrust, conflicting relationship development, litigation and arbitration and a general feeling of trepidation towards one another.

Delays affect each project stakeholder differently, with the consultant being least affected and the contractor the most affected by the delay. Project clients often bear the cost implications of the delays. They are forced to quickly absorb the additional expenses due to the delay to ensure that construction is continuous and is not further delayed (Rothgerber, Johnson and Lyons, 2013). In recent years, contractors have voiced their concerns over the difficulty in overcoming construction delays due to their inability to identify the main reasons for the delays (Aziz and Abdel- Hakam, 2016). It results in additional cost for the contractor resulting from having to pay for labour and/ or equipment that sits idly by during the delay or increases in material price, fuel price and labour after the delay (Rothgerber, Johnson and Lyons, 2013).

The construction industry is the means through which society and the country achieve their goals of development (Enhassi et al., 2006). It is a key ingredient for the economic development of the country, and any delays in the project negatively impacts the economy. Faridi and El-Sayegh (2006) state that construction delays not only affect the project or construction industry but also have an impact on the economy of the country (Faridi and El-Sayegh, 2006). This is supported by Prasad and Vasugi (2018) who state that effects of delays in a construction project are not confined to the construction industry but impact the overall economy of the country. According to Mahamid et al. (2012), delays in road construction projects are a common problem which creates difficulties for construction companies in terms of competitiveness and sustainability in the global market as well as negatively impacting the economic growth of the country.

Project delays occur in every road project; however, the magnitude of the delay varies from project to project and could vary from a week behind schedule to over a year delay. Delays occur in all stages of the project, from project initiation through to project completion. While most studies focus on delays during the construction phase, few studies have analysed delays during the planning and design phase (Halim and Zin, 2016; Yang and Wei, 2010). A study conducted by Halim and Zin (2016) revealed that delays which occur during the planning and design phase of the project are usually unknown to the public but have severe cost and time implications (Halim and Zin, 2016).

It is often delays during the planning and design phases that are carried through to the construction phase. It is better to identify these delays in the design phase, preventing them from occurring than resolving subsequent delay-related disrupted in the construction phase (Yang and Wei, 2010). Delays during the planning and design phase are not isolated from the construction phase; however, they are not concurrent (Halim and Zin, 2016). Each phase has a defined schedule where certain objectives must be met. Most projects have delays in the design stage which subsequently lead to overall project delays (Halim and Zin, 2016). The identification of causes of delays in the planning and design phase will inevitably assist in alleviating project delays all through to the construction phase (Halim and Zin, 2016). The limited research on delays during the planning and design phase creates a gap in the current literature on delays in road construction that are addressed in this study.

In reviewing the relevant literature, several authors such as Bagues, Rivera, and Yeom, (2020); Khair et al. (2016) and Twana (2015), have acknowledged the adverse effects of delays on construction projects and their negative impact on project implementation and project completion as well as project success factors such as cost and quality. Studies have identified delays as the highest and most common risk encountered on a construction project (Aziz and Abdel-Hakam, 2016; Shi, Cheung, and Arditi, 2001) which cause schedule and cost overruns, reduced quality as well as negatively affect stakeholders in the form of loss of reputation, cost implications, frustration, mistrust, litigation, and adversarial relationship development (Seboru, 2015; Ahmed et al. 2003). A study on project delays will result in a better understanding of the causes of inefficiencies in road construction projects and lead to the identification of significant causes of delays. This will then allow for stakeholders to channel energy and resources to the identified factors; thereby reducing delays to the project.

2.4 Types of Construction Project Delays

There are various classifications of project delays by different authors, but they are common in terms of their fundamentals. The most commonly used classification is presented by Trauner (2009), which classifies construction project delays into four categories: critical or non-critical, excusable, or non-excusable, compensable, or non-compensable and concurrent or non-concurrent. Kartam (1999) classifies project delays in terms or their origin (owner caused, contractor caused, or third party caused), timing (concurrent or non-concurrent), and compensability (excusable or non-excusable. The focus of Kartam's (1999) categorisation was on where the responsibility of the delay falls. Another categorisation of delays is in three groups: excusable but non-compensable delay, excusable and compensable delay, and inexcusable delays (Bolton, 1990). Ahmed et al. (2003) provides two categories of project delays: internal and external causes. The internal delays arise from the actions of the stakeholders (client, consultant, and contractor), whereas external delays arise from events that are beyond the control of the project stakeholders (Ahmed et al., 2003).

In reviewing the different categories on construction project delays, one can identify key criteria that the classification is dependent upon. These criteria can be summarised as who is responsible for the delay among the stakeholders, the magnitude of the delay and the impact on the project in terms of cost and time.

For this study, the project delay categorisation provided by Trauner (2009) was adopted and is discussed in the subsequent sections. Figure 2.1 below provides a flow chart summary of the different delay categories. The flow chart provides a systematic approach for one to identify the type of delay in a project, determine if it is critical, excusable, or compensable, who is the responsible stakeholder and what actions can be taken. By determining if the delay is critical, excusable, or compensable, one can determine the cause of the delay and its effects on the project schedule and budget. When evaluating the project delay, it is important to read the project contract documentation.

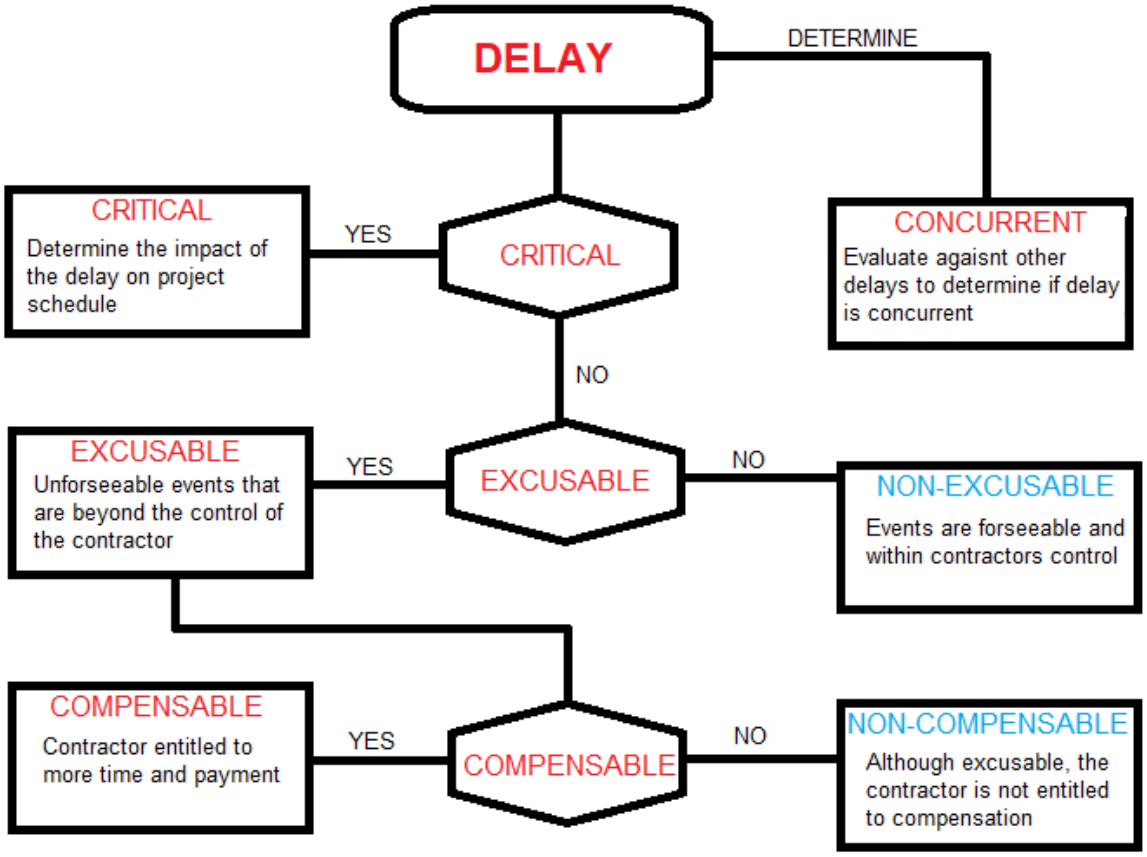

Figure 2.1: Flow Chart Summarising Construction Project Delay Types

Source: Researcher's Summary (2021)

2.4.1 Critical and non-critical delays

All projects have critical activities that need to be complete to meet the project's objectives. These critical activities are often referred to as the control items on the project. Should there be any delays in the critical path, it will result in overall project delays. Trauner (2009) defines critical delays as delays that affect the project completion date. This is derived from the critical path method (CPM) which helps in identifying and managing the critical activities in the construction project (Trauner et al., 2009). Non- critical delays are those delays that do not affect the completion date of the project as agreed upon in the contract document but affect the progress of the work.

2.4.2 Excusable or non-excusable delays

According to Trauner (2009), all project delays are either excusable or non-excusable. Excusable delays are caused by events that are beyond the contractor's control while non- excusable delays are foreseeable events that are within the control of the contractor (Majid, 1998; Trauner, 2009). Table 2.1 provides examples of delays that are categorised as excusable delays and non-excusable delays.

Table 2.1: Examples of Excusable and Non-Excusable Delays

Excusable Delays	Non-Excusable Delays
➢ **General labour strikes,** ➢ **Rain, fires, floods, Natural disasters,** ➢ **Client variation** ➢ **Errors and omissions in construction plans and specifications,** ➢ **Differing site conditions,** ➢ **Restricted access to site.**	➢ Inadequate scheduling, ➢ Mismanagement, ➢ Construction mistake, ➢ Equipment breakdown or servicing, ➢ Late performance of subcontractors.

Reference: Hamzah et al. (2011)

Decisions concerning delays are made within the context of the agreed contract document (Eshetu, 2019). The contract document should clearly define excusable delays on the project that will justify a time extension of the contract completion date. An extension of time is awarded to contractors when critical construction activities are impacted due to excusable delays, while adjustments are made to float times when non-critical activities are affected by excusable delays (Alkaas, Mazerolle, and Harris.,

1996). As the responsibility of non- excusable delays lies with the contractors, they are responsible to accelerate work progress and/or pay a compensation to the client due to the delay or project going over schedule (Hamzah et al., 2011).

2.4.3 Compensable and non-compensable delays

Compensable delays are classified as delays where the contractor is entitled to a time extension as well as compensation in the form of payment for the delay experienced, while non-compensable delays result from excusable delays that entitle the contractor to a time extension without payment compensation (Trauner et al., 2009). It is only excusable delays that are compensable or non-compensable (Eshetu, 2019).

Compensable delays are either caused by the client or the client's representative and is no fault of the contractor (Hamzah et al., 2011). Trauner (2009) provide changes in project scope, site conditions and site accessibility as examples of compensable delays. Non-compensable delays are usually beyond the control of the client or contractor and may be caused by third parties, heavy rains, floods, natural disasters, conflicts, or force majeure (Mubarak, 2005).

It is important to determine whether the delay is compensable or not. This is clearly defined in the terms of the contract. In most cases, the contract document specifies which delays are non-compensable for which the contractor will not receive additional payment but allowed an extension of time (Eshetu, 2019).

2.4.4 Concurrent and non- concurrent delays

Concurrent delays are defined as two or more independent delays that occur at the same time on the project (Trauner et al., 2009). This differs to Levy's (2006) view, which states that concurrent delays may not be independent and may overlap with one another. According to Eshetu (2019), concurrent delays do not necessarily have to be simultaneous, but can occur on two parallel critical path chains. The effects of two delay events by the project stakeholders which impact project progress at mutually exclusive periods, are non-concurrent delays (Braimah, 2014).

Any project stakeholder may be responsible for concurrent delays on the project (Levy, 2006). As such, Levy (2006) states that no party is entitled to compensation because of the delay. Trauner (2009) concludes that when concurrent delays occur, extensions

of time are given when the delays are excusable; the delay is shared between client and contractor; or circumstances warrant the extension of time.

2.5 Delay Analysis Techniques

When a delay occurs on a project, the impact of the delay must be studied, and outcome quantified. Delay analysis refers to a forensic investigation as to what caused the project to fall behind project schedule (Vasilyeva-Lyulina, Onishi, and Kobayashi., 2015). It is an analytical process that uses the project's contractual documentation and data from the site in analysing the cause and effects of the delay (Meena and Babu, 2015). Ndekugri, Braimah, and Gameson., (2008) define delay analysis as the task of investigating causes and impacts of the delays for the purpose of determining financial responsibilities of the contracting parties. The aim of the analysis is to establish lines of investigation, indicating entitlement of the delay and assist in presenting or evaluating the delay claim (Vasilyeva-Lyulina et al., 2015).

The schedule analysis is used to identify and measure delays and the impacts they have on the project. Tools used in schedule analysis include bar charts schedules and critical path method schedules. The delay analyses method provides a logical path to the cause and effect of the delay, clearly identifying the events that resulted in the delay occurring, and the effect of the delay (Vasilyeva-Lyulina et al., 2015). There are different delay analysis techniques that provide different outcomes from one another. Depending on the project party doing the analysis, a technique may be selected that will provide a favourable outcome from the relevant party's viewpoint (Hoda, Ossama, Khaled, and Rania., 2018). There are five commonly used delay analysis techniques (Meena and Babu, 2015), which are discussed next.

2.5.1 Impact as- planned method

In this method, the changes that caused project delays are inserted into the as-planned schedule and are the only determined delays recorded during construction that impact on the project schedule (Meena and Babu, 2015). According to Trauner at al. (2009), a weakness in this technique is its inability to reflect the active nature of the construction project and the critical path. Nguyen (2007) asserts that the impact as-planned method is more reliable than the as-built method as it distinguishes between the types of delays.

2.5.2 Time impact analysis method

Nguyen (2007) further asserts that this technique is one of the most reliable methods currently available in doing delays analysis. The method calculates the amount of project delay that resulted from each successive delay causing activity by determining the difference between the initial project completion date and the new completion date after the addition of each delay. A disadvantage of this method is it could be impractical to use if the project is subjected to a large number of delay events (Hoda et al., 2018). It also requires sufficient and reliable project records that are periodically updated. According to Ndekugri et al. (2008), the method is time consuming and costly to operate. This is especially true when the project is faced with many delaying activities. Despite these disadvantages the Society on Construction Law (2021) recommends this method as the most favourable method for delay analysis. The method is most suited for the evaluation of a time extension due to the contractor at the time of the delay. To accurately determine the extension time, the method is reliant upon on-site diaries and records to be accurate.

2.5.3 Collapsed as- built

In this technique, all concurrent project documentation is studied and a detailed as-built is prepared instead of an as-planned schedule (Meena and Babu, 2015). All activities that impacted on the project are removed from the as-built schedule. Trauner (2009) identify two major weaknesses with this method which include the requirement for a CPM network diagram based on as- built information that can easily be created to support a predisposed conclusion and furthermore, the method is extremely subjective and can easily be manipulated.

2.5.4 Window analysis method

Also referred to as the contemporaneous period analysis, this method divides the total project duration of a CPM schedule into smaller time periods (Nguyen, 2007). The selection of window boundaries is specified by major project milestones, changes to the critical path, occurrence of delays and revision to the project schedule. The delays of each period are successively analysed by focusing on the project's critical path. The disadvantages of this method were highlighted in a study by Hegazy and Zhang (2005). They concluded that the method as-built information is critical to accurate delay analysis that can be subjected to errors, because the technique does not consider the fluctuations in the critical path as the events occur on site and the

sensitivity of the time the delay was caused is lost (Hegazy and Menesi, 2008). Ndekugri et al. (2008) argue that the main strength of this method is its ability to take care of the dynamic nature of the critical path scheduling, that is used successively for each window to specify the impact of all project delays on the project's completion.

2.5.5 As-planned versus as-built method

This technique compares the as-built schedule against the as-planned schedule (Meena and Babu, 2015). By comparing the two schedules, one can determine the net impact of all claimed delays on the contractual project completion date. The assumption of this technique is that one stakeholder causes no delays while the other stakeholder causes all the delays. The main advantage of this method is its simplicity, and ease of use. However, the major disadvantage is the failure to consider changes to the critical path and ability to manage complex projects (Ndekugri et al., 2008).

There are several delay analysis techniques with their own advantages and disadvantages. The selection of the method should be according to the appropriateness of the technique. The selection of the delay analysis is dependent on a variety of factors which include the available contractual documentation, time of the delay occurring and documents available at the time of the delay, reliability of the documents and the type of the delay to attribute the responsibility, and the analyst's level of skill (Hoda et al., 2018). In a study by Hoda et al. (2018) in evaluating the different techniques, the authors concluded that at the beginning of the project, the impact as-planned is the most appropriate method, while during and at the end of the project, the time impact analysis or window analysis would be the best selection in evaluating delay analyses.

2.6 Causes of Delays in Construction Projects

Ahmed et al. (2003) state that project delays are the most common, costly, complex, and risky problem that is encountered on a construction project. The delay occurs due to problems arising from the owner, consultant, contractor, technical issues, legal issues and natural difficulties (Kazaz, Ulubeyli, and Tuncbilekli., 2012).

Several authors such as Bagues et al. (2020); Divya and Ramya, (2015); and Enhassi et al. (2006) have researched the causes of delays in construction projects with some research attempting to categorise the causes of delays based on the responsible stakeholder or project components such as labour, financial, material and equipment.

Although there are similarities in the findings of these studies, there are some geographical limitations which limit the application as a one solution finding (Twana, 2015). This explains why over twenty studies have been completed globally, identifying the causes of construction delays in different countries. Table 2.2 presents a summary of the major causes of delays and categorisation of causes of delays in construction projects identified in literature. The literature is not limited to road construction only, but the construction industry in general.

Table 2.2: Summary of Major Delays and Delay Category on Construction Projects

No.	No. of causes	Country of study	Major Cause of Delays	Categories Identified	Citation
1.	31	Malaysia	Financial problems; coordination problems *Total (2)*	Client factors; Constructor factors; Consultant factors; External factors. *Total (4)*	(Amoatey and Ankrah, 2017)
2.	73	Saudi Arabia	Variation of orders by client during construction; Delay in progress payment; Ineffective planning and scheduling; Shortage of labour; Difficulties in financing by contractor. *Total (5)*	Owner; Contractor; Consultant; Design; Project; Labour; Materials; Equipment; External *Total (9)*	(Assaf and Al-Hejji, 2006)
3.	55	Jordan	Inadequate management/ supervision by the contractor; client's change of design; contractor cash flow difficulties; adoption of lowest bid; changes to extent of the project; errors in design and contract documents; payment delays by client; rework due to construction mistakes; changes to original design; low level of productivity. *Total (10)*	Client related; Consultant related; Contractor related; External related. *Total (4)*	(Bekr, 2018)
4.	32	Ghana	Delay in issuing payment certificates; difficulty in accessing credit and fluctuation in prices; scheduling and controlling factors. *Total (3)*	Material; Labour; Equipment; Financing; Environmental; Changes; Scheduling and controlling techniques; Contractual relations; Government actions. *Total (9)*	(Fugar & Agyakwah-baah, 2010)
5.	53	South and Southeast Asia; Middle East and Africa	Delay in payment by owner; Contractor's cash flow problems; improper planning and scheduling; poor site management; variation order. *Total (5)*	Financial; Owner, Contractor; Project; Consultant; Manpower and Resources; Managerial; External. *Total (8)*	(Islam and Trigunarsyah, 2017)
6.	26	Zambia	Weather; delayed payments; financial issues; materials procurement; change in drawings, labour issues. *Total (6)*	Client; Contractor; Consultant. *Total (3)*	(Kaliba et al., 2009)
7.	52	Palestine	Political situation; limited movement between areas; award project to lowest bid price; progress payment	Project group; Owner group; Contractors group; Consultant group; Design group; External group;	(Mahamid et al., 2012)

			delay by owner; shortage of equipment. *Total (5)*	Labourers group; Equipment and materials group. *Total (8)*	
8.	81	Uganda	Slow change order; financial dishonesty by contractor; inadequate contractor experience; design errors made by designer; inadequate site investigation by the consultant. *Total (5)*	Client related; Consultant related; Contractor related; External related. *Total (4)*	(Muhwezi et al., 2014)
9.	36	Iran	Lack of attention to inflation; inaccurate budgeting and resource planning; inaccurate first drafts. *Total (3)*	Owner; Contractor; Consultant; Low regulations; General defects. *Total (5)*	(Samarghandi et al., 2016)
10.	28	Malaysia	Poor planning by the contractor; poor site management; lack of contractor's experience; finance; problems with subcontractors. *Total (5)*	Client; Contractor; Consultant; Material; Labour and equipment; Contract; Contract relations; External. *Total (7)*	(Sambasivan and Soon, 2007)

Source: Researcher's Summary (2021)

Through a review of the available literature on the subject matter, the major causes and categories of causes were identified and listed in Table 2.2. For the purpose of this study, the delay causes were categorised into four categories: Client-related, Consultant-related, Contractor-related and External-related. These broad categories are similar to the ones adopted by several authors (Amoatey and Ankrah, 2017; Bekr, 2018; Kaliba et al., 2009 and Muhwezi et al., 2014).

2.6.1 Client (owner)- related causes of delays

Through the review of available literature on the subject matter, the major causes of delays related to the client are presented in Table 2.3.

Table 2.3:Client Related Causes of Delays

No	Cause of Delay	References
1	Delay in payment by client	Bekr (2018); Fugar and Agyakwah (2010); Mahamid et al. (2012)
2	Changes in project scope by the client	Bekr (2018); Motaleb and Kishk (2010); Muhwezi et al. (2014)
3	Changes in design by the client	Bekr (2018); Owolabi et al. (2014)
4	Delay in reviewing and approving drawings and documentation	Mukuka et al. (2013)
5	Delay in decision making by client	Bekr (2018); Mahamid et al. (2012); Seboru (2015)
6	Poor communication by client	Aziz and Abdel- Hakam (2016): Kikwasi (2012); Owolabi et al. (2014)

Source: Researcher's Summary (2021)

Previous studies like those of Faridi and El- Savegh (2006) and Motaleb and Kishk (2010), reveal that the most significant causes of construction delays are client- related causes. This is discussed in more detail in the following sub-sections.

2.6.1.1 Delay in payment by client

The literature review of the studies by Fugar and Agyakwah (2010) and Mahamid et al. (2012) identified the delayed payment for completed work by the client to the contractor as a client-related delay factor. This causes cash-flow problems for the contractor which results in project delays. Mahamid et al. (2012) reveal that a delay in payment for completed work by the client can cause a delay to work progress as the contractor has inadequate cash flow to support the high construction expenses, especially contractors who are not financially sound. This result is in line with Fugar and Agyakwah (2010), who identify delays in the release of project funds by project clients as a common issue resulting in project delays observed in Ghana. Kamanga and Steyn (2013) reveal that delays in the processing of payment certificates for contractors and the client's financial difficulties are the major causes of time overruns related to clients. In another study in Ghana, the author identified the client's inadequate financial resources and late payment for work completed as key contributors to project delays (Daniel, 2015).

2.6.1.2 Changes in project scope and changes in design by client

The study by Motaleb and Kishk (2010) identified that the most significant client related causes of construction delays in the UAE are change orders issued from the client's team. According to the study, during several phases of the project's construction, clients make a request for changes that affect the original design, impact the pace of construction work, and subsequently delay the project in its entirety (Motaleb and Kishk, 2010). This is further highlighted in other studies by and Bekr (2018); Muhwezi et al. (2014) and Owolabi et al. (2014); which identify changes in project scope or changes in design by the client as major causes of construction project delays. In the study by Bekr (2018), change orders were ranked the most crucial delay causing factor in the client related group.

Owlabi et al. (2014) acknowledge that in Nigeria, changes in design impact the completion of the project according to the agreed schedule. The authors conclude that obstructions to project completion due to the change of mindset of the owner on the

design interest and a request for change during construction are major issue that cannot be overlooked when addressing the causes of delays in construction projects (Owolabi et al., 2014). Faridi and El-Savegh (2006) conclude that half of the construction projects are affected by delays and not completed on time with the main cause being owners' interference during construction in the form of design changes to the original project. It is clear from these studies that the change in mindset of the project's client and request for variation during construction affects the entire implementation of the project. This is intensified when project owners' make an error in the variation orders and further delay the construction phase through wrong changes in their orders that might lead to the contractor incorrectly completing most of the procurement and other arrangements for the variation order (Owolabi et al., 2014). This results in unnecessary time losses and cost consuming work on the part of the contractor which will have to be corrected.

2.6.1.3 Delay in reviewing and decision making by client

Mukuka et al. (2013) rank the delay in reviewing and approving drawings and documentation fifth in their identified client related causes of delays. This is similar to the study by Mahamid et al. (2012) which ranked delays in decision making by the client fourth in their top five causes of delays from the contractor's view. Seboru (2015) concludes that clients should remove bureaucracy and red tape to speed up decision making as this is the cause of delays in construction projects.

2.6.1.4 Poor communication by client

Poor communication was identified by Aziz and Abdel- Hakam (2016); Kikwasi (2012) and Owolabi et al. (2014) in their respective studies on causes of construction delays. Due to the lack of effective communication, there is no collaboration between the client, consultant, and contractor. This results in misunderstandings of the project's objectives and leads to delays because of redoing incorrect work. Bagues et al. (2020) conclude that it is important to create a chain of command for communication to ensure effective implementation of the project. It is through effective communication channels that schedule and cost delays can be avoided (Khoiry et al., 2018).

2.6.2 Consultant-related causes of delays

The consultant related causes of construction project delays are shown in Table 2.4 below. These delays have been identified through a literature study on the subject and

only major causes identified by authors like Aziz & Abdel- Hakam (2016); Bekr (2018) and Mukuka et al. (2013) are shown in Table 2.4. A discussion of the consultant-related causes of delays are discussed below.

Table 2.4: Consultant Related Causes of Delays

No	Cause of Delay	References
1	Delays in performing inspections and testing	Kikwasi (2012); Sambasivan and Soon (2007)
2	Delays in implementing changes to scope of work	Baloyi and Bekker (2011); Motaleb and Kishk (2010)
3	Inadequate experience/skills of consultants	Assaf and Al- Hejji (2006); Motaleb and Kishk (2010)
4	Delays in preparing design, drawings and documentation	Baloyi and Bekker (2011); El- Sayegh (2006)
5	Errors in the contract documentation	Aziz and Abdel- Hakam (2016); Bekr (2018)
6	Unclear and inadequate details in construction drawings	Bekr (2018); Aibinu and Odeyinka (2006); Motaleb and Kishk (2010)
7	Poor communication between client and contractor	Assaf & Al- Hejji (2006); Aziz & Abdel- Hakam (2016); Owolabi et al. (2014)

Source: Researcher's Summary (2021)

2.6.2.1 Delays in performing inspections and testing

In South Africa, on SANRAL projects, site supervision is the responsibility of the consultant. It is a necessary activity by the consultant to verify the quantity and quality of completed construction work. The study by Kikwasi (2012) revealed that poor site management is a major contributor to construction project delays in Tanzania. In the study by Sambasivan and Soon (2007), the authors concluded that poor management by the supervision team through quality assurance and control and long waiting times for approval of tests and inspections were factors that cause delays on construction projects.

2.6.2.2 Delays in implementing changes to scope by consultants

Motaleb and Kishk (2010), in their study in Dubai, revealed delays by the consultant in implementing scope changes as a cause of construction project delays (Motaleb and Kishk, 2010). This is supported by the study in Zambia by Mukuka et al. (2013) that ranked the delay in approving major changes in scope of work as the number one consultant related cause of delay. These results concur with other studies by Wei (2010) and Trauner (2009), where the delay in approving and implementing scope changes was the major consultant related cause of delay.

2.6.2.3 Delays due to inadequate experience/ skills of consultants

In the study by Motaleb and Kishk (2010), the major consultant related cause of delay identified by the authors was inadequate level of experience of consultants. This concurs with the study by Assaf and Al- Hejji (2006), which identified lack of experience of the consultants as a major cause of delay. The lack of, or inadequate, experience, of consultants is a contributing factor to other causes of delays, such as delays in preparing drawings and documentation, errors in documents and unclear or inadequate details issued for construction drawings.

2.6.2.4 Delays due to preparing design, drawings, and documentation

Baloyi and Bekker (2011) studied the causes of construction cost and time overruns with regard to the 2010 FIFA World Cup Stadia in South Africa. The authors reveal that the delayed actions of consultants on construction projects in the issuing of incomplete drawings and delays in issuing site instructions as factors of time overruns on construction projects (Baloyi and Bekker, 2011). This is supported by Alaghbari et. al. (2007) in their study in Malaysia that identified the late issuing of drawings from the consultant as resulting in delays in the construction project. This is due to the contractor not having all the information at the commencement of the construction. The standing time of the contractor awaiting complete construction information from the consultant results in the project delay.

2.6.2.5 Delays due to errors in contract documentation and unclear/ inadequate construction drawings

Errors in design, incomplete drawings, and delays in issuing instructions are other consultant- related delays identified in the literature. In the study by Bekr (2018), errors in design and contract documentation were the most influencing delay causing factors that are consultant related. This is similar to the findings by Aziz and Abdel- Hakam (2016) that identified design errors made by the designers/ consultants as the number one cause of delays under the design related group.

Faridi and El- Sayegh (2006) identify incomplete, unclear, and inadequate drawings as consultant related delay causes. In the study by Bekr (2018), issuing of inefficient drawings was ranked third for consultant related causes of delays. Similar to errors and late issuing of construction information, the delay is a result of the contractor awaiting correct and complete construction information.

Another consequence of inadequate consultant experience results in other delay causes such as improper planning which leads to delayed procurement of resources, labour and materials, unrealistic project schedules and underutilisation of equipment. Aziz (2013) conducted a study in Egypt where he ranked the delay factors in construction projects post the Egyptian Revolution. He reveals that lack of project planning and improper planning are amongst the contributing causes of delays in project implementation and completion (Aziz, 2013).

2.6.2.6 Poor communication between client and contractor by consultant

Similar to client related cause of delay, lack of effective communication is identified as a major consultant related cause of delay. The consultant acts as the middle person in the contract and is the representative of the client to supervise the contractor. It is the responsibility of the consultant to convey the instructions of the client to the contractor and provide feedback on progress and difficulties from the contractor to the client. The study by Owolabi et al. (2014) identified the lack of adequate information and communication amongst the project stakeholders as a major cause of project delays. This is supported in the study by Kikwasi (2012) which concluded that lack of information flow was a contributor of project delays in Tanzania. The study established that delays in information flow affect the effective communication between key project participants; that is the client, consultant, and contractor (Kikwasi, 2012). The author also states that effective communication is critical for the project to be delivered within schedule (Kikwasi, 2012). Poor communication and coordination between consultant and contractor can contribute to project construction delays (Assaf and Al- Hejji, 2006).

2.6.3 Contractor- related causes of delays

The study by Muhwezi et. al. (2014) identified contractor related causes of delays as the most important cause of construction project delays. Table 2.5 below shows the major contractor related causes of delays identified through a literature review on the study. A discussion of the causes of delays listed in Table 2.5 is provided in the following sub-sections.

Table 2.5: Contractor Related Causes of Delays

No	Cause of Delay	References
1	Cash flow difficulties by the contractor	Meena and Babu (2015); Owolabi et al. (2014); Sweis et al. (2008)
2	Late payment to subcontractors	Aziz and Abdel- Hakam, (2016)
3	Poor management of subcontractors	Assaf and Al- Hejji (2006); Bekr (2018)
4	Poor management and supervision by contractor	Bekr (2018); Mukuka et al. (2013)
5	Inefficient planning and scheduling of project	Meena and Babu (2015); Seboru (2015)
6	Inadequate contractor experience	Aziz and Abdel- Hakam (2016);Odeh and Battaineh (2002)
7	Improper construction methods	Aziz and Abdel- Hakam (2016); Bekr, (2018); Mukuka, et al. (2013)
8	Technical issues faced by contractor	Bekr (2018); Mukuka, et al. (2013)
9	Low level of productivity	Bekr (2018);Odeh and Battaineh (2002); Sambasivan and Soon (2007);
10	Rework due to mistakes during construction	Bekr (2018); Mukuka, et al. (2013)
11	Poor management of materials	Aziz & Abdel- Hakam (2016); Khoiry et al. (2018)
12	Delay in material delivery	Aziz and Abdel- Hakam (2016); Ogunlana et al. (1996)
13	Shortage of materials in market	Bagues et al. (2020); Kouski et al. (2005); Ogunlana, et al. (1996)
14	Change in material type during construction	Koushki et al. (2005); Mukuka et al. (2013)
15	Poor management of equipment	Aziz and Abdel- Hakam (2016)
16	Equipment breakdown	Aziz and Abdel- Hakam (2016); Mukuka et al. (2013)
17	Low level of equipment operator's skill	Aziz and Abdel- Hakam (2016); Rivas, et al. (2011)
18	Unavailability of equipment	Bagues, et al. (2020); Mahamid, et al. (2012); Rivas, et al. (2011)

2.6.3.1 Cash flow difficulties by contractor and late payment to subcontractors

Contractors lack the resource capacity to pre-finance projects, and the delay in releasing of project funds causes contractor frustrations and cash flow difficulties which ultimately delay the projects schedule. The study by Tumi et al. (2009), identified that the lack of resources to fund the entire project from initiation to completion and cashflow difficulties during project implementation, are amongst the prominent causes of construction delays. On exhausting initial funds during project mobilisation, contractors may have to delay work awaiting the release of remaining funds to complete the project (Tumi et al., 2009).

This is supported by other studies such as those of Odeh and Battaineh (2002), and Sweis et al. (2008), which identify contractors' cash flow difficulties as a leading cause of delays in Jordan. The study by Aibinu and Odeyinka (2006) identified contractors' financial difficulties as one of the major contributors to contractor-related delays. This factor results in the cause of other delays such as late payment to subcontractors, and lack of finance for labour or no finance to purchase materials which result in shortages of material supply and labour.

2.6.3.2 Poor management and supervision by contractor of site staff and sub-contractors

In the study by Oshungade and Kruger (2017) on delays and disruptions in the construction industry in South Africa, the authors identified delays that are unique to the South African environment. The authors identified a major cause of delay is strikes by individuals subcontracted to the main contractor due to cash flow difficulties of the main contractor (Oshungade and Kruger, 2017). Assaf and Al- Hejji (2006) identified delays in subcontractors' works and change in subcontractors due to inefficient work as causes of delays in construction projects.

The study by Bekr (2018) highlighted that the most significant factors causing delays within the contractor related group was the inadequate management and supervision by the contractor on site. Delays from inadequate management of supervision by the contractor, lead to poor management and supervision of the construction site and poor management of subcontractors that cause construction project delays. Bekr (2018) reveals that poor management by the contractor leads to mismanagement of subcontractors which results in construction project delays. Odeh and Battaineh (2002) identify inadequate contractor experience as a contributor to project delays. The authors also identifiy poor site management and supervision by the contractor as causes of construction project delays. Moreover, Muhwezi et. al. (2014) identifies inadequate contractor experience, and poor supervision of the project team as critical factors causing delays in the Ugandan construction industry.

2.6.3.3 Inefficient planning and scheduling, inadequate contractor experience and improper construction methods

Linked to poor management and supervision by the contractor is the cause of inefficient planning and scheduling that result in project delays. Sambasivan and Soon (2007) investigated the causes and effects of delays in the Malaysian construction

industry. Amongst their findings of the critical causes of construction delays, they identified contractors' improper planning as a main contributor to construction project delays in Malaysia (Sambasivan and Soon, 2007). Furthermore, inadequate planning and scheduling were ranked in the top five causes of delays by Seboru (2015).

Construction project delays occur due to inadequate contractor experience resulting in the contractor using improper construction methods that cause delays in the construction work. Aziz and Abdel-Hakem (2016) rank inadequate contractor experience as the number three overall cause of delay in construction projects. This is supported by the earlier study of Odeh and Battaineh (2002), which identified inadequate contractor experience as a contributor to project delays. Often during the construction phase, problems occur that can quickly be solved without impacting the project schedule. However, this is not the case if the contractor lacks the experience to solve the problems. The study by Bekr (2018) revealed that the lack of contractor experience was shown in the use of incorrect construction methods as the cause of delays in construction projects.

2.6.3.4 Delays due to technical issues faced by contractor

The lack of contractor experience is a factor that results in the contractor facing delays due to technical issues, a low level of productivity and rework due to mistakes. In the study by Bekr (2018), technical problems, low level of productivity and rework were listed as significant causes of contractor related delay causes. Additionally, technical issues faced by the contractor and rework due to errors during construction were ranked fourth and fifth respectively in the study by Mukuka et al. (2013) in the list of contractor related causes of delays.

2.6.3.5 Delays due to contractor material related

The poor management of material is a factor that causes delays in material delivery on site, shortages of material due to scarcity of material in the market and changes in material type during construction which ultimately cause construction project delays. Ogunlana et al. (1996) and Kouski et al. (2005) identified in their separate studies that a shortage of construction material is a cause of construction project delays. Another critical aspect is the quality of the material, as poor construction material contributes to construction project delays (Koushki et al., 2005). It is important that the contractor manages the demand and supply of the materials on site as lack of materials, or the

delay in delivery of materials, disrupts the construction progress and leads to project delays (Ogunlana et al., 1996).

To add to the contractor's cash flow difficulties is the change in price of construction materials. The nature of prices in the marketplace is volatile and generally affects most construction budgets. Ogunlana et al. (1996) posit that the escalation of the cost of construction materials causes delays in the construction project. In another study by Tumi et al. (2009), they concluded that frequent changes in prices of material lead to cash flow difficulties that were a critical cause of delays in construction projects in Libya.

2.6.3.6 Delays due to contractor equipment related

Similar to poor management of material, is the factor of poor management of equipment which results in equipment breakdown causing a delay in the construction work. The study by Mahamid et al. (2012) identified the shortage of equipment as a top cause of construction project delays. Due to the small size of contracting firms in the West Bank, many contractors do not own equipment and hire the required equipment (Mahamid et al., 2012). This is like the situation in South Africa where many SMMEs do not have the financial stability to purchase all the required equipment and may opt to hire what is required to complete the project. The project delay arises when there are many construction projects running simultaneously and this leads to a shortage in the supply of equipment and poorly maintained equipment. This leads to failure of the equipment causing project delays (Mahamid et al., 2012). Assaf and Al-Hejji (2006) identify the shortage of equipment and breakdown of the equipment as major causes of equipment-related construction delays.

In addition to the unavailability of construction equipment, the low skills of operators are a contributing factor (Rivas et al., 2011). Odeh and Battaineh (2002) found that poor labour supply was a contributor to construction project delays. Sambasivan and Soon (2007) identified low productivity of site workers as a cause of project delays in Malaysia. Assaf and Al- Hejji (2006) identified delays in sub-contractors' works, change in subcontractors due to inefficient work and poor qualification of the contractor's technical staff as contributing factors to construction delays.

2.6.4 External- related causes of delays

The major external related causes of delays are shown in Table 2.6. These delays have been identified through a review of literature on the topic under study by authors such as Aziz and Abdel- Hakam (2016); Bekr (2018) and Mukuka et al. (2013). The identified causes are discussed below in Table 2.6.

Table 2.6: External Related Causes of Delays

No	Cause of Delay	References
1	Poor engagement with local community	Bekr (2018); Mashwama et al. (2018)
2	Lack of acceptance of project by community	Bekr (2018); Sunjka and Jacob (2013)
3	Unrest by local communities	Bekr (2018);Mashwama, et al. (2018); Rathenam and Dabup (2017)
4	Stoppages of work by construction mafia/ neighbouring communities/ wards	Cokayne (2018); Oshungade & Kruger (2017)
5	Changes in government laws and regulations	Bekr (2018); Mukuka et al. (2013)
6	Political interference	Aziz and Abdel- Hakam (2016); Mahamid et al. (2012)
7	Delays in obtaining permits/ approvals from DFFE/ DMR	Aziz & Abdel- Hakam (2016); Mukuka et al. (2013)
8	Land acquisition delays	Elawi et al.(2016); Motlhatlhedi and Nel (2019); Soni and Punjabi (2018)
9	Municipal bylaw approvals	Aziz and Abdel- Hakam (2016); Mukuka et al. (2013)
10	Extreme weather conditions and other natural disasters	Assaf and Al-Hejji (2006); Kamanga and Steyn (2013); Sambasivan and Soon (2007)
11	Unforeseen ground conditions	Assaf and Al- Hejji (2006); Mukuka et al. (2013)

Source: Researcher's Summary (2021)

2.6.4.1 Delays due to community issues

Stakeholder engagement and in particular community engagement, is critical for project success. Causes of project delays associated with communities are closely linked together. Often, poor engagement with the local community results in the lack of acceptance of the project by the community, or unrest by the community, which causes the delay in the project. The effect on project success of the local community due to poor engagement, or lack thereof, ranked third in the external related factors causing delays (Bekr, 2018). In the study by Mashwama et al. (2018) in Gauteng Province of South Africa, the authors concluded that community unrest was the highest ranked factor that was of major concern to all project stakeholders (client, consultant, and contractor). Sunjka and Jacob (2013) identified the lack of community

buy-in as a delay on construction projects. It is important to get the community to invest in the implementation of the project to ensure they are cooperative with the contractors during the construction of the project (Sunjka and Jacob, 2013). Mashwama et al (2018) argue that the biggest threat to road construction projects is the delay due to the time spent in negotiations addressing community grievances and sometimes the unsettlement of issues that result in total abandonment of the project. This is further supported by Rathenam and Dabup (2017), in their study in the City of Tshwane in South Africa. The authors concluded that the local community proved to be a major factor, who influenced the project schedule and budget (Rathenam and Dabup, 2017).

With the government of South Africa creating jobs through the construction industry, it has led to the development of Small Medium and Micro-Sized Enterprises as well as the construction mafia (Cokayne, 2018). In the study by Oshungade and Kruger (2017) on delays and disruptions in the construction industry in South Africa, the authors identified delays that are unique to the South African environment. This is supported in another study in Gauteng Province of South Africa which identified delays caused by communities that included strikes, stoppages by business forums, interference by the construction mafia and councillors' interruptions (Mashwama et al., 2018). Oshungade and Kruger (2017) state that if a certain ward in the community is not benefiting from employment on the construction project, this leads to strikes and stoppages of work and delays in the project.

2.6.4.2 Delays due to political and municipal interference

Similar to delays due to variation orders by the project's client, several other factors such as social or political interference in the project may result in a sudden change order during construction. In external related cause of delays, Bekr (2018) identified bureaucracy and changes of government regulations as the most significant causes of delays. Mahamid et al. (2012) identified the political situation as one of the top five delay causes on construction projects. Due to the conflict between Palestine and Israel, the study area of Mahamid, et al. (2012), the West Bank is classified as politically unstable. The authors reveal that this led to a high cost of materials, limitations on the material imported, and lack of available resources which led to project cost increase and delays in the construction progress (Mahamid et al., 2012).

2.6.4.3 Delays due to land acquisition

Land acquisition is the process where land is acquired for some public purpose like the building of roads, bridges, railway line etcetera. The acquisition of the land indirectly improves the development of the country. However, land acquisition disputes are an important cause of project delays and cost overruns (Soni and Punjabi, 2018). In a recent study in South Africa, the authors revealed that 40% of respondents in the research survey listed land acquisition as a cause of project delays (Motlhatlhedi and Nel, 2019). The acquisition process creates an antidevelopment and undemocratic sentiment within the community where the project is implemented (Soni and Punjabi, 2018). In a study in Saudi Arabia by Elawi et al. (2016), the authors identified land acquisition as the most severe cause of project delays in the country (Elawi et al., 2016). This was in line with the study conducted in the Gulf Countries Construction of project delays (Elawi et al., 2016). Sunjka and Jacob identified the delay or non-payment of compensation for land acquired for the project as a delay on construction projects. A delay in making the payment results in the affected landowners resisting the sale of their land, resisting demolishing of their property, which may require negotiations which lead to project delays (Sunjka and Jacob, 2013).

2.6.4.4 Delays in municipal and other approvals

Furthermore, work is often halted awaiting approval and permits from municipalities and other governing bodies. In the study by Aziz and Abdel- Hakam (2016), the authors ranked delays in obtaining permits from municipalities as the number one cause of delay under the rules and regulations group and the twenty sixth cause of delay overall. This differs from the study by Mukuka et al. (2013) which ranked this delay fifth under the external causes of delay group.

2.6.4.5 Delays due to extreme weather conditions

There are several factors that are unforeseeable and beyond the control of the project stakeholders, which contribute to project delays such as extreme weather conditions, unexpected site conditions and natural disasters. Assaf and Al- Hejji (2006) identified weather conditions as a major external factor responsible for construction project delays in Saudi Arabia. Sambasivan and Soon (2007) found that weather conditions impact on construction projects in Malaysia, resulting in project delays. This is supported by Kamanga and Steyn (2013) who noted weather effects as external factors that contribute to project delays in Malawi. In the study by Haseeb et al. (2011),

the authors identified the most important contributors to project delays in Pakistan as unexpected site conditions, natural disasters, changes in rule and organisational changes.

2.6.4.6 Delays due to unforeseen ground conditions

Mukuka et al. (2013) ranked unforeseen ground conditions as the fourth highest cause of delay related to external causes. The severity of this delay is further highlighted in previous studies by Assaf and Al-Hejji (2006) and Wei (2012), which ranked effects of unforeseen ground conditions as the major cause of external related causes of delays.

2.6.5 Summary of causes of construction project delays

This studied reviewed the relevant literature on causes of construction delays and identified 42 causes of construction delays for use in the designated questionnaire survey. These delays are mostly adopted from the theoretical framework proposed by Muhwezi at al. (2014) and presented in the various tables above (Tables 2.2-2.6). The causes of delays are grouped in the four broad categories of client-related, consultant-related, contractor-related and external-related, and expanded to make it geographically specific to South Africa.

2.7 Effects of Delays on Construction Projects

When the causes of project delays are not identified and resolved meritoriously, the consequences of such delays are referred to as the effects of delays (Mukuka et al., 2013). Studies on the effects of delays in construction projects have been completed by several authors such as Kikwasi (2012); Oshungade and Kruger (2017); Sunjka and Jacob (2013) and Youniss et al. (2018) and have been reviewed in this study to identify the most common effects. The 15 commonly identified effects have been listed in Table 2.7 with their relevant references. Further evaluation of the effects of project delays in Table 2.7 has resulted in the formation of broader effects categories, which are budget implications; schedule implications; legal implications and negative social/work relationship implications. The details of each of the categories are discussed in the sub-sections below.

Table 2.7: Categories and Effects of Construction Project Delays

Category	Effect of Delay	References
Budget Implications	Cost overruns	Khair et al. (2016); Kikwasi (2012); Sunjka and Jacob (2013)
	Delays in paying back loans	Haseeb et al. (2011); Kikwasi (2012); Oshungade and Kruger, (2017)
	Delays in generating profit	Haseeb et al. (2011); Kikwasi (2012); Oshungade and Kruger (2017)
	Bankruptcy	Haseeb et al. (2011); Kikwasi (2012)
	Stress	Kamanga and Steyn (2013); Oshungade and Kruger (2017)
	Acceleration of losses	Kikwasi (2012); Oshungade and Kruger (2017); Twana (2015)
Schedule Implications	Time overruns	Aibinu and Jagboro (2002); Khair et al. (2016); Youniss et al. (2018)
	Idling resources	Haseeb et al. (2011); Kikwasi (2012)
	Poor quality of work	Aibinu and Jagboro (2002); Sunjka and Jacob (2013)
	Total abandonment	Sambasivan and Soon (2007); Motaleb and Kishk, (2010); Haseeb, et al. (2011).
Legal Implications	Dispute and claims	Aibinu and Jagboro (2002); Ahmed at al. (2002); Youniss et al. (2018)
	Arbitration	Kikwasi (2012); Motaleb and Kishk (2010); Youniss, et al. (2018)
	Litigation	Aibinu and Jagboro (2002); Haseeb et al. (2011); Sambasivan and Soon (2007)
Negative social/ work relationship implication	Negative social impact	Akomah and Jackson (2016); Oshungade and Kruger (2017); Twana (2015)
	Poor relationship development/ negative public relation	Fugar and Agyakwah-baah (2010); Kamanga and Steyn (2013); Sunjka and Jacob (2013)

Source: Researcher's Summary (2021)

2.7.1 Budget implications

Cost overruns are defined as the situation where the cost of the project at completion is higher than what was budgeted for (Sunjka and Jacob, 2013). Delays that cause cost overruns include changes in scope of work, issuing of incomplete drawings, inadequate, or a lack of, planning and monitoring, and contractual claims (Kikwasi, 2012). According to Khair et al. (2016), cost overruns have been identified as the main effect of delays and are a recurring problem on road construction projects. Although effects of delays vary from region to region, country to country, one common effect that can be found on any project experiencing delays is cost overruns (Kaliba et al., 2009).

The financial implications of cost overruns could lead to delays in the paying back of loans; delays in generating profits; acceleration of losses as well as bankruptcy and stress for project stakeholders. The extra costs incurred due to the delay will result in the delay of payment of loans by the client (Oshungade and Kruger, 2017). Due to the delay, the client may not benefit from the implementation of the project, or the contractor will not receive the profit on the project in time which could lead to cash flow and financial difficulty.

To overcome the delay, additional budgeting is required. The contractor might try to reduce the delay by utilising extra labour and equipment which require additional budget (Oshungade and Kruger, 2017). This could accelerate losses and may result in bankruptcy due to depleted financial resources. In the study by Haseeb et al. (2011), the authors concluded that to recover on the project schedule due to the delay, additional material, equipment, and labour may be used, which incur additional expenditure. The need for additional resources, fear of loss of profit and fear of bankruptcy creates stress for the project stakeholders as well as stress to complete the project within schedule (Oshungade and Kruger, 2017).

2.7.2 Schedule implications

A construction project experiences time overruns when the project completion goes beyond the agreed schedule (Youniss et al., 2018). Delays in construction projects often result in time extensions; however, this is not always the case as non-critical delays that do not impact the project schedule, will not receive a time extension (Trauner et al., 2009). Causes of time overruns include external factors like weather conditions, strikes as well as material/ equipment and labour shortages and delays in issuing designs.

Due to the delay, the resources (labour and equipment) will be under-utilised awaiting resolution of the delay. To make up for the delay, work is rushed and as a result quality is compromised (Sunjka and Jacob, 2013). This is supported by an earlier study by Aibinu and Jagboro (2002), which identified poor quality of completed work as an effect of project delays.

Haseeb et al. (2011) define total abandonment of the project as the stoppage or suspension of work for a prolonged period. The decision of total abandonment is a

result of changes in finances and payments, organisational policy changes or natural occurring disasters (Haseeb et al., 2011).

2.7.3 Legal implications

A contractual dispute arises when there is a loss either by the client or contractor due to delays and is usually accompanied by a claim (Youniss et al., 2018). According to Ahmed at al. (2002), the dispute arises when trying to determine the responsible party for the time overrun, the magnitude of the overrun and if monetary compensation is applicable. A delay has cost implications that must be recovered. Identifying and settling of the financial implications lead to the issuing of claims and disputes. In a study by Sunjka and Jacob (2013), the authors identified one of the three most significant effects of delays as disputes and claims with the other two being cost and time overruns. If no settlement is reached, arbitration, or litigation, is required.

A delay in the project can lead to arbitration between the contractual parties which will incur ational cost and time overruns due to the engagement with the professional arbitrator (Youniss et al., 2018). In the studies by Aibinu and Jagboro (2002) in Nigeria, the authors identified arbitration as one of the main effects of delays in construction projects. This was supported by Sambasivan and Soon (2007) and Motaleb and Kishk (2010) in Malaysia and the UAE respectively.

Litigation is the timeous process of going to court to solve a contractual dispute that is often the result of delayed or non-payment of works completed (Haseeb et al., 2011). Similar to arbitration, in many studies such as those of Aibinu and Jagboro (2002); Motaleb and Kishk (2010) and Sambasivan and Soon (2007), the authors identify litigation as a major effect of delays on the construction project.

2.7.4 Negative social/ work relationship implication

Delays causes negative attitudes and feelings between project stakeholders This is due to the project having a social or financial benefit related to it. Any form of delay thus presents a negative attitude towards the project. Sunjka and Jacob (2013) identified negative social impact in their list of effects of delays. In a study by Akomah and Jackson (2016), the authors concluded that the company's reputation can be damaged if it cannot complete the project within schedule. The paper identifies damage to the company's reputation as one of the main effects of road construction delays (Akomah and Jackson, 2016). Fugar and Agyakwah- baah (2010) state that

delays have consequences that include conflict between stakeholders and a negative reputation for the parties involved. Sunjka and Jacob (2013) state that project delays put the public reputation of the client, consultant, and contractor at risk. Kamanga and Steyn (2013) list disputes and anxiety amongst stakeholders and negative reputation in their list of effects of project delays. The delay creates a negative working relationship amongst the stakeholders which affects current and future projects. Oshungade and Kruger (2017) conclude that due to project delays, the socio-economic benefit of the project may be delayed. Due to the delay, the public develops a negative reputation of the client, consultant, and contractor (Sunjka and Jacob, 2013).

2.8 Methods of Minimising Construction Delays

In reviewing the previous sections, project delays are a common phenomenon in the construction industry and the effects are detrimental to the client, consultant, and contractor as well as the economic and social development of the country. A systematic methodology is required to mitigate these delays or at least minimise their impact on the project. Previous studies by Aziz and Abdel- Hakam (2016); Mahamid et al. (2012); and Sambasivan and Soon, (2007), have provided strategies on how to mitigate construction project delays. A review of construction project mitigation measures was completed and is presented in Table 2.8. The 15 methods of construction delays identified can be divided into four categories: management and control; communication; financial and planning as shown in Table 2.8. The details of each of the categories are discussed in the following sub-sections.

Table 2.8: Identified Mitigation Measures for Client, Consultant, and Contractor

Category	Mitigation Measures	References
Management and Control	Effective management and supervision of construction site	Aziz and Abdel- Hakam (2016); Meena and Babu (2015)
	Improved management of subcontractors	Aziz and Abdel- Hakam (2016); Khoiry et al. (2018)
	Employing appropriate construction methods	Divya and Ramya (2015); Khair et al. (2016)
	Adherence to construction specifications	Khair et al. (2016); Khoiry et al. (2018)
	Consultants to ensure that drawings and documentation are submitted on time without any errors	Sambasivan and Soon (2007); Mahamid et al. (2012)
Communication	Early engagement with community	Rathenam and Dabup (2017)
	Establishing clear communication channels	Divya and Ramya (2015); Meena and Babu (2015)
	Improved collaboration between client, consultant, and contractor	Bagues, et al. (2020); Mahamid et al. (2012)
Financial	Do not award to lowest bidder, award based on technical experience and financial stability.	Mahamid et al. (2012); Sambasivan and Soon (2007)
	Contractors to ensure they have sufficient funding before starting the project	Meena and Babu (2015); Sambasivan and Soon (2007)
	Timeous payments to contractor and consultant	Mahamid et al. (2012); Seboru (2015)
Planning	Effective strategic planning by contractor	Divya and Ramya (2015); Meena and Babu (2015)
	Ensure adequate training of project staff	Mahamid et al. (2012); Sambasivan and Soon (2007)
	Contractor to develop contingency plans in the event of any delays	Bagues et al. (2020); Seboru (2015)
	Clients and consultants to approve variation orders on time	Sambasivan and Soon (2007) Seboru (2015)

2.8.1 Management and control

Construction project management entails the planning, coordinating and control of the project from the start of construction to the completion of the project, ensuring that the objectives of the client are satisfied (Khoiry et al., 2018). It is a way that project contributors organise their skills and techniques in the most appropriate manner and time, ensuring maximum benefit for the client. Control during the project is an important aspect as objectives of the project are achieved through control by the client on the consultant, control by the consultant on the contractor and control by the

contractor on the sub-contractors. The control is achieved through supervising and monitoring of works as agreed upon in the contract document.

Khoiry et al. (2018) conclude that through effective management and supervision of construction work, clients and contractors can identify issues early and provide solutions to prevent delays. Aziz and Abdel- Hakam (2016) state in their research that to minimise delays, there is a need for the contractor to employ experts in the management and supervision of site work. This includes the management of subcontractors by the contractor. The authors emphasise that choosing subcontractors with experience and a good reputation is necessary to minimise delays on the project (Aziz and Abdel- Hakam, 2016). Khair et al. (2016) list adherence to construction specifications as a method to reduce project delays. By adhering to the construction specifications, it prevents the rejection and redoing of completed work by the contractor.

Another key criterion to minimise construction delays is the adoption of suitable construction methods by the contractor (Divya and Ramya, 2015). It is important for the contractors to train and update their knowledge and their teams with respect to new construction techniques and technologies. This allows for the selection of the most optimum technique for implementation, ensuring the project is completed in the most efficient way. Khoiry et al. (2018) state that utilising manpower with advanced knowledge and great skill in construction is the only way to avoid construction delays.

In the study by Mahamid et al. (2012), the authors conclude that consultants should provide comprehensive information for easier interpretation of the drawings and setting out of work to reduce the occurrence of delays. This is supported by an earlier study by Sambasivan and Soon (2007) that found consultants should avoid discrepancies when drafting documents, ensure that drawings are issued timeously and are error free. The issuing of incomplete, delayed or error construction drawings and documents leads to discrepancies, back and forth of information and incorrect completion of the work which results in overall project delay.

2.8.2 Communication

Effective communication is critical to the success of any project as it improves collaboration between project stakeholders, leads to better partnership development and reduces any misunderstandings. Improved communication between the client,

consultant, and contractor reduces schedule delays, cost escalations, increases production and is effective in avoiding construction delays (Khoiry et al., 2018). Khoiry et al. (2018) further assert that the establishment of clear communication leads to pre-planned project execution and agreement to avoid any delays. It is improved collaboration between stakeholders that promotes successful implementation of the project (Bagues et al., 2020). In the paper by Mahamid et al. (2012), the authors identify better communication as an important aspect that both clients and contractors should consider so that objectives are clear and can be achieved in the specified time, within budget and meet the quality required. Communication about the project also includes external stakeholder like the community. Rathenam and Dabup (2017) conclude that through communication and engagement with the community, one can understand and identify the influence of the project on the community and vice versa. In a study in South Africa, the local community proved to be the major influencing factor and early engagement and understanding of their need and requirements will improve project completion time and cost (Rathenam and Dabup, 2017).

2.8.3 Financial

Project delays can be reduced by timeous payments to the contractor and client (Seboru, 2015). The timely payments assist the contractor to finance the progress of future works, providing him with an adequate cashflow. Fast payment to the contractor will assist the contractor in financing the project (Khoiry et al., 2018). It is also a form of motivation for the contractor to progress with the work and maintain a high-quality standard (Khoiry et al., 2018). Aibinu and Jagboro (2002) state that acceleration of project activities and providing contingency funds are the main methods for minimising construction project delays. In another study, the authors conclude that clients should pay progress payments for work completed to contractors timeously as it impacts the contractor's ability to finance works and results in project delays (Mahamid et al., 2012).

Meena and Babu (2015) state that to avoid delays, it is important to optimise cash flows in accordance with the project requirements and ensure that funds needed to execute the project are available at the start of the project. This is supported by Sambasivan and Soon (2007) who state that the contractor should secure financial resources at the start of the project. This will ensure that the contractor has a

continuous cash flow and does not run into financial difficulties and is able to pay subcontractors on time for work completed.

It is important to check the capabilities and resources before awarding the contract to the lowest bidder. If the lowest bidder has insufficient resources, it could lead to cash flow difficulties and project delays. Sambasivan and Soon (2007) recommend awarding the contract based on experience, technical and financial abilities and not to the lowest tenderer.

2.8.4 Planning

Project delays can be prevented through appropriate project planning and effective strategic planning as they are critical success factors for project completion (Bagues et al., 2020). It is through effective strategic planning that the contractor sets out to meet the objectives of the client and complete the project.

The low technical and managerial skills of contractors are problems that result in project delays, thus by attending training programmes, labourers can update their skills and knowledge (Khoiry et al., 2018). New construction technologies and methodologies are introduced to the industry on a daily basis. To avoid delays and ensure a smoother working force with higher quality of work, contractors are required to equip their team through training and development. Meena and Babu (2015) state that contractors need to be aware of new technology and techniques to reduce any delays in their labour force being able to complete construction activities. By providing adequate training and skills development on new technology, it increases the productivity and efficiency of the workers. This also applies to consultants completing design work. Khoiry et al. (2018) state that training for designers will ensure that designs are realistic, completed on time and without errors. Designers are also equipped with the ability to complete site inspections ensuring continuous progress on construction work. Aziz and Abdel- Hakam (2016) conclude that design errors made by inexperienced designers unfamiliar with conditions, result in delays. Therefore, to minimise the delay, Aziz and Abdel-Hakam (2016) advise employing experienced designers or providing training that enables them to adjust to the conditions (Aziz and Abdel- Hakam, 2016).

Although it is difficult to predict delays, especially the occurrence of natural disasters, contingency plans by the contractor are important in minimising the effect of the delay.

Bagues et al. (2020) state that delays due to such events can be avoided by incorporating certain precautionary measures during the preparation stage. This is achieved through a proper plan and schedule to conduct construction activities should the delay occur (Bagues et al., 2020). Seboru (2015) concludes that during rainy seasons, contractors should execute work that is not affected by the rain.

Seboru (2015) further concludes that bureaucracy in decision making by the client should be reduced to improve decision making time and minimise any delays. It is often that variation orders take time to get approved during which time construction work stops, resulting in a delay. By reducing the time, the client takes to decide and consultants take in implementing the decisions, delays can significantly be reduced. Sambasivan and Soon (2007) conclude that to minimise delays, clients should make quick decisions when the need arises.

2.9 Theoretical Framework

The conceptual framework that forms the basis of this research is shown schematically in Figure 2.2 and from which the research questionnaire is developed, is based on the work of previous authors such as Amoatey and Ankrah (2017), Bekr (2018) and Muhwezi at al. (2014) that categorised the causes of delays as client-related, consultant-related, contractor-related and external-related. The major causes of delays were identified and those delays pertinent to the conditions in South Africa were included in the questionnaire.

Several studies have been completed by authors such as Kikwasi (2012), Oshungade and Kruger (2017), Sunjka and Jacob (2013) and Youniss et al. (2018) on the effects of road construction delays and were grouped according to their categories of budget, schedule, legal and negative social implications.

The mitigation measures adopted in this study were drawn from previous studies by Aziz and Abdel- Hakam (2016), Mahamid et al. (2012) and Sambasivan and Soon, (2007). These measures were grouped into four categories: management and control; communication; financial and planning and used to develop the research questionnaire.

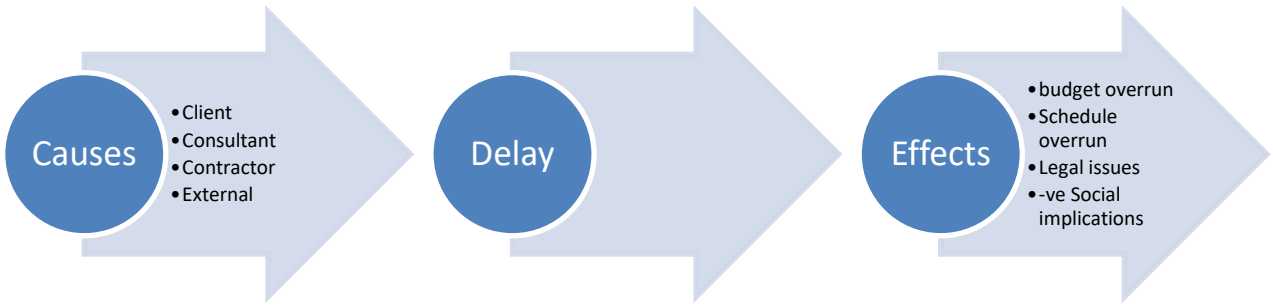

Figure 2.2 Conceptual Framework of the Study

Figure 2.2 proposes that the client, consultant, contractor and external-related factors cause delays on construction projects. Furthermore, the delays lead to budget and schedule overrun, legal issues and negative social implications.

2.10 Summary of the Literature Review Chapter

This chapter focused on the study of literature relevant to the topic under study. Through the literature review, an understanding of what research was previously completed on the topic and gaps such as the exclusion of external project stakeholders, were identified. The literature review identified 42 causes of construction project delays, 15 effects of delays and 15 methods to minimise project construction delays. These were used to develop the questionnaire as discussed in the next chapter, Chapter Three: Research Methodology

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

Kothari (2004) defines research methodology as a systematic approach to solving a research problem. This includes the numerous steps followed by the researcher in completing the study. This chapter presents the research approach, research design that includes the area of study, population of the study, sample size and sampling techniques. The chapter further indicates the method of data collection, data processing and analysis, validity, and reliability of data. This is followed by a discussion of the ethical considerations of the study.

3.2 Research Approach and Design

The research approach is a plan and process that entails steps from a broad assumption to detail methods of data collection and analysis dependent on the nature of the research area being addressed (Chetty, 2016). The research approach can be categorised into inductive and deductive research. An inductive research approach starts with a set of observations by the researcher and then moves from particular experiences to a more general set of propositions about those experiences; whereas, a deductive approach begins with a theory that develops into a hypothesis and thereafter data is collected and analysed to test the theory (DeCarlo, 2018).

The three common research approaches are quantitative, qualitative, and mixed methods (Wiliams, 2007). A method is selected based on the type of data the researcher anticipates will be required to answer the research question. A research question that requires a response in the form of numerical data is quantitatively based, while research questions requiring textural data are qualitatively based and research questions requiring both numerical and textural data are considered as mixed methods (Wiliams, 2007).

This study adopted a deductive reasoning and a quantitative research approach. The researcher studied what others have done, read existing theories and then developed a hypothesis that was tested through the analysis of the data collected. The theory covered the review of all literature relevant to the research topic. The questionnaire assessed the perception of clients, consultants, contractors, and other project

stakeholders on the causes and effects of road construction delays in South Africa and proposed measures that minimise the identified delays. The data gathered was analysed using statistical methods, using IBM SPSS Statiistics 27 computer software.

The research design is defined as the overall strategy that the researcher adopts to integrate the different areas of the study in a logical way ensuring the research addresses its objectives (De Vaus, 2006). It is the general plan on how the researcher intends to answer the research question (Saunders et al., 2009). This research adopts a quantitative method with a five-step research design to answer the research question and meet the objectives of the study.

The first step of the research design was defining the research problem, aim and objectives of the study and defining and adopting a research approach and plan. The second step was the review of literature relevant to the current study to identify and categorise the causes of construction project delays, the effects of these delays and what measures can minimise the occurrence of the delays in South African road construction projects. The literature review was used in the development of the questionnaire which was sent to the project stakeholders to obtain the research data. The third step involved the development of the methodology of the study that defined the research technique and sampling method, area of study, population and sample size, data collection, processing, and analysis. The fourth step included the analysis of the data using statistical methods and software. The final step included the discussion of the results, the research conclusion, and recommendations.

The following subsections elaborate on step three which discusses the area of study, population of study, sample and sampling technique, data collection, processing and analysis.

3.3 Area of Study

The South African National Roads Agency Ltd (SANRAL) is a state-owned entity that is responsible for 21 403km of National Roads in the country. SANRAL has five offices, the head office and four regional offices that service the entire South Africa. Head office is based in Pretoria with four regional offices. The Northern Region covers Gauteng, Limpopo, Mpumalanga and Northwest province, the Eastern Region covers

the KZN and Free State province, Southern Region covers the Eastern Cape, and Western Region covers the Western and Northern Cape.

The area of this study is the whole of South Africa. Within the four regional offices, the organisation completes projects in all nine provinces; therefore, information received from respondents who worked on SANRAL projects will provide a holistic view of the causes and effects of road construction delays in South Africa.

3.4 Population of Study

The population of the study is defined as all the members, individuals, or groups that the researcher wants to present in the study (Amin, 2005). Winch (2010) categorises construction stakeholders according to their relationship with the client, internal stakeholders, and external stakeholders. Internal stakeholders are those who have legal contracts binding them to the client, whereas external stakeholders are those who have a direct interest in the project yet do not necessarily have direct contract with the client (Winch, 2010).In the construction industry, stakeholders can be the client, consultant, contractor, community leaders, service providers and suppliers (Chinyio and Olomolaiye, 2010).

The population of this study comprises project stakeholders who have worked on SANRAL projects. This includes SANRAL project managers (clients), consultants, contractors and other external stakeholders who have worked on a SANRAL project.

3.5 Sampling Technique and Sample Size

There are two main types of sampling techniques, probability, and non-probability sampling. Probability or random sampling is most associated with surveys and experimental research (Al Zefeiti and Mohamad, 2015). A positivist quantitative approach is more aligned with a random sampling technique as it ensures that the objective reality is measured accurately (Davis et al., 2014). Random sampling allows for an equal probability of selection by all participants in the study population (Creswell, 2002).

This study adopted a random sampling technique to allow for an equal chance of selection of all project stakeholders (project manager, consultant, contractor and other). The subcategories for this research include SANRAL project managers (clients), consultants, contractors and others (public liaison officers) who worked on SANRAL projects.

In the study by Louanglath (2017), the author researched the minimum sample size based on the type of response scale used in surveys. The author treated the Likert scale as quantitative data and concluded that the minimum sample size is about 31.61 ± 2.33 (Louanglath, 2017). This number is consistent with other literature (Smith and Wells, 2006) which promotes the minimum sample size to be 30 for the central limit theorem to hold. The central limit theorem suggests that a representation of 30 members or more of a given population would result in the graph of the sample mean moving towards a normal distribution (Ross, 2020).

As there was no official SANRAL database with the number of consultants, contractors, and others who worked on SANRAL projects, no official population size could be determined. The researcher's work email was used as the database and potential respondents who met the criteria of working on a SANRAL project were emailed. All potential respondents were emailed to allow for random sampling and an equal chance to respond to the questionnaire. The number of stakeholders emailed per stakeholder group, number of responses per group received and response rate is shown in Table 3.1.

Table 3.1: Number of Surveys and Response Rate per Stakeholder Category

Category of Stakeholder	Study Population	Number of Completed Responses	Response Percentage
Client	40	21	53%
Consultant	34	24	71%
Co ntractor	22	13	59%
Other	10	6	60%
Total	106	64	60%

This research received a total of 64 responses, which is a 60% response rate. This is above the minimum sample size of 30 proposed by Louanglath (2017) and adheres to the central limit theorem.

3.6 Methods of Data Collection

As per the research design, a structured questionnaire was used as the data collecting instrument. Saunders et al. (2009) define a questionnaire as a technique for collecting data that requires the survey population to respond to the same set of questions that are set in a predetermined order. Compared to other data methods, questionnaires are cheap, quick, and have standardised answers that make data processing and analysis simple (Kabir, 2016).

3.6.1 Questionnaire format

The questionnaire consisted of five sections; namely, A, B, C, D and E. Section A of the questionnaire aimed at collecting the background information of the respondents, age, gender, qualification, and years of experience, while Section B aimed at collecting project information. Sections C, D and E of the questionnaire aimed at obtaining information from the respondents that met the objectives of the study; that is causes, effects and methods to minimise road construction delays, respectively. The questionnaire is attached as Appendix A and the summary of the responses is attached as Appendix B.

A Likert scale was used to measure the degree to which the respondents ranked each of the causes, effects, and methods to minimise the delays. A Likert scale is a one-dimensional psychometric scale that uses a rating system that is designed to measure the respondents' attitudes, opinions, or perceptions about the question (Jamieson, 2017). The Likert scale used five ordinal measures from 1- Strongly Disagree; 2- Disagree; 3- Undecided; 4- Agree and 5- Strongly Agree.

3.6.2 Method of administration

Data collection is the process of gathering information from different sources for the purpose of answering the research question (Creswell, 2002). The questionnaire was set up using Microsoft Forms and the link was emailed to all 106 participants on the researcher's email list. Emails sent out included the link to the survey, information regarding the research, ethical clearance letters (Appendix C and Appendix D). Respondents were given four weeks to complete the online questionnaire. The researcher followed up weekly via emails encouraging participants to complete the questionnaires. Once the four-week period expired, the online survey closed, and the 64 completed responses were captured for analysis.

3.7 Methods of Data Analysis

The data collected from respondents through the questionnaire survey was cleaned to remove any errors (half completed questionnaire) to ensure accuracy of data being analysed. Data analysis methods used were the Relative Importance Index to determine the ranking of the causes, effects and minimising methods, Kruskal- Wallis Test, and Chi-square Test to test the research hypothesis. Statistical software IBM SPSS Statistics 27 computer software in tandem with Microsoft Excel were used to analyse the data and produce bars, graphs and charts as presented in the results in Chapter 4 of this paper. The analysed data was used to conclude about the most significant causes and effects of delays in road construction projects in South Africa. Based on the results, a discussion of the results was presented, conclusions derived, and delay minimising recommendations were made and suggestions for further studies on the research topic.

3.7.1 Relative Importance Index

The Relative Importance Index (RII) was used to rank the most significant delays, causes and minimising methods received from the respondents in the questionnaire. The RII is computed as:

$$RII = \frac{\sum_{i=1}^{5} w_i x_i}{\sum_{i=1}^{5} x_i}$$

Where:

I = The response category index= 1,2,3,4,5 representing Strongly Disagree; Disagree; Undecided, Agree and Strongly Agree, respectively.

W_I = The weighted assigned to the i^{th} response; that is 1, 2, 3, 4, 5.

X_i = The frequency of the i^{th} response given as a percentage of the total response for each delay, cause, and minimising method.

3.7.2 Kruskal-Wallis Test

The Kruskal-Wallis test is a nonparametric test that is used to determine if there are any statistically significant differences between two or more groups. The calculated Kruskal- Wallis test H is compared to the critical values for a sample size greater than

five adopted from DataAnalytics (2021). A calculated Kruskal- Wallis H value greater than the critical value is statistically significant (DataAnalytics, 2021). A calculated significance (*P*) value of less 0.05 is considered statistically significant (Marzouk & El-Raas, 2014). The Kruskal-Wallis (H) value is calculated using the formula:

$$H = \left[\frac{12}{N(N+1)} \times \sum \frac{Tc^2}{n_c}\right] - 3 \times (N + 1)$$

Where:

H = Calculated Kruskal- Wallis value

N = The total number of participants

T_c = The rank total for each group

n_c = The number of participants in each group

3.7.3 Chi- Square Test

The Chi Square test is a common statistical calculation used for testing the research hypothesis that draws its conclusion from categorical data or proportions (Knight & Ruddock, 2008). The null hypothesis of the Chi Square test concludes that no relationship exists between the categorical variables in the population whereas the alternate hypothesis (H_A) indicates that a relationship exists.

This study used the Chi Square formula to test the research hypothesis:

H_1 : *External-related causes of delays are more significant contributors to construction project delays in South Africa than client, consultant, and contractor related causes.*

The formula is given by Knight & Ruddock (2008):

$$x^2 = \sum \frac{(Observed - Expected)^2}{Expected}$$

3.8 Validity and Reliability

The quality of research is achieved through the measurement of the validity and reliability of the study. Heale and Twycross (2015) define validity in quantitative studies as the degree to which a concept is correctly measured. The validity of the research instrument is the accuracy of measurement of the instrument addressing the objectives of the study (Kothari, 2004).

To improve on the quality of the questionnaire and to ensure that the identified causes, effects, and methods to minimise delays are relevant to the South African road construction industry, the questionnaire was reviewed by an experienced research supervisor and four senior construction managers working for SANRAL, representing SANRAL's four regions. The senior construction managers were chosen from the four regions as they have the required knowledge related to the research topic and are involved in all SANRAL projects in their respective regions. They were asked to provide their opinions on the content of the questions, relevance to the current conditions and to indicate any unclear and uncomfortable wording. Based on the feedback received from the supervisor and senior construction managers, the questionnaire was improved to remove ambiguity in the wording of the questions, provide more clarity on the type of projects, the project planned and actual cost and the addition of five causes of delays. This ensured that data obtained using the instrument was accurate in obtaining the objectives of the study.

The reliability of the study is related to the consistency of results or the accuracy of an instrument in producing the same results if used in the same situation repeatedly (Heale and Twycross, 2015). Cronbach's Alpha was used to measure the reliability of the closely related items in the data obtained. It is common in science research to consider an alpha value of 0.70 as a sufficient measure of reliability of an instrument (Taber, 2018). The results of the Cronbach's Alpha are presented in Table 3.2.

Table 3.2: Results of Cronbach's Alpha Showing Reliability of Closely Related Items

No.	Category of Results	Cronbach's Alpha
1	Client related causes of delays	0.827
2	Consultant related causes of delays	0.928
3	Contractor related causes of delays	0.924
4	External related causes of delays	0.843
5	Effects of construction project delays	0.930
6	Measures for minimising construction project delays	0.871

The results in Table 3.2 show Cronbach's Alpha values all above 0.7 with a minimum alpha value of 0.871. According to George and Malley (2003), this is acceptable and indicates reliability between closely related items.

3.9 Ethical Consideration

In line with the ethical considerations for conducting research of the University of Cape Town, the application for ethics clearance was completed (Appendix C) and a cover letter permitting the research with a confidentiality statement included, was attached to the questionnaire that was given to all participants. This was accompanied by a letter by SANRAL (Appendix C) granting permission to conduct the survey with its employees and service providers. The research adhered to the following ethical considerations:

- Respondents were assured of confidentiality throughout the research.
- Respondents were not asked their names, race, or religion.
- Respondents were not forced to participate in the study and there was no physical or psychological damage due to the research.
- The aim and objective of the study were clearly explained to all participants.
- Data collected and information obtained were exclusively for the purpose of the study.
- The researcher ensured that the sample size was a true representation of stakeholders in the construction industry and did not favour one stakeholder over another to create bias.
- The research acknowledged the work of previous studies by using citations and referencing where applicable.

3.10 Chapter Summary

This chapter highlighted the research approach and design adopted in this study. It further described the study area, population, sampling technique and sample size determination. The data collection method and analysis were discussed, and validity and reliability of the study presented. The chapter discussed the ethical considerations of this research and all limitations to the study were presented. The subsequent chapter presents the results and discussion of this study obtained through the methods discussed in this chapter.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents the analysis of the data collected from respondents through a structured questionnaire that is attached as Appendix A. A total of 64 responses were received for the online questionnaire completed through Microsoft Forms. A summary of the responses received is attached as Appendix B. The data was analysed using IBM SPSS Statistics 27 software and appropriate statistical methods were used to best analyse the data. The Relative Importance Index (RII) was employed to rank the significance of variables. A Kruskal-Wallis test was used to determine the statistical significance between the views of the different stakeholder groups and a Chi-square test was used to test the research hypothesis. The results are presented in charts and tables for interpretation and discussed below.

4.2 Data Presentation

4.2.1 Analysis of profile of respondents

The profile of respondents was assessed during the study by acquiring the gender, age, job profile, years of experience in the road construction industry and number of projects completed in the last five years. This was important in determining the representation of the respondents as a respondent profile is essential in acquiring broader views and opinions based on life experiences and understanding. The analysis of respondents' professional experience was important to assess the role that the respondents play on the project as this influences their responses to the survey. Different stakeholders have different views of causes and effects of delays; therefore, it was important to determine the distribution of the stakeholders who participated in the study. The experience of respondents was significant in determining the value the respondents bring in terms of the professional experience and expertise in road construction projects. The project information assessed the location of the project, type, budget and if any delays occurred. Analyses of respondent's gender and age, professional experience and project information is presented in the subsequent sections.

4.2.1.1 Gender and age of respondents

Analysis of the data on the representation of the respondent's gender and age are presented in Figure 4.1 and Figure 4.2. As seen in the results in Figure 4.1 for the respondent's gender, from the 64 responses received, 70% are male and 30% are female.

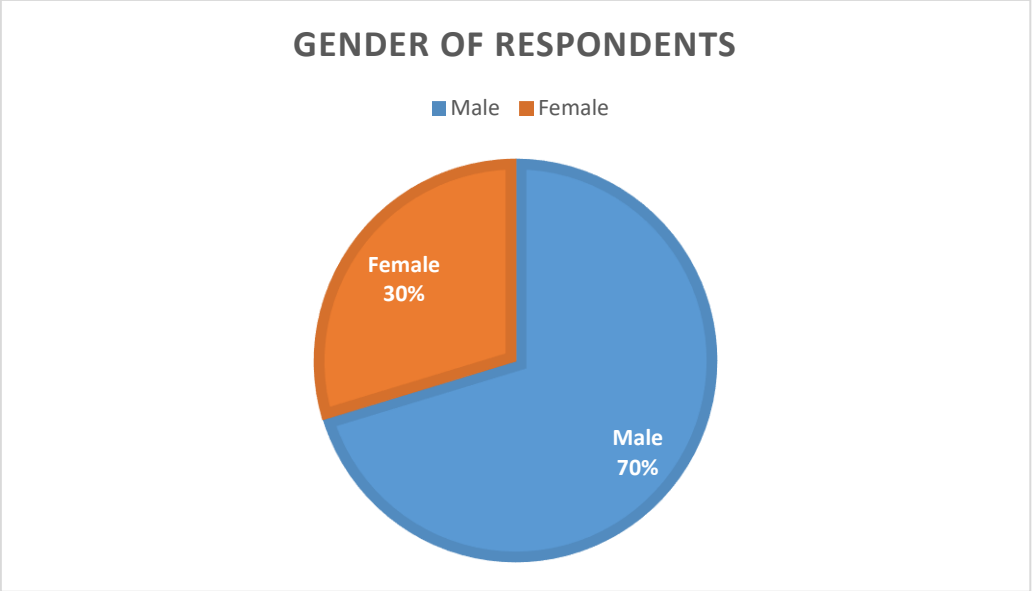

Figure 4.1: Analysis of Gender of Respondents

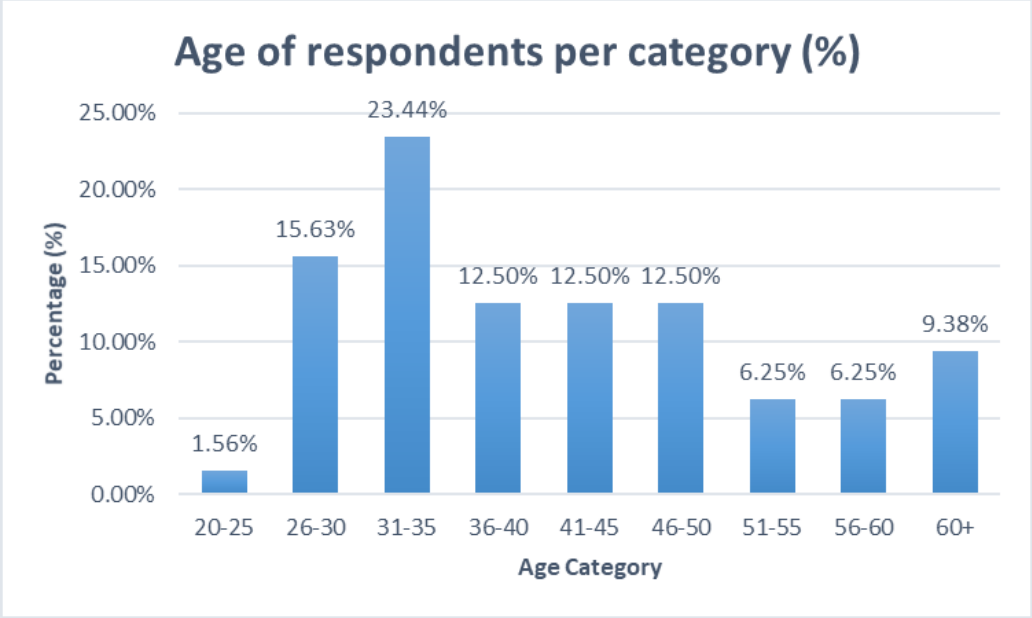

Figure 4.2: Analysis of Age of Respondents per Category (%)

The distribution of respondents age shown in Figure 4.2 indicates an even distribution of respondents within three of the age groups, 36-40 years, 41-45 years, and 46-50 years all having (12.50%) respondents each. Most respondents, (23.44%) were aged between 31-35 years. This is followed by respondents (15.63%) between 26-30 years. Overall, respondents over the age of 31 years constituted 82.82%.

4.2.1.2 Project role of respondents

The results contained in Figure 4.3 reveals that the highest response came from the Consultant group (38%), while 33% of the responses were from the Client group (SANRAL), followed by 20% from the Contractor group, and 9% from the 'Other' group.

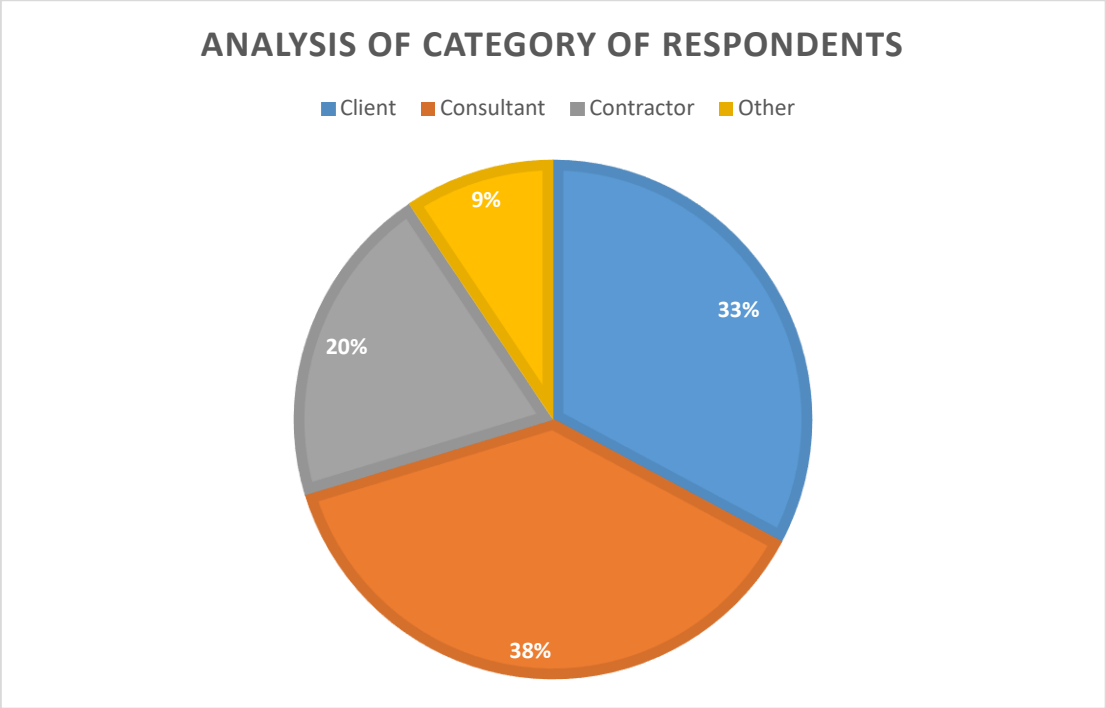

Figure 4.3: Analysis of Stakeholder Category of Respondents

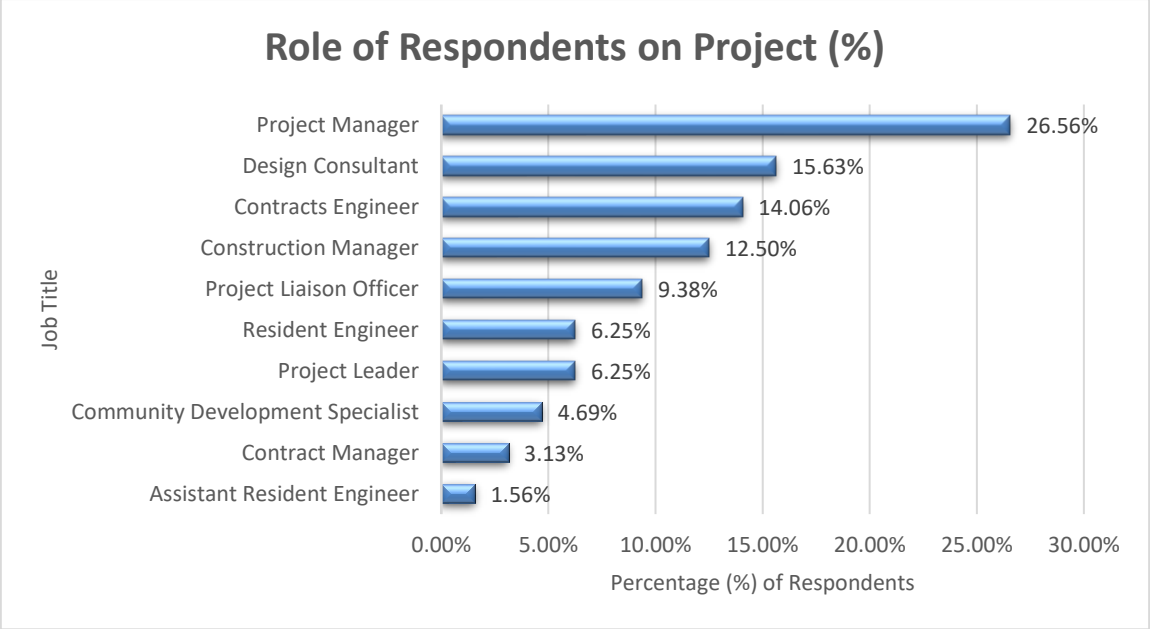

Figure 4.4: Analysis of Role of Respondents on Project (%)

The results in Figure 4.4 show the breakdown of respondents by designation. When the role of stakeholders on the project are distributed according to stakeholder category presented in Figure 4.3, it emerged that the Client group consisted of project managers (26.56%), community development specialists (4.69%) and one project leader (1.56%) who worked for SANRAL, the client. The Consultant group includes design consultants (15.63%), contract engineers (14.06%), resident engineers (6.25%), and an assistant resident engineer (1.56%). The Contractor group includes the contract managers (3.13%), construction managers (12.50%) and project leaders (4.69%), while the 'Other' group is represented by six project liaison officers (9.38%).

4.2.1.3 Experience of respondents

The analysis of years of respondents' experience and number of projects completed in the last five years are presented in Figure 4.5 and Figure 4.6. Results pertaining to the number of years of experience in the road construction industry reveal that 34.38% of respondents have between 6-10 years of experience, followed by 14.06% of respondents having 21-25 years of experience, while 12.50% of respondents have 11-15 years of relevant experience. Further analysis reveals that 54.70% of respondents have over ten years of relevant experience, while 45.30% have less than ten years experiences in the road construction industry.

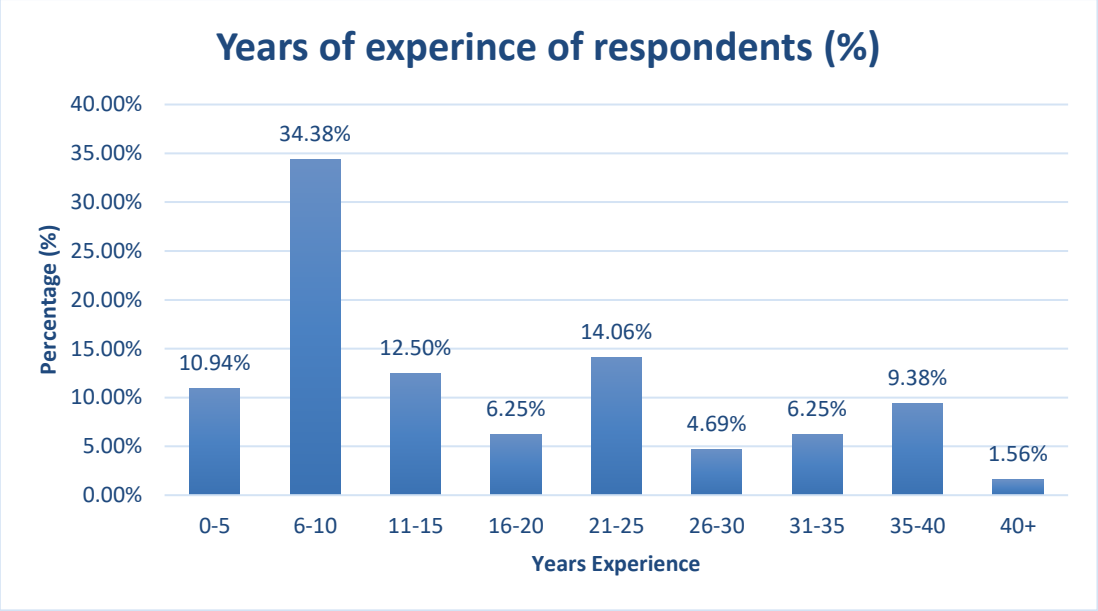

Figure 4.5: Analysis of Years of Experience of Respondents (%)

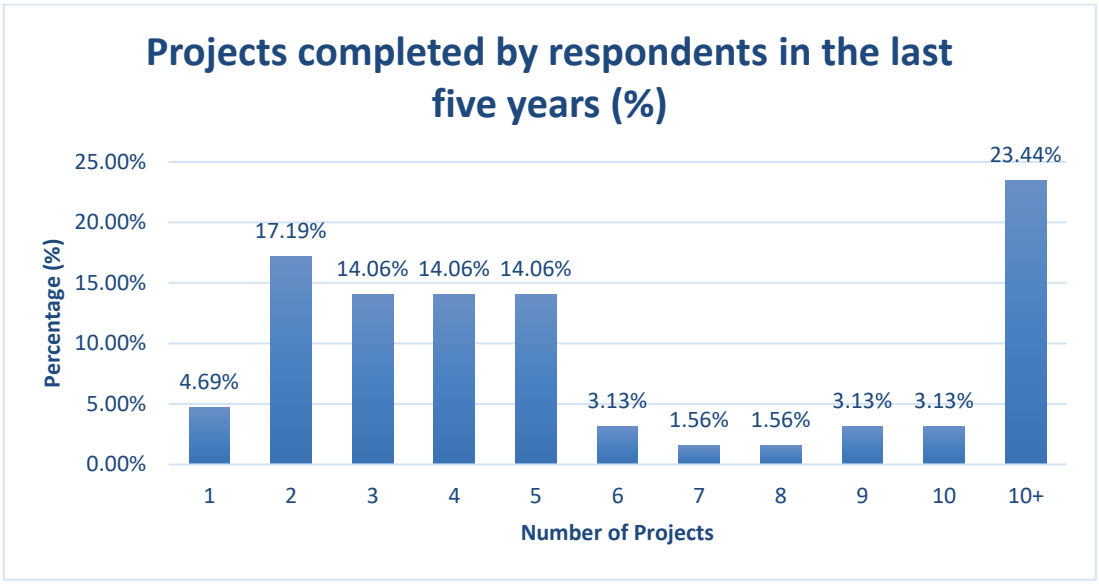

Figure 4.6: Analysis of Percentage of Projects Completed by Respondents in the Last Five Years

The results in Figure 4.6 substantiate the results of Figure 4.5 by revealing the number of projects respondents were involved in, in the last five years. The analysis revealed that 23.44% of the respondents completed more than ten projects, followed 17.19% who completed two projects in the last five years, while 14.06% of respondents completed three, four and five projects in the last five years.

4.2.2 Analysis of project information

4.2.2.1 Project location

The analysis of the locations of the projects that were submitted by the respondents are summarised per province and shown in Figure 4.7. From the 64 responses received through the survey, only 57 respondents provided the location of their project. This was not material and therefore the exclusion of these answers was accepted. The question of project location was merely asked to support that the research was completed nationally.

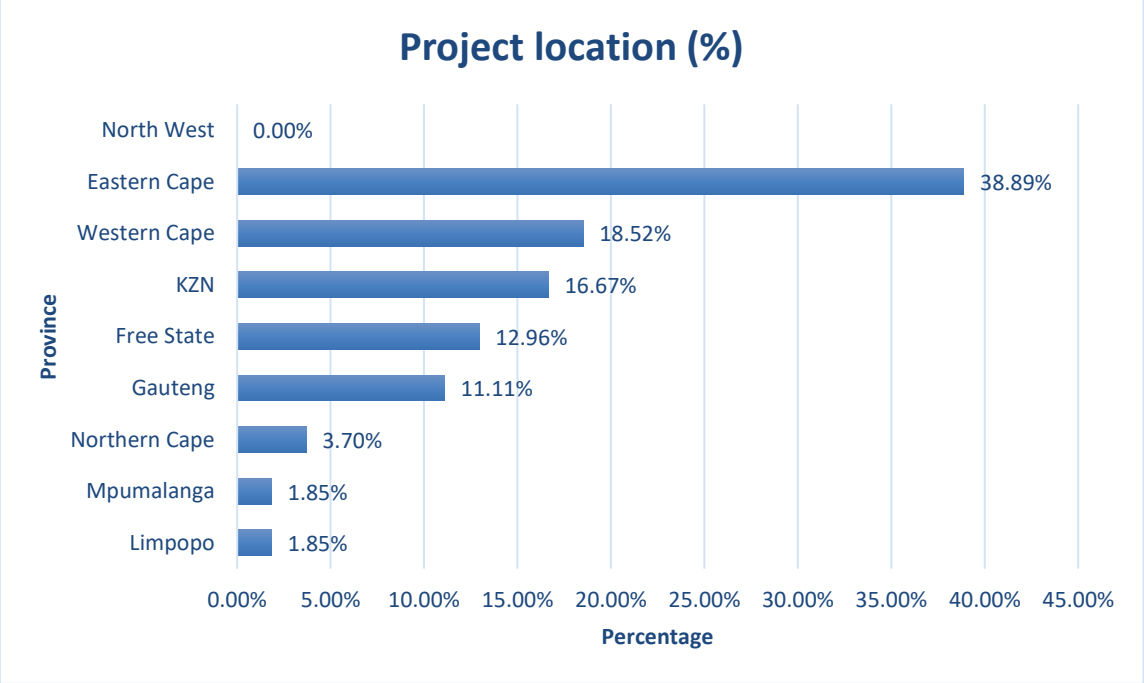

Figure 4.7: Analysis of Location of Projects Submitted by Respondents (%)

The results in Figure 4.7 show that eight of the nine provinces are represented in the project. Although the two provinces, Mpumalanga and Limpopo have one project each, they are still represented in this study. The location with the highest number of projects submitted by the participants was the Eastern Cape that had 38.89% followed by Western Cape and KZN 18.52% and 16.67% respectively. Free State represented 12.96%, Gauteng 11.11%, Northern Cape 3.70% while Mpumalanga and Limpopo represented 1.85%. There were no projects from North West province.

4.2.2.2 Types of projects submitted

The type of project provides an understanding of the project's budget and the complexity associated with the project. The submissions of respondents on the type of project completed and summaries and shown in Figure 4.8. Only 63 responses were received for the question. The one omission was deemed nonmaterial and acceptable.

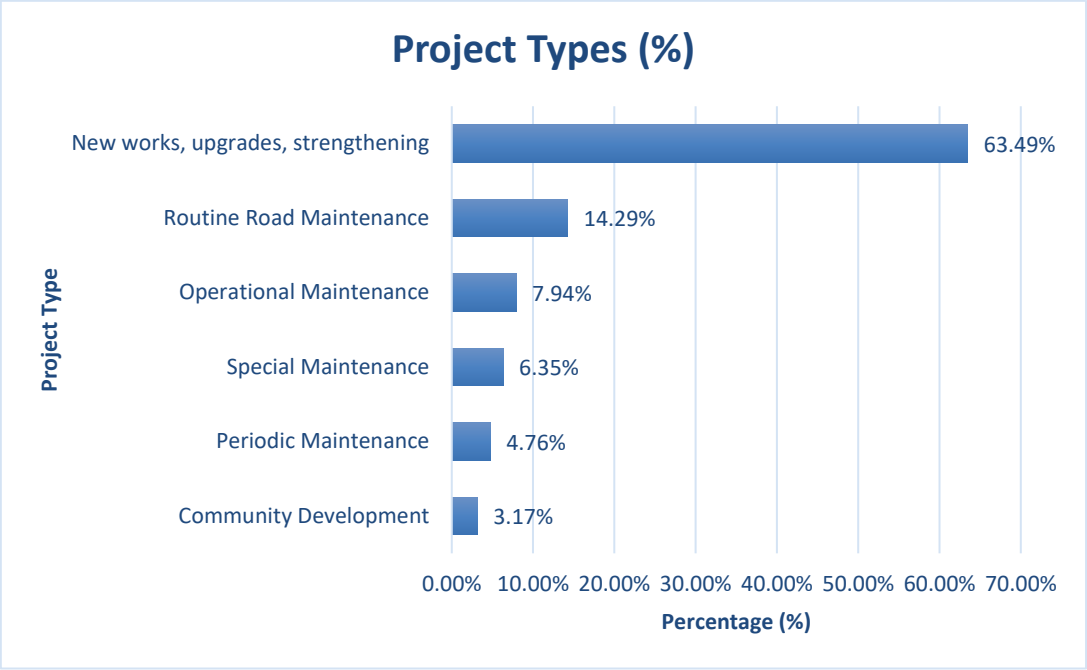

Figure 4.8: Categories of Different Project Types (%)

The results in Figure 4.8 show that new works, upgrades and strengthening projects consisted of the highest number of submissions (63.49%) of the projects submitted, followed by Routine Road Maintenance projects (14.29%) of the projects submitted. The remainder of the projects submitted were, operational maintenance (7,94%), special maintenance (6.35%), periodic maintenance (4.76%) and community development (3.17%).

4.2.2.3 Evaluation of delays of Respondents' listed projects

Respondents were asked in the questionnaire to indicate if their identified project experienced delays in the design phase and the construction phase. The results of the enquiry are presented in Figures 4.9 and Figure 4.10.

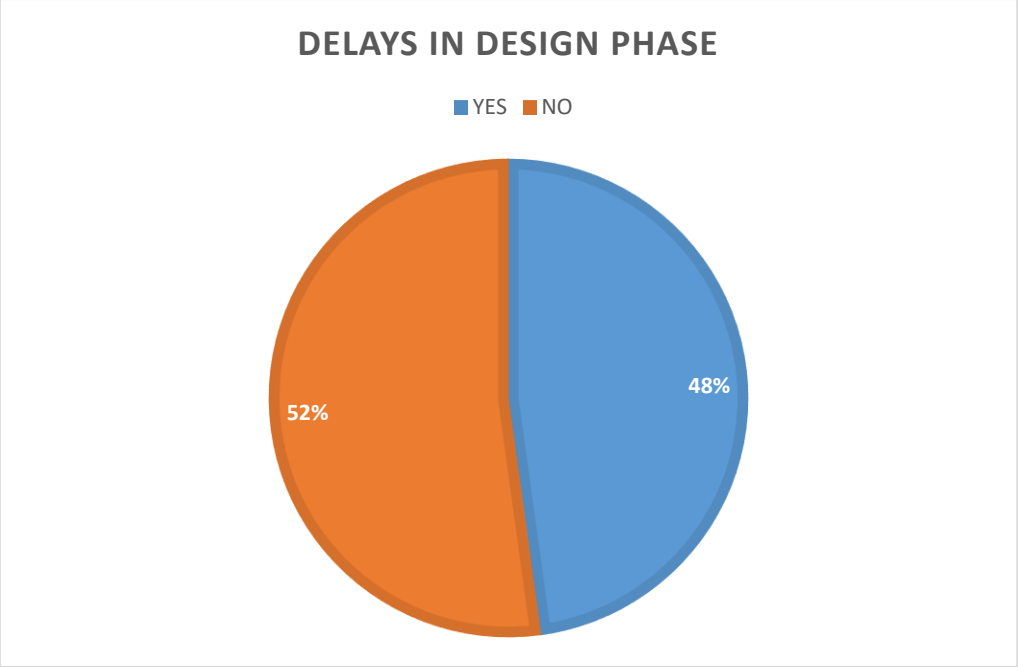

Figure 4.9: Percentage of Respondents' Delays During Design Phase

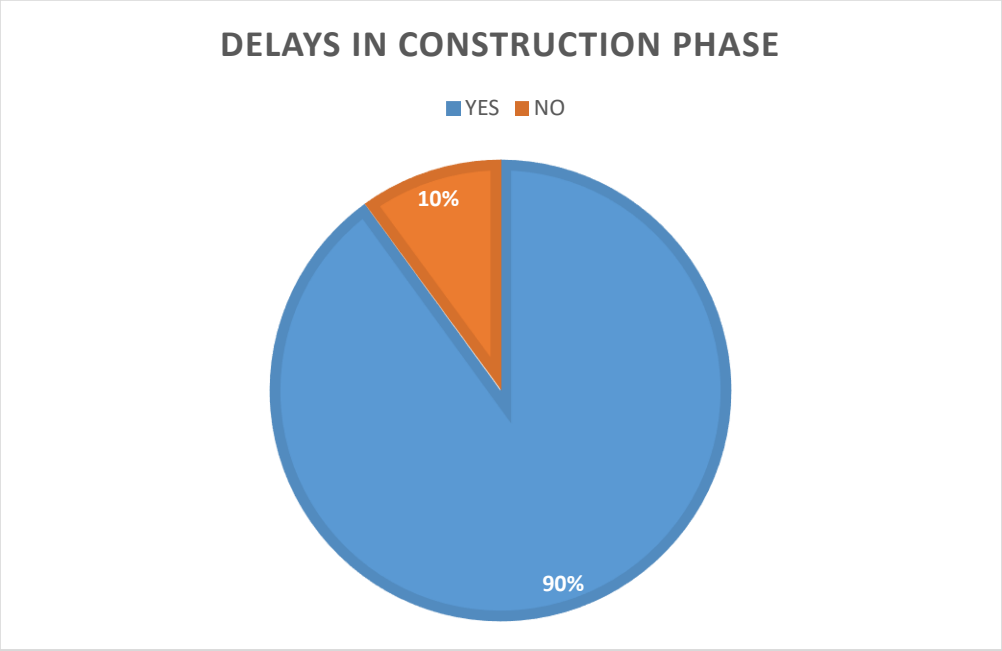

Figure 4.10: Percentage of Respondents' Delays During Construction Phase

The results for percentage delays during the design phase and construction phase are shown in Figure 4.9 and Figure 4.10 respectively. As seen in Figure 4.9, there is almost an equal split between projects experiencing delays during the design phase with 48% of respondents indicating delays occurred and 52% indicating delays did not occur

during the design phase. The same is not true for projects during the construction phase, with 90% of respondents indicating delays did occur and 10% indicating that delays did not occur. The above results indicate that delays are more frequent during the construction phase of projects in road projects in South Africa. The causes and effects of the delays will be analysed and discussed in the subsequent sections of this chapter.

The responses from the questionnaire were evaluated further. Four parameters were used: no delay from respondent; delay in design and construction phase; delay in design only and delay in construction only. The results of the analysis are represented in Figure 4.11.

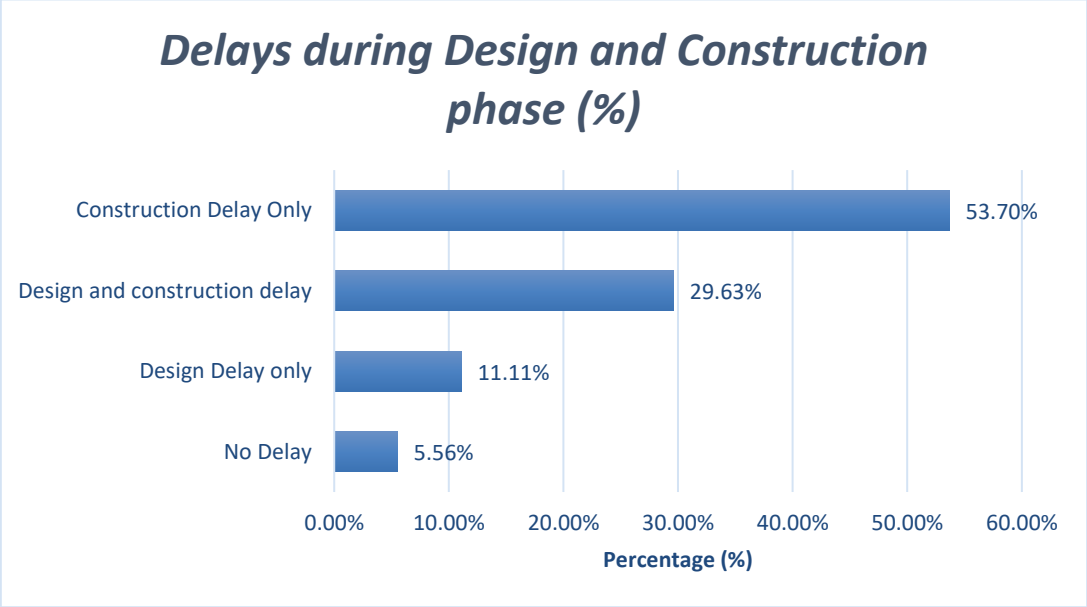

Figure 4.11: Analysis of Delays During Design and Construction Phase (%)

The analysis shown in Figure 4.11 are in support of the results shown in Figure 4.10, that delays occur more frequently during the construction phase than the design phase. In Figure 4.11, 53.70% of the projects experienced delays during the construction phase only, while 11.11% of the project experienced delays in the design phase only, and 29.63% of the projects experienced delays during the design and construction phase. A mere 5.56% of the projects indicated that there was no delay during the project's life.

4.2.2.4 Evaluation of cost of respondents' listed project

Respondents were asked to provide planned and actual cost for the design and construction phase of the projects. Similar to the previous question, certain respondents had limited knowledge of the different project phases or project elements and could not provide the information requested. The analysis of the results is presented in Figures 4.12 and 4.13.

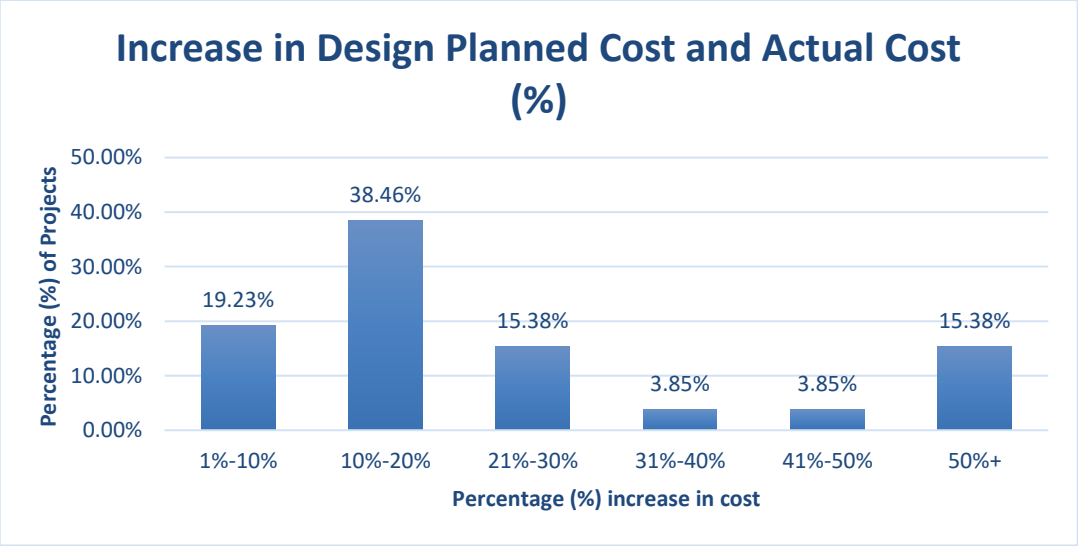

Figure 4.12: Percentage Increase in Planned and Actual Cost during Design Phase

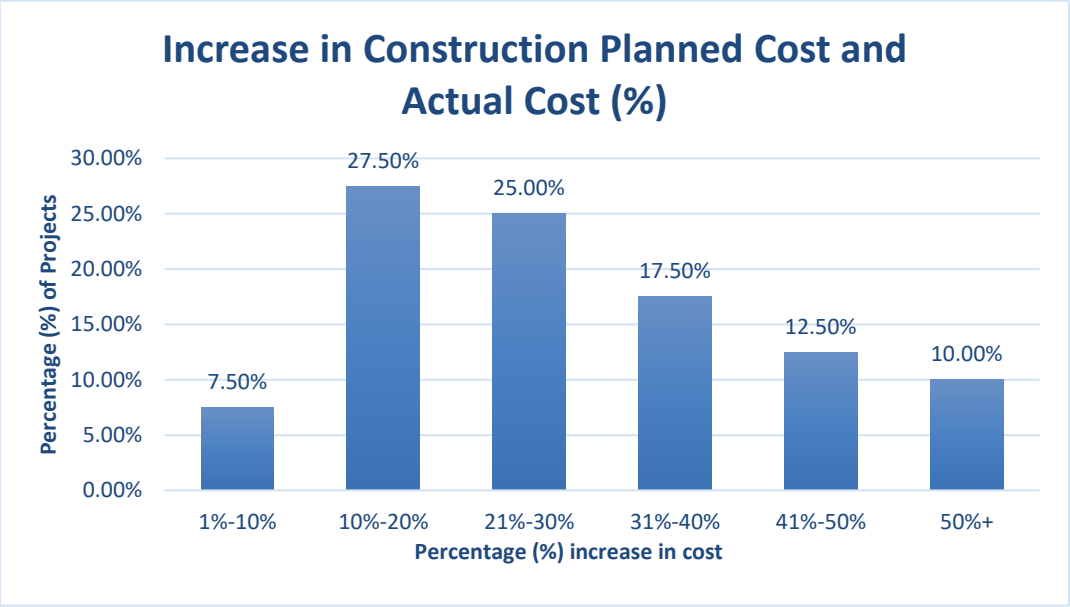

Figure 4.13 Percentage Increase in Planned and Actual Cost during Construction Phase

The information presented in Figure 4.12 show that 57.7% of the projects experienced an increase in project cost of less than 20% during the design phase while 42.3% of the projects experienced an increase of greater than 20%. This differs significantly from the construction phase as shown in Figure 4.13, where 32.5% of the projects experienced a cost increase of less than 20% and 67% experienced a cost increase of greater than 20%.

4.2.2.5 Evaluation of percentage subcontracted on respondents' listed project

A total of 49 responses were received for the question on percentage of project subcontracted and is presented in Figure 4.14. The average percentage of projects subcontracted is 35%. A total of 40.82% projects subcontracted between 21-30 % while 28.57% projects subcontracted between 31-40%. There were 12.24% projects that subcontracted between 10-20% and 41-50% and 6.12% projects subcontracted more than 51% of the work.

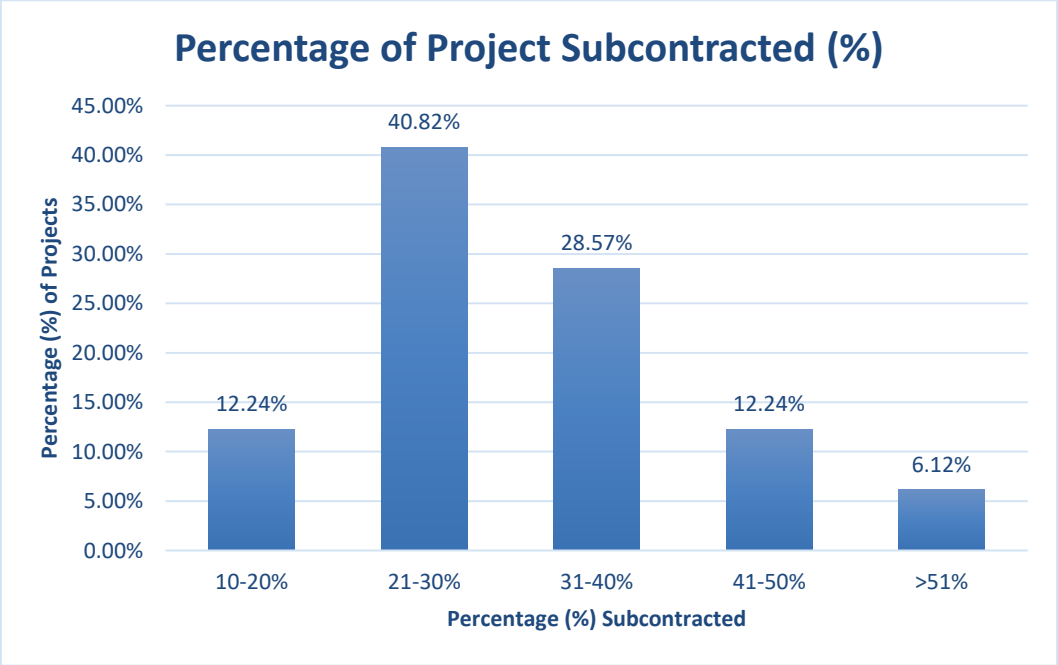

Figure 4.14: Analysis of Percentage of Project Subcontracted

4.2.3 Analysis of causes of delay in road construction projects

This section of the chapter consists of the results and discussions of the causes of road construction delays in South Africa. A total of 47 causes of delays were identified

through the literature review and expert review of the pilot questionnaire and were included in the final questionnaire sent out to all respondents. The causes of delays were categorised into four major groups: Client-related, Consultant-related, Contractor-related and External-related causes. The causes for each group were analysed statistically and ranked using their relative importance index. They are presented and discussed in the subsequent sections. An overall ranking was also examined to determine the top five overall causes of road construction project delays in South Africa.

4.2.3.1 Analysis of client related cause of delays

A total of nine client related causes of delays were identified through the literature review and pilot survey. The causes were analysed and ranked using the Relative Importance Index (RII) and presented in Table 4.1 according to the views of the client, consultant, contractor and other. An overall ranking of client related causes of delays is presented in Table 4.1.

Table 4.1: Analysis and Ranking of Client Related Causes of Delays

Cause of Delay	Overall Group		Client Group		Consultant Group		Contractor Group		Other Group	
Number of Respondents (N)	64		21		24		13		6	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Delays due to regulatory approval processes	0.772	1	0.810	1	0.783	1	0.723	1	0.700	4
Delay in decision making by client	0.647	2	0.629	2	0.625	2	0.662	--4	0.767	2
Delay in reviewing and approving drawings and documentation	0.609	3	0.552	5	0.575	3	0.723	1	0.700	4
Changes in design by the client	0.581	4	0.619	4	0.558	5	0.569	8	0.567	6
Changes in project scope by the client	0.578	5	0.629	2	0.553	6	0.646	6	0.433	8
Delays as a result of employer risk in terms of the FIDIC Conditions of Contract for Construction Work	0.569	6	0.543	6	0.575	3	0.600	7	0.567	6
Poor communication by client	0.566	7	0.495	7	0.525	7	0.662	4	0.767	2
Delay in payment by client	0.538	8	0.429	8	0.458	8	0.723	1	0.833	1
Other	0.216	9	0.390	9	0.192	9	0.015	9	0.133	9

Delays due to the regulatory approval process was ranked first overall with an RII of 0.772. This result was also true in the view of clients, consultants and contractors who scored an RII of 0.810, 0.783, and 0.723 respectively. However, the 'Other' group ranked this delay fourth with an RII of 0.700.

Delay in decision making by the client was ranked second overall, and by the client, consultant, and 'Other' group with RIIs of 0.647, 0.629, 0.625 and 0.767 respectively. The contractor group ranked delay in decision making by the client fourth with an RII of 0.662.

Delay in reviewing and approving drawings and documentation was ranked third overall and by the consultant group with RIIs of 0.609 and 0.575 respectively. This delay was ranked first in the view of the contractor group with an RII of 0.723, while the 'Other' group and client group ranked this delay fourth and fifth respectively with RIIs of 0.700 for the 'Other' group and 0.552 for the client group.

Changes in design by the client was ranked fourth overall and by the client group with RIIs of 0.581 and 0.619 respectively. The consultant group ranked this delay fifth with an RII of 0.558, while the 'Other' group ranked the delay sixth with an RII of 0.567. The contractor group ranked changes in design by the client eighth with an RII of 0.569.

Changes in project scope by the client was ranked fifth overall with an RII of 0.578, while the client group ranked this delay second with an RII of 0.629. The consultant and contractor groups both ranked this delay sixth with RIIs of 0.553 and 0.646 respectively. The 'Other' group ranked this delay eighth with an RII of 0.433.

Delays as a result of Employer Risk in terms of the FIDIC Conditions of Contract for Construction Work was ranked sixth overall as well as by the client and 'Other' group with RIIs of 0.569 overall, 0.543 for the client group and 0.567 for the 'Other' group. The consultant group ranked this delay third with an RII of 0.575 while the contractor group ranked the delay seventh with an RII of 0.600.

The delay of poor communication by the client was ranked seventh overall with an RII of 0.566. The client and consultant groups also ranked this delay seventh with RIIs of 0.495 and 0.525 respectively, while the contractor group ranked this delay fourth with an RII of 0.662. Poor communication by the client was ranked second by the 'Other' group with an RII of 0.767.

Delay in payment by the client was ranked eighth overall and by the client and consultant group with RIIs of 0.538, 0.429 and 0.458 respectively. This delay was ranked first by the contractor group and 'Other' group with RIIs of 0.723 and 0.833 respectively.

The other causes of delays ranked last for all group and overall consisted of the following comments by respondents:

- Delays in procurement

- Delays in land acquisition
- Delays in continuity by design project manager and construction project manager
- Socio-economic factors
- Funding issues
- Incremental weather
- Contractor liquidated
- Delays due to claims resolution
- Project scope changed
- Delays from unions
- Delays due to public strikes
- Lack of funding

The delays in procurement can be absorbed in the delay in regulatory approval ranked first as the client related delays, while the delay due to project scope was listed as a client related cause of delay and ranked fifth. The delay due land acquisition, community strikes, weather and socio-economic factors are discussed under external related causes of delays.

4.2.3.2 Analysis of consultant related cause of delays

The consultant related delays consisted of nine causes of delays that were identified through the literature review and pilot questionnaire. The relative importance index for each cause of delays was calculated and presented in Table 4.2 under the view of each project stakeholder. The overall ranking of the consultant related causes of delays is presented in Table 4.2.

Table 4.2: Analysis and Ranking of Consultant Related Causes of Delays

Cause of Delay	Overall		Client Group		Consultant Group		Contractor Group		Other Group	
Number of Respondents (N)	64		21		24		13		6	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Errors in the contract documentation	0.575	1	0.657	1	0.417	7	0.692	1	0.667	2
Poor communication between client and contractor	0.566	2	0.590	6	0.475	1	0.631	4	0.700	1
Unclear and inadequate details in construction drawings	0.563	3	0.610	3	0.442	4	0.692	1	0.600	6
Inadequate experience/skills of consultants	0.563	3	0.619	2	0.425	6	0.692	1	0.633	5
Changes in design during construction	0.556	5	0.610	3	0.467	2	0.585	8	0.667	2
Delays in implementing changes to scope of work	0.544	6	0.571	7	0.458	3	0.600	7	0.667	2
Delays in preparing design, drawings, and documentation	0.541	7	0.610	3	0.433	5	0.615	6	0.567	8
Delays in performing inspections and testing	0.513	8	0.524	9	0.417	7	0.631	4	0.600	6
Conflict between consultant and contractor	0.494	9	0.562	8	0.400	9	0.462	9	0.567	8
Other	0.053	10	0.076	10	0.050	10	0.000	10	0.100	10

Errors in the contract documentation was ranked first overall, by the client group and contractor group with an RII of 0.575, 0.675 and 0.692 respectively. The consultant group ranked this delay seventh with an RII of 0.417, while the 'Other' group ranked the delay second with an RII of 0.667.

Poor communication between client and contractor was ranked second overall for client related causes of delays, while the consultant and 'Other' group ranked this delay first with RIIs of 0.475 and 0.700 respectively. The client group ranked this delay sixth with an RII of 0.590 and the contractor group ranked the delay fourth with an RII of 0.631.

The delay due to unclear and inadequate details in construction drawings was ranked third overall and by the client group with RIIs of 0.563 and 0.610 respectively. The contractor group ranked this delay first with an RII of 0.692 while the consultant group ranked the delay fourth with an RII of 0.442. The 'Other' group ranked this delay sixth with an RII of 0.600.

The delay due to inadequate experience/skills of consultants was ranked third overall as the consultant related cause of delay with an RII of 0.563. The contractor group ranked this delay first with an RII of 0.692 while the client group ranked this delay second with an RII of 0.619. The 'Other' group ranked inadequate experience/skills of consultants fifth with an RII of 0.633 while the consultant group ranked the delay sixth with an RII of 0.425.

Moreover, changes in design during construction was ranked fifth overall with an RII of 0.556, the consultant and 'Other' group ranked the delay second with RIIs of 0.467 and 0.667 respectively. The client group ranked the delay third with an RII of 0.610, while the contractor group ranked the delay eighth with an RII of 0.585.

Delays in implementing changes to scope of work was ranked sixth overall with an RII of 0.544. The 'Other' and consultant group ranked the delay second and third with RIIs of 0.667 and 0.458 respectively. The client and contractor group both ranked the delay seventh with RIIs of 0571 and 0.600 respectively.

The delay in preparing design, drawings, and documentation was ranked seventh overall with an RII of 0.541. The client group ranked the delay third with an RII of 0.610 while the delay was ranked fifth, sixth and eighth by the consultant, contractor, and 'Other' group in that order with RIIs of 0.433, 0.615 and 0.567 respectively.

Delays in performing inspections and testing on site by the consultant was ranked eighth overall with an RII of 0.513. The contractor group ranked the delay fourth with and RII of 0.631 while the 'Other' group ranked the delay sixth with an RII of 0.600.

The consultant group ranked the delay seventh with an RII of 0417 and the client group ranked the delay ninth with an RII of 0.524.

The delay due to conflict between consultant and contractor was ranked ninth overall, and by the consultant and contract group with RIIs of 0.494, 0.400 and 0.462 respectively. This delay was ranked eighth for both the client and 'Other' group with RIIs of 0.562 and 0.567 respectively.

The other causes of delays ranked last by all groups consisted of the following comments by respondents:

- Community unrest
- COTO specification changes
- Socio- economic factors
- More demands by SMMEs

These causes of delays are discussed under external related causes of delays.

4.2.3.3 Analysis of contractor related cause of delays

The contractor related causes of delays had the highest number of identified delays through the literature review and pilot questionnaire with a total of 19 delays identified. These delays were ranked using their Relative Importance Index (RII) and presented according to the overall client, consultant, contractor, and 'Other' group in Table 4.3.

Table 4.3: Analysis and Ranking of Contractor Related Causes of Delays

Cause of Delay	Overall Group		Client Group		Consultant Group		Contractor Group		Other Group	
Number of Respondents (N)	64		21		24		13		6	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Poor management of subcontractors	0.716	1	0.743	1	0.700	1	0.631	2	0.867	1
Employee Strikes	0.682	2	0.686	2	0.625	5	0.708	1	0.833	3
Late payment to subcontractors	0.656	3	0.657	5	0.667	3	0.538	5	0.867	1
Poor management and supervision by contractor	0.650	4	0.667	3	0.692	2	0.508	7	0.733	5
Cash flow difficulties by the contractor	0.647	5	0.648	6	0.633	4	0.631	2	0.733	5
Inefficient planning and scheduling of project	0.625	6	0.667	3	0.608	6	0.508	7	0.767	4
Rework due to mistakes during construction	0.591	7	0.648	6	0.583	9	0.523	6	0.567	11
Technical issues faced by contractor	0.581	8	0.629	8	0.600	7	0.508	7	0.500	14
Low level of productivity	0.578	9	0.629	8	0.583	9	0.508	7	0.533	12
Delay in material delivery	0.575	10	0.571	11	0.542	14	0.508	7	0.633	9
Shortage of materials in market	0.569	11	0.553	15	0.558	12	0.600	4	0.667	7
Poor management of materials	0.534	12	0.562	12	0.525	15	0.446	16	0.667	7
Improper construction methods	0.531	13	0.543	14	0.592	8	0.415	18	0.500	14
Inadequate contractor experience	0.525	14	0.610	10	0.567	11	0.338	19	0.467	16
Low level of equipment operator's skill	0.516	15	0.514	17	0.550	13	0.508	7	0.400	18

Change in material type during construction	0.516	15	0.552	13	0.467	19	0.508	7	0.600	10
Poor management of equipment	0.500	17	0.533	15	0.492	17	0.446	16	0.533	12
Equipment breakdown	0.488	18	0.486	18	0.517	16	0.447	14	0.367	19
Unavailability of equipment	0.453	19	0.457	19	0.475	18	0.462	15	0.433	17
Other	0.147	20	0.229	20	0.100	20	0.015	20	0.100	20

Poor management of subcontractor was ranked first by all groups except for the contractor group which ranked the delay second. The RII of the overall ranking of the delay was 0.716, while for the client group it was 0.743. The RIIs for the consultant, contractor and 'Other' group was 0.700, 0.631 and 0.867 respectively.

Employee strikes was ranked second overall and by the client group with RIIs of 0.682 and 0.686 respectively. The delay was ranked first by the contractor group with an RII of 0.708. The consultant group ranked the delay fifth with an RII of 0.625 while the 'Other' group ranked the delay third with an RII of 0.833.

The delay due to late payment to subcontractors was ranked third overall and by the consultant group with RIIs of 0.656 and 0.667 respectively while the 'Other' group ranked the delay first with an RII of 0867. Both the client and contractor groups ranked this delay fifth with RIIs of 0.657 and 0.538 respectively.

Poor management and supervision by the contractor was ranked fourth as a contractor related cause of delay with an RII of 0.650. The delay was ranked second and third by the consultant (RII of 0.629) and client (RII of 0.667) groups respectively. The 'Other' group ranked the delay fifth with an RII of 0.733 while the contractor group ranked the delay seventh with an RII of 0.508.

Cash flow difficulties by the contractor was ranked fifth overall and by the 'Other' group, with RIIs of 0.647 and 0.733 respectively, while the delay was ranked second by the contractor group with an RII of 0.631. The consultant group ranked the delay fourth with an RII of 0.633 and the client group ranked the delay sixth with an RII of 0.648.

Inefficient planning and scheduling of project was ranked sixth overall and by the consultant group with RIIs of 0.625 and 0.608 respectively. The client group ranked the delay third with an RII of 0.667, while the 'Other' group ranked the delay fourth with an RII of 0.767. The contractor group ranked the delay seventh with an RII of 0.508.

The delay due to rework due to mistakes during construction was ranked seventh overall with an RII of 0.591. The client and consultant group both ranked the delay sixth with RIIs of 0.648 and 0.567 respectively, while the consultant group ranked the delay ninth with an RII of 0.583. The 'Other' group ranked the delay 11th with an RII of 0.567.

Technical issues faced by the contractor was ranked eighth overall and by the client group with RIIs of 0.581 and 0.629 respectively. The consultant and contractor groups ranked the delay seventh with RIIs of 0.600 and 0.508 respectively. The 'Other' group ranked technical issues by the contractor 14th with an RII of 0.500.

The delay due to low level of productivity was ranked ninth overall and by the consultant group with RIIs of 0.578 and 0.583 respectively. The contractor and client group ranked the delay seventh and eighth with RIIs of 0.508 and 0.629 respectively. The 'Other' group ranked the delay 12th with an RII of 0.533.

Delay in the delivery of material was ranked tenth overall with an RII of 0.575. The contractor group ranked the delay seventh with an RII if 0.508 while the 'Other' group ranked the delay ninth with an RII of 0.633. The client group ranked the delay of materials 11th with an RII of 0.571 and the consultant group ranked the delay 14th with an RII of 0.542.

The shortage of material in the market was ranked overall 11th with an RII of 0.569. The consultant group ranked this delay fourth with an RII of 0.600, while the 'Other' group ranked the delay seventh with an RII of 0.667. The consultant group ranked the delay 12th with an RII of 0.558 and the client group ranked the delay 15th with an RII of 0.553.

The poor management of materials was ranked 12th overall and by the client group with RIIs of 0.543 and 0.562 respectively. The 'Other' group ranked the delay seventh with an RII of 0.667. The consultant group ranked the delay 15th with an RII of 0.525 while the contractor group ranked the delay 16th with an RII of 0.446.

Improper construction methods was ranked 13th overall with an RII of 0.531. The consultant group ranked this delay eight with an RII of 0.592. The delay was ranked 14th by the client and 'Other' groups with RIIs of 0.543 and 0.500 respectively. The contractor group ranked this delay 18th with an RII of 0.415.

Inadequate contractor experience was ranked 14th overall with an RII of 0.525. The client and consultant groups ranked the delay tenth and 11th with RIIs of 0.610 and 0.567 respectively. The 'Other' group ranked the delay 16th with and an RII of 0.467 while the contractor group ranked the delay 19th with an RII of 0.338.

The low level of equipment operator's skill was ranked 15th overall with an RII of 0.516 while the contractor group ranked the delay seventh with an RII of 0.508. The consultant group ranked this delay 13th with an RII of 0.550. The client and 'Other' groups ranked the delay 17th and 18th with RIIs of 0.514 and 0.400 respectively.

The change in material type during construction was ranked 15th overall with an RII of 0.516 while the contractor group ranked the delay seventh with an RII of 0.508. The 'Other' group ranked the delay tenth with an RII of 0.600. The client group ranked the delay 13th with an RII of 0.552, while the consultant group ranked the delay 19th with an RII of 0.467.

The poor management of equipment was ranked 17th overall and by the consultant group with RIIs of 0.500 and 0.492 respectively. The 'Other' group ranked the delay 12th with an RII of 0.533 The delay was ranked by clients and contractor's 15th and 16th with RIIs of 0.533 and 0.446 respectively.

The delay due to equipment breakdown was ranked 18th overall and by the client group with RIIs of 0.488 and 0.486 respectively. The contractor group ranked the delay 14th with an RII of 0.447, while the consultant group ranked the delay 16th with an RII of 0.517. The delay was ranked 19th by the 'Other' group with an RII of 0.367.

The unavailability of equipment was ranked 19th overall and by the client group with RIIs of 0.453 and 0.457 respectively. The delay was ranked 15th by the contractor group with an RII of 0.462. The 'Other' and consultant groups ranked the delay 17th and 18th with RIIs of 0.433 and 0.475 respectively.

The other causes of delays ranked last for all groups consisted of the following comments by respondents:

- Delays in procuring subcontractors
- Delay due to project transverse municipal ward with each ward requesting share of work
- Delays due to community strikes for employment
- Delays due to business forums
- Delays due to socio-economic factors
- Delays due to SMME demand
- Delays due to cash flow difficulties
- Delays due to community engagement

The cause of delay due to cash flow difficulties was identified in the study and ranked fifth as client related cause of delay. The other delays relate to community issues, poor community engagement, community unrest and demand for work and are discussed under external related causes of delays.

4.2.3.4 Analysis of external related cause of delays

A total of 11 external related causes of delays have been identified and listed in Table 4.4. They are presented under the view of the client, consultant, contractor and 'Other' group. The overall ranking of external related causes of delays is presented in Table 4.4. These causes of delays have been identified through a literature review and pilot survey sent to experts in the field. The causes of delays have been ranked in Table 4.4 according to their Relative Importance Index (RII).

Table 4.4: Analysis and Ranking of External Related Causes of Delays

Cause of Delay	Overall Group		Client Group		Consultant Group		Contractor Group		Other Group	
Number of Respondents (N)	64		21		24		13		6	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Unrest by local communities	0.841	1	0.914	1	0.792	1	0.800	2	0.867	1
Stoppages of work by construction mafia/ neighbouring communities/ wards	0.806	2	0.886	2	0.750	4	0.800	2	0.767	2
Poor engagement with local community	0.763	3	0.733	3	0.767	2	0.862	1	0.633	6
Lack of acceptance of project by community	0.756	4	0.724	4	0.758	3	0.800	2	0.767	2
Land acquisition delays	0.634	5	0.695	6	0.667	5	0.554	7	0.467	7
Delays in obtaining permits/ approvals from DFFE/ DMR	0.631	6	0.686	7	0.633	6	0.615	5	0.467	7
Political interference	0.625	7	0.705	5	0.567	7	0.554	7	0.733	4
Changes in government laws and regulations	0.591	8	0.657	8	0.542	8	0.523	9	0.700	5
Extreme weather conditions and other natural disasters	0.550	9	0.552	10	0.542	8	0.600	6	0.467	7
Unforeseen ground conditions	0.525	10	0.600	9	0.517	11	0.492	11	0.367	11
Municipal bylaw approvals	0.503	11	0.476	11	0.533	10	0.508	10	0.467	7
Other	0.038	12	0.048	12	0.058	12	0.000	12	0.000	12

Unrest by local communities was ranked first overall and by the client, consultant, and 'Other' groups with RIIs of 0.841, 0.914, 0.792 and 0.867 respectively. The only group

to rank this external related cause of delay second was the contractor group with an RII of 0.800.

The delay due to stoppages of work by construction mafia/ neighbouring communities/ wards was ranked second overall and by the client, contractor and 'Other' group with RIIs of 0.806, 0.886, 0.800 and 0.767 respectively. The consultant group ranked this delay fourth with an RII of 0.750.

The delay due to poor engagement with local community was ranked third overall and by the client group with RIIs of 0.763 and 0.733 respectively. The contractor group ranked this delay first with an RII of 0.862. The consultant group ranked the delay second with an RII of 0.767, while the 'Other' group ranked the delay sixth with an RII of 0.633.

The lack of acceptance of project by community was ranked fourth overall and by the client group with RIIs of 0.756 and 0.724 respectively. Both the contractor and 'Other' group ranked the delay second with RIIs of 0.800 and 0.767 respectively. The consultant group ranked the delay third with an RII of 0.758.

Land acquisition delays was ranked fifth overall and by the consultant group with RIIs of 0.634 and 0.667 respectively. Both the contractor and 'Other' groups ranked the delay seventh with RIIs of 0.554 and 0.467 respectively. The client group ranked the delay sixth with an RII of 0.695.

Delays in obtaining permits/ approvals from DFFE/ DMR was ranked sixth overall and by the consultant group with RIIs of 0.631 and 0.633 respectively. Both the client and 'Other' groups ranked the delay seventh with RIIs of 0.686 and 0.467 respectively. The contractor group ranked the delay fifth with an RII of 0.615.

The delay due to political interference was ranked seventh overall and by the consultant and contractor groups with RIIs of 0.625, 0.567 and 0.554 respectively. The delay was ranked fourth by the 'Other' group with an RII of 0.733 while the client group ranked the delay fifth with an RII of 0.705.

Changes in government laws and regulations was ranked eighth overall and by the client and consultant groups with RIIs of 0.591, 0.657 and 0.542 respectively. The

‘Other’ group ranked the delay fifth with an RII of 0.700, while the contractor group ranked the delay ninth with an RII of 0.523.

Extreme weather conditions and other natural disasters was ranked ninth overall with an RII of 0.550. The contractor, ‘Other’ and consultant groups ranked the delay sixth, seventh and eighth with RIIs of 0.600, 0.467, and 0.542 respectively. The client group ranked the delay due to extreme weather conditions and other natural disasters tenth with an RII of 0.552.

The delay due to unforeseen ground conditions ranked tenth overall with an RII of 0.525, while it was ranked ninth in the client group with an RII of 0.600. The delay was ranked 11th by the consultant, contractor, and ‘Other’ groups with RIIs of 0.517, 0.492, and 0.367 respectively.

The delay due to municipal bylaw approvals ranked 11th overall and for the client group with RIIs of 0.503 and 0.476 respectively. The delay ranked seventh for the ‘Other’ group with an RII of 0.467. Both the consultant and contractor groups ranked the delay tenth with RIIs of 0.533 and 0.508 respectively.

The other causes of delays ranked last for all groups and consisted of the following comments by respondents:

- Socio- economic factors

This has been identified and discussed as external related causes of delays under community issues.

4.2.3.5 Analysis of overall major cause of delays

To get a holistic view of the most important causes of delays in road construction projects in South Africa, all causes of delays were analysed together and the top five causes of delays are presented in Table 4.5.

Table 4.5: A Review of the Top Five overall Causes of Delays in Road Construction Projects in South Africa

Ranking	Cause of Delay	Category of delay	RII
1	Unrest by local communities	External	0.8406
2	Stoppages of work by construction mafia/ neighbouring communities/ wards	External	0.8063
3	Delays due to regulatory approval processes	Client	0.7719
4	Poor engagement with local community	External	0.7625
5	Lack of acceptance of project by community	External	0.7563

In reviewing Table 4.5, external related causes of delays account for a significant 80% of the top five causes of delays. Only one (20%) of the top five identified causes of delays are client related with no consultant and contractor related causes of delays mentioned in the top five causes.

The number one ranked overall delay is unrest by the local communities followed by stoppages of work by construction mafia/ neighbouring communities and wards in second place. The delay due to regulatory approval by the client is ranked third. The external delays due to poor engagement with local community and lack of acceptance of the project by the community are ranked fourth and fifth respectively.

4.2.4 Analysis of effects of delays in road construction projects

The effects of delays in road construction projects were identified through a literature review on the subject and presented in the questionnaire for respondents to rank using a Likert scale from 1 (strongly disagree) to 5 (strongly agree). The data was analysed and ranked using the Relative Importance Index and presented in Table 4.6. Table 4.6 presents the overall ranking as well as the views of the client, consultant, contractor, and ‘Other’ group.

Table 4.6: Analysis of Effects of Delays in Road Construction Projects in South Africa

Effects of Delay	Overall Group		Client Group		Consultant Group		Contractor Group		Other Group	
Number of Respondents (N)	64		21		24		13		6	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Time overruns	0.822	1	0.886	1	0.817	1	0.785	1	0.700	2
Cost overruns	0.800	2	0.876	2	0.783	2	0.785	1	0.633	4
Disputes and claims between contract parties	0.753	3	0.810	3	0.708	3	0.754	3	0.733	1
Stress	0.653	4	0.705	5	0.617	4	0.677	4	0.600	7
Negative social impact/ Bad reputation	0.619	5	0.667	6	0.592	5	0.569	7	0.667	3
Arbitration	0.594	6	0.714	4	0.550	9	0.523	10	0.500	13
Idling of resources	0.594	6	0.667	6	0.550	9	0.569	7	0.567	9
Delays in paying back loans	0.584	8	0.590	13	0.575	6	0.615	5	0.533	10
Negative relationship development between client, consultant, and contractor	0.578	9	0.619	9	0.533	13	0.569	7	0.633	4
Poor quality of work due to rushing	0.575	10	0.581	14	0.558	8	0.585	6	0.600	7
Acceleration of losses	0.572	11	0.619	9	0.567	7	0.523	10	0.533	10
Litigation	0.559	12	0.619	9	0.542	11	0.508	12	0.533	10
Delay in profits	0.556	13	0.638	8	0.517	14	0.462	14	0.633	4
Bankruptcy	0.556	13	0.619	9	0.542	11	0.508	12	0.500	13
Total project abandonment	0.450	15	0.467	15	0.458	15	0.400	15	0.467	15
Other	0.022	16	0.029	16	0.033	16	0.000	16	0.000	16

The effect of time overruns ranked first overall and for the client, consultant, and contractor groups with RIIs of 0.822, 0.886, 0.817 and 0.785 respectively. The 'Other' group ranked this delay effect as second with an RII of 0.700.

Cost overruns was ranked second overall and by the client and consultant groups with RIIs of 0.800, 0.876, and 0.783 respectively. The contractor group also ranked cost

overruns as the number one effect of delays with an RII of 0.785 while the 'Other' group ranked the effect as fourth with an RII of 0.633.

The effect of disputes and claims between contract parties ranked third overall and for the client, consultant and contractor group with RIIs of 0.753, 0.810, 0.708 and 0.784 respectively. The 'Other' group ranked this delay effect as their first delay choice in road construction projects with an RII of 0.733.

The effect of stress ranked fourth overall and for the consultant and contractor groups with RIIs of 0.653, 0.617 and 0.677 respectively. The client group ranked this effect fifth with an RII of 0.705, while the 'Other' group ranked the effect seventh with an RII of 0.600.

Negative social impact/ bad reputation ranked fifth overall and for the consultant group with RIIs of 0.619 and 0.592 respectively. The effect ranked third for the 'Other' group with an RII of 0.667. The client and contractor groups ranked the effect sixth and seventh with RIIs of 0.667 and 0.569 respectively.

Arbitration ranked sixth overall as an effect of delays in road construction projects in South Africa with an RII of 0.594. The client group ranked this effect fourth with an RII of 0.714. The consultant and contractor groups ranked the effect ninth and tenth with RIIs of 0.550 and 0.523 respectively. The 'Other' group ranked the effect of arbitration 13^{th} with an RII of 0.500.

The effect of idling of resources ranked sixth overall and for the client group with RIIs of 0.594 and 0.667 respectively with both the consultant and 'Other' groups ranking the effect ninth with RIIs if 0.550 and 0.567 respectively. The contractor group ranked the effect seventh with an RII of 0.569.

The effect of delays in paying back loans ranked eighth overall with an RII of 0.584. The contractor and consultant groups ranked the effect fifth and sixth with RIIs of 0.615 and 0.575 respectively. The 'Other' group ranked the effect tenth with an RII of 0.533.

Negative relationship development between client consultant and contractor ranked ninth overall and for the client group with RIIs of 0.578 and 0.619 respectively. The 'Other' group ranked this effect of delay fourth with an RII of 0.633, while the contractor

group ranked the effect seventh with an RII of 0.569. The consultant group ranked the effect 13th with an RII of 0.533.

Poor quality of work due to rushing ranked tenth overall with an RII of 0.575. For the contractor, 'Other' and consultant groups the effect was ranked sixth, seventh and eighth with RIIs of 0.585, 0.600 and 0.558 respectively. The client group ranked this effect 14th with an RII of 0.581.

Acceleration of loses ranked 11th overall with an RII of 0.572. The consultant group ranked the effect seventh with an RII of 0.567 while the client group ranked the effect ninth with an RII of 0.619. Both the contractor and 'Other' groups ranked the effect tenth with RIIs if 0.523 and 0.533 respectively.

The effect of litigation ranked 12th overall and for the contractor group with RIIs of 0.559 and 0.508 respectively. The client group ranked the effect ninth with an RII of 0.619, while the 'Other' and consultant groups ranked the effect tenth and 11th with RIIs of 0.533 and 0.542 respectively.

The effect of delays in profit ranked 13th overall with an RII of 0.556. The 'Other' group ranked the effect fourth with an RII of 0.633, while the client group ranked the effect eight with an RII if 0.638. Both the consultant and contractor groups ranked the effect 14th with RIIs of 0.517 and 0.462 respectively.

Bankruptcy ranked 13th overall and for the 'Other' group with RIIs of 0.556 and 0.500 respectively. The client group ranked the effect ninth with an RII of 0.619. The consultant and contractor groups ranked the effect 11th and 12th with RIIs of 0.542 and 0.508 respectively.

Total project abandonment ranked 15th overall and for all groups. The RII overall was 0.450 while the RII for the client group was 0.467. The RIIs for the consultant, contractor and 'Other' group were 0.458, 0.400 and 0.467 respectively.

4.2.5 Analysis of measures to minimise delays in road construction projects

A total of 15 delay minimising measures were identified through a literature review and presented in the questionnaire for respondents to rank using the Likert scale. The responses received were analysed and ranked using the Relative Importance Index

and presented in Table 4.7. Table 4.7 presents the ranking of the views of the client, consultant, contractor, and 'Other' group.

Table 4.7: Analysis and Ranking of Delay Minimising Measures

Minimising Measures	Other Group		Client Group		Consultant Group		Contractor Group		Other Group	
Number of Respondents (N)	64		21		24		13		6	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Early engagement with the community	0.909	1	0.886	1	0.942	1	0.908	4	0.867	9
Improved communication with community	0.909	1	0.876	2	0.917	2	0.969	1	0.867	9
Improved management of subcontractors	0.884	3	0.800	7	0.900	4	0.908	4	0.867	9
Effective strategic planning by contractor	0.872	4	0.810	5	0.917	2	0.862	8	0.933	2
Timeous payment to contractor and consultant	0.866	5	0.752	13	0.883	5	0.954	2	1.000	1
Establishing clear communication channels	0.853	6	0.848	3	0.875	6	0.846	10	0.800	15
Improved collaboration between client, consultant, and contractor	0.853	6	0.819	4	0.850	10	0.892	6	0.900	4
Clients and consultants to approve variation orders on time	0.853	6	0.781	10	0.875	6	0.923	3	0.867	9
Effective management of construction site and supervision by contractor through site diaries	0.853	6	0.800	7	0.875	6	0.877	7	0.900	4
Consultants to ensure that drawings and documentation are submitted on time without any errors	0.834	10	0.771	12	0.875	6	0.846	10	0.867	9

Employing appropriate construction methods	0.825	11	0.781	10	0.842	13	0.831	13	0.900	4
Ensuring adequate training of project staff	0.822	12	0.800	7	0.808	14	0.846	10	0.900	4
Contractor to develop contingency plans in the event of strikes, shortages of material	0.822	12	0.810	5	0.800	15	0.831	13	0.933	2
Adherence to construction specifications	0.813	14	0.752	13	0.850	10	0.831	13	0.833	14
Contractors to ensure they have sufficient funding before starting the project	0.806	15	0.695	15	0.850	10	0.862	8	0.900	14
Other	0.075	16	0.162	16	0.058	16	0.000	16	0.000	16

The measure of early engagement with the community ranked first overall and for the client and consultant groups with RIIs of 0.909, 0.886 and 0.942 respectively. The contractor group ranked this measure fourth with an RII of 0.908, while the 'Other' group ranked the measure ninth with an RII of 0.867.

Improved communication with the community also ranked first overall and for the contractor group with RIIs of 0.909 and 0.969 respectively. Both the client and consultant groups ranked the delay second with RIIs of 0.876 and 0.917 respectively. The 'Other' group ranked the measure ninth with an RII of 0.867.

Improved management of subcontractors ranked third overall with an RII of 0.884 while both consultants and contractors ranked the measure fourth with RIIs of 0.900 and 0.908 respectively. The client group ranked the measure seventh with an RII of 0.800, while the 'Other' group ranked the measure ninth with an RII of 0.867.

Effective strategic planning by contractor ranked fourth overall with an RII of 0.872. Both the consultant and 'Other' groups ranked the measure second with RIIs of 0.917 and 0.933 respectively. The client group ranked the measure fifth with an RII of 0.810 while the contractor group ranked the measure eight with an RII of 0.862.

Timeous payment to contractor and consultant ranked fifth overall and for the consultant group with RIIs of 0.866 and 0.883 respectively. The 'Other' group ranked this measure first with an RII of 1.000 while the contractor group ranked the measure second with an RII of 0.954. The measure ranked 13th for the client group with an RII of 0.752.

The measure of establishing clear communication channels ranked sixth overall and for the consultant group with RIIs of 0.853 and 0.846 respectively. The client group ranked the measure third with an RII of 0.848. The contractor group ranked the measure tenth with an RII of 0.846, while the 'Other' group ranked the measure 15th with an RII of 0.800.

Improved collaboration between client, consultant, and contractor ranked sixth overall and for the contractor group with RIIs of 0.853 and 0.892 respectively. Both the client and 'Other' groups ranked the measure fourth with RIIs of 0.819 and 0.900 respectively while the consultant group ranked the measure tenth with an RII of 0.850.

Clients and consultants to approve variation orders on time ranked sixth overall and for the consultant group with RIIs of 0.853 and 0.875 respectively. The contractor group ranked this measure third with an RII of 0.923. The 'Other' and client group ranked this measure ninth and tenth with RIIs of 0.867 and 0.781 respectively.

Effective management of construction site and supervision by contractor through site diaries ranked sixth overall and for the consultant group with RIIs of 0.853 and 0.875 respectively. The 'Other' group ranked this measure fourth with an RII of 0.900. Both the client and contractor groups ranked the measure seventh with RIIs of 0.800 and 0.877 respectively.

The measure of consultants to ensure that drawings and documentation are submitted on time without any errors ranked tenth overall and for the contractor group with RIIs of 0.834 and 0.867 respectively. The consultant group ranked this measure sixth with an RII of 0.875, while the 'Other' group ranked the measure ninth with an RII of 0.867. The client group ranked this delay minimising measure 12th with an RII of 0.875.

Employing appropriate construction methods ranked 11th overall with an RII of 0.825. The 'Other' group ranked the measure fourth with an RII of 0.900 while the client group

ranked the measure tenth with an RII of 0.781. Both the consultant and contractor groups ranked the measure 13th with RIIs of 0.842 and 0.831 respectively.

The measure of ensuring adequate training of project staff ranked 12th overall with an RII of 0.822. The 'Other' group ranked this measure fourth with an RII of 0.900, while the client group ranked the measure seventh with an RII of 0.800. The contractor group ranked the measure tenth with an RII of 0.846 and the consultant group ranked the measure 14th with an RII of 0.808.

Contractor to develop contingency plans in the event of strikes, shortage of material staff ranked 12th overall with an RII of 0.822. The 'Other' group ranked this measure second with an RII of 0.933 while the client group ranked the measure fifth with an RII of 0.810. The contractor group ranked the measure 13th with an RII of 0.831 and the consultant group ranked the measure 15th with an RII of 0.800.

Adherence to construction specifications ranked 14th overall and for the 'Other' group with RIIs of 0.813 and 0.833 respectively. The consultant group ranked the measure tenth with an RII of 0.850. Both the client and contractor groups ranked the measure 13th with RIIs of 0.752 and 0.831 respectively.

The measure of the contractors to ensure they have sufficient funding before starting the project ranked 15th overall and for the client group with RIIs of 0.806 and 0.695 respectively. The contractor group ranked the measure eighth with an RII of 0.862 while the consultant group ranked the measure tenth with an RII of 0.850. The 'Other' group ranked the measure 14th with an RII of 0.900.

The other delays ranked last for all groups consisted of the following comments by respondents:

- Improved procurement process
- Ensure adequate technical capacity/experience/expertise amongst site staff for both Engineer and Contractor
- Early and rigorous engagement with community and local stakeholders appears to be delaying contracts more rather than less. This appears to stem from infighting amongst the stakeholders as well as the fact a higher percentage of the contract expenditure is demanded regardless of what percentage is offered

- There needs to be an understanding from leadership as to how their decisions (or indecision) affect operations.

4.3 Data Analysis

The statistical significance of the views of all stakeholders was tested using the Kruskal-Wallis Test for the major causes, effects and minimising measures of road construction delays identified in this research. The Chi-square test was used to test the research hypothesis. The following sections present the data analysis and test of the research hypothesis.

4.3.1 Major causes of delays in road construction projects in South Africa

The Kruskal-Wallis test was used to determine any statistically significant difference across the views of client, consultant, contractor, and 'Other' groups for the top five major causes of road construction project delays in South Africa. The results are presented in Table 4.8. The test was carried out at the 5% confidence level.

Table 4.8: Kruskal-Wallis Test Statistics for the Top Five Major Causes of Road Construction Project Delays

Top Five Major Causes of Delays	
Kruskal- Wallis H	.679
Df	3
Asymp. Sig.	.878

Kruskal- Wallis Test
Grouping Variable: All Project Stakeholders

The Kruskal-Wallis test shows that there is no statistically significant difference in the scores of the top five major causes of road construction project delays amongst all project stakeholders ($X^2(3) = 0.679$, $p = 0.878$). The calculated Kruskal-Wallis H value of 0.679 is lower than the critical value of 7.815 for three degrees of freedom and the calculated *p*-value of 0.878 is greater than the significance level of 0.05. Therefore, the distribution of the top five major causes of delays is the same across the views of all project stakeholders.

4.3.2 Major effects of delays in road construction projects in South Africa

The Kruskal-Wallis test was used to determine any statistically significant difference across the views of client, consultant, contractor, and 'Other' groups for the top five effects of causes of road construction project delays in South Africa. The results are presented in Table 4.9. The test was carried out at the 5% confidence level.

Table 4.9: Kruskal-Wallis Test Statistics for the Top Five Major Effects of Road Construction Delays

Top five major effects of Delays	
Kruskal-Wallis H	5.042
Df	3
Asymp. Sig.	.169

Kruskal- Wallis Test
Grouping Variable: All Project Stakeholders

The Kruskal- Wallis test shows that there is no statistically significant difference in the scores of the top five major effects of road construction project delays amongst all project stakeholders ($X^2(3) = 5.042$, $p = 0.169$). The calculated Kruskal-Wallis H value of 5.042 is lower than the critical value of 7.815 for three degrees of freedom and the calculated *p*-value of 0.169 is greater than the significance level of 0.05. Therefore, the distribution of the top five major effects of delays is the same across the views of all project stakeholders.

4.3.3 Major delay minimising in road construction projects in South Africa

The Kruskal-Wallis test was used to determine any statistically significant difference across the views of client, consultant, contractor and 'Other' groups for the top five delay minimising measures for road project construction delays in South Africa. The results are presented in Table 4.10. The test was carried out at the 5% confidence level.

Table 4.10: Kruskal-Wallis Test Statistics for the Top Five Delay Minimising Measures for Road Construction Delays

Top Five Delay Minimising Measures	
Kruskal- Wallis H	8.016
Df	3
Asymp. Sig.	.046

Kruskal- Wallis Test
Grouping Variable: All Project Stakeholders

The Kruskal-Wallis test shows that there is a statistically significant difference in the scores of the top five delay minimising measures of road construction project delays amongst all project stakeholders ($X^2(3) = 8.016$, $p = 0.046$). The calculated Kruskal-Wallis H value of 8.016 is higher than the critical value of 7.815 for three degrees of freedom and the calculated *p*- value of 0.046 is lower than the significance level of

0.05. Therefore, the distribution of the top five minimising measures of delays is not the same across the views of all project stakeholders

4.3.4 Testing of hypothesis

The Chi-square test was used to test the research hypothesis by comparing the observed and expected responses at 4 degrees of freedom and a 5% level of confidence. The results of the Chi- square tests are presented in Table 4.11. The research hypothesis is given as:

H_1: *External-related causes of delays are more significant contributors to construction project delays in South Africa than client, consultant, and contractor related causes.*

Table 4.11: Testing for Hypothesis using Chi-square Test

Cause of Delay	Client-related	Consultant-related	Contractor-related	External-related
Chi-square	31.94	34.28	48.03	54.13
Critical Chi-square	9.488	9.488	9.488	9.488

The calculated Chi-square values for all categories of causes of road construction delays presented in Table 4.11 are greater than the critical Chi-square value at 4 degrees of freedom and 5% level of confidence. Since the calculated Chi-square for external-related causes of 54.13 is greater than the client-related (31.94), consultant-related (34.28) and contractor related (48.03) groups, and it is greater than the critical value of 9.488 at 4 degrees of freedom and 5% level of confidence, the null hypothesis can be rejected, and the alternative hypothesis can be accepted.

4.4 Discussion of Findings

The results presented in the previous sections are discussed generally according to respondents' personal information and project information to form the basis for the study. This is followed by a detailed discussion of the results based on the four objectives of the study.

4.4.1 Discussion of respondents' age, gender, and project information

The gender analysis implies that although there is a gender representation in the study, the responses are influenced by the dominant view of the male respondents. The higher level of male respondents than female respondents was expected as the study population has a history of being predominantly male. It is positive to see the 30% female responses, indicating the increase in females joining the construction industry.

The age analysis is significant as is shows that respondents have a considerable amount of life experience and maturity in responding to the questionnaire, with 83% over the age of 30 years old. It is encouraging to see that 17% of respondents below the age of 30 took an interest in the study to attain its objectives and improve the performance of road construction projects in South Africa by identifying and reducing delays through suitable mitigation measures.

The project role and category of respondents indicates that there is a distribution between the three main stakeholder groups, that is the Client, Consultant and Contractor groups, while the 'Other' group consisting of external stakeholders who were ignored in previous studies, is represented in this study.

The results of the analysis of the experience of respondents shows that more than half of the respondents (54.7%) have a significant amount of experience of being involved in the road construction industry and are thus able to provide valuable responses to attain the objectives of this study. This was substantiated by 78% of respondents who had completed more than two projects in the last five years providing them with valuable insight into the causes and effects of road construction delays in South Africa and what measures can be adopted to minimise the delays.

Eight of the nine provinces in South Africa are represented in this study. Therefore, this study provides a holistic view of the causes and effects of delays in road construction projects in South Africa. Any recommendations made in this study can be applied nationally.

The high number of new works, upgrades and strengthening types of projects submitted is beneficial for the purpose of the study, as these projects are known to be complex and require substantial amounts of financial, time and human resources to

complete. Although Routine Road Maintenance projects may not require as substantial financial resources, they have their own complexities with regard to management of resources and subcontractors. The high number of submissions of these two different project types provides a broader evaluation of project delays and effects in South Africa Road construction projects.

The results in this study indicate that the occurrence of delays is present in road construction projects in South Africa and occur during the design and construction phase. Delays are a major issue in road construction projects in South Africa and therefore the need for this study. A total of 26.6% of the projects submitted indicated that delays occurred during the design and construction phase. In most projects, the delay in the design phase is carried forward into the construction phase. This result supports the statement by Halim and Zin (2016) that delays during the planning and design phase are not isolated from the construction phase; however, they are not concurrent.

4.4.2 Discussion of causes of delays in road construction projects

There are many causes of delays in road construction projects as indicated in the studies by Divya and Ramya (2015), Kamanga and Steyn (2013), and Sambasivan and Soon (2007), and several studies such as those of Twana (2015) and Khair et al. (2016), indicated the geographical isolation of these delays. The causes of delays are discussed according to the client related, consultant related, contractor related, and external related causes. An overall view of the top five major causes of delays in road construction projects in South Africa is also presented and discussed. Moreover, the Kruskal-Wallis Test has revealed that there is no statistically significant difference in the scores of top five major causes of road construction project delays amongst the views of all project stakeholders.

4.4.2.1 Discussion of client related causes of delays

Among the client related causes of delays, delays due to regulatory approval processes was ranked first with an RII of 0.772, followed by delay in decision making by the client with an RII of 0.647. The delay in reviewing and approving drawings and documentation was ranked third with an RII Of 0.609, with changes in design by the client ranked fourth with an RII of 0.581 and the fifth ranked client related delay was changes in the project scope by the client with an RII of 0.578.

The delay due to regulatory approval, ranked first as a client related delay was identified after the pilot review of the questionnaire by experts in the industry. The main factor contributing to this cause is the delay in finalising the tender proforma document. SANRAL is a state-owned entity that awards work through the tender process. Each element of the project whether design, construction, environmental, health and safety or drilling gets awarded via tender. Without a proforma tender document, the work cannot be awarded, and progression of work is affected resulting in the project experiencing delays. This is further supported by the comments of one respondent which stated “delay in procurement” under the reason of other causes of delays not listed in the questionnaire. This delay was not identified in the literature review or identified through the pilot testing of the questionnaire.

Delays ranked second and third are closely related and involve the decision making by the client. The results indicate that delays in the client making decisions (ranked second) regarding the project implementation impacts on its schedule and causes project delays. This is supported in the findings by Assaf and Al- Hejji (2006) that agree that clients’ delays in decision making is a major cause of construction delays. The slow decision making includes the delay in reviewing and approving drawings and documentation ranked third. This result is similar to the study by Mukuka et al. (2013) which ranked delay in reviewing and approving documentation fifth as a client related cause of delay. The severity of the cause of delay due to slow decision making is so high that Seboru (2015) concluded that clients should remove bureaucracy and red tape when making decisions.

Delays ranked fourth and fifth are related in terms of changes during the design and construction phase. This involves the changes to the design and/ or scope of the project. These findings agree with Bekr (2018); Muhwezi et al. (2014) and Owolabi et al. (2014); who all identify changes in project scope or changes in design by the client as major causes of construction project delays. The impact of these delays is intensified when a percentage of the project is already complete or resources are already procured and then the client changes the project scope, or design, during the construction phase. The project construction schedule is determined by the complexity of the design and a change in deign results in the development of a new schedule that can have an extended project completion date. The difference in schedule is classified as the delay. Owolabi et al. (2014) conclude that changes in the mindset of clients on

the design and request for change during construction are major obstructions impacting the project schedule that cannot be ignored.

4.4.2.2 Discussion of consultant related causes of delay

Errors in the contract documents were ranked number one with an RII of 0.575 followed by poor communication by the consultant between the client and contractor, ranked second with an RII of 0.566. The delays due to unclear and inadequate details in construction drawings and inadequate experience and skills of the consultant were both ranked third with an RII if 0.563, while delay due to changes in design during construction drawings was ranked the fifth consultant related cause of construction project delays.

The result of errors in contract documentation as the first ranked consultant related cause of delay is in total agreement with Bekr (2018), whoalso ranked errors in design and contract documentation as the most influencing delay causing factors that are consultant related. Errors in documentation result in misunderstanding of the scope of work, unclear communication/ transfer of information and incorrect project implementation. This requires rework of completed work which results in project delays. Errors in drawings and documentation may also result in a delay in standing time by the contractor awaiting clarity and correction of information.

Poor communication, ranked second in this study, supports the findings of Assaf and Al-Hejji (2006) and Owolabi et al. (2014). These authors conclude that poor communication is a major issue and can contribute to project delay. Poor communication impacts the flow of information, resulting in the objectives of the client not being met or site instructions not being clearly communicated, and the incorrect work being completed. There are also issues with feedback on project progress or problems arising that, if effectively communicated, could have been avoided or their impact reduced.

The delays ranked third both relate to the lack of experience by the consultant which results in the production of unclear and inadequate construction drawings. This is supported by the studies of Assaf and Al-Hejji (2006) as well as Motaleb and Kish (2012) who identify the experience of the consultants as a major cause of delay. With a lack of experience, consultants face technical challenges on the project that take

time to learn and apply. This results in a delay in project progression while the consultant gains knowledge and experience to solve the issue.

The delay in **c**hanges in design during construction by the consultant ranked fifth as a consultant related cause of delays is linked to the fourth and fifth client related delays due to changes in project scope and changes in design. The delay in approval of changes is rippled through to consultants who take time in implementing the changes by the client that result in the delay occurring. Although this delay was identified by the experts through the pilot questionnaire, the finding is also similar to studies by Wei (2010) and Traurner et al. (2009), where delay in approving and implementing scope changes is the major consultant related cause of delay that was ranked sixth in this study.

4.4.2.3 Discussion of contractor related causes of delay

Ranked first for contractor related causes of delays is the poor management of subcontractors with an RII of 0.7156. This is followed by employee strikes and late payment to subcontractors with RIIs of 0.6813 and 0.6563 respectively. The fourth ranked cause of delay is poor management and supervision by contractor with an RII of 0.6500 and the fifth ranked cause of delay is cash flow difficulties by the contractor with an RII of 0.6469.

The top five causes of contractor related delays can be grouped into two themes, which are management and supervision and financial difficulties. The financial difficulties are due to cash flow problems by the contractor (ranked fifth) that result in late payment to subcontractors (ranked third), site staff (employees) amongst other things. The second theme of poor management and supervision (ranked fourth) also includes the poor management of subcontractors (ranked first). This poor management and late payment to subcontractors and other site staff results in employee strikes (ranked second).

The delay due to poor management of subcontractors (ranked first) is supported by the study by Bekr (2018). In South Africa, subcontractors are Grade 1 to Grade 6 CE, who have very little knowledge in the construction industry. They are start-up construction firms looking to join the industry. It is therefore critical to provide them with sufficient support, training, and supervision in completing the work. Poor

management of these subcontractors will result in construction project delays as seen in the results in this study.

Employee strikes (ranked second) was identified after the pilot survey with experts in the field and included in the questionnaire. This is due to mismanagement of the contractor's staff including the subcontractors which is a major cause of delay as indicated by the high ranking. It is also due to late payment of subcontractors (ranked third) which impacts their cash flows and ability to build and develop their businesses. Late payment to subcontractors was also identified as a cause of delay by Aziz and Abdel-Hakam (2016); however, the authors ranked it third in the finance group of causes of project delays.

Poor management and supervision by the contractor during construction, ranked fourth in this study, supports the findings by Bekr (2018), who ranked it as the first cause of delay for large public construction projects. Construction projects require proper planning before the start of the project and proper management and supervision ensuring that work is completed according to the plan. Poor planning and supervision result in deviations from the plan and delays occurring. This finding is also in agreement with the findings by Mukuka et al. (2013) who identify poor management and supervision as a cause of construction project delays.

The fifth ranked contractor related cause of delay, difficulties in contractors' cash flow are in agreement with studies by Odeh and Battaineh (2002), and Sweis et al. (2008) who identify contractors' cash flow difficulties as a leading cause of delays. As discussed earlier, this factor results in many other causes of construction project delays. The cash flow difficulties result in delayed payments for the necessary construction materials, salaries for contractors' employees and subcontractors, equipment servicing and repairs. All these are critically required to avoid construction project delays.

4.4.2.4 Discussion of external related causes of delay

The top four external related causes of delays listed in order of rank include unrest by local communities with an RII of 0.8406, followed by stoppages of work by construction mafia/ neighbouring communities/ wards with an RII of 0.8063, poor engagement with local community with an RII of 0.7625 and lack of acceptance of the project by the

community with an RII of 0. 7563.The fifth ranked external cause of delay is land acquisition delays with an RII of 0.6344.

The central cause of external related delays from the analysis is due to community issues. This includes poor engagement with the community (ranked third) informing them about the project and listening to the needs and request of the community. This leads to a lack of acceptance of the project by the community (ranked fourth) and no ownership of the project. To vent their frustration, the community/ies resort/s to unrest and stoppages of work (ranked first and second) until their requests are heard. The delays arise from the time spent in negotiations with the community addressing their grievances. These finding agree with Mashwama et al. (2018) who also completed their study in South Africa and concluded that community unrest was the highest ranked factor that was of major concern to all project stakeholders. They are also in agreement with the findings of another study in South Africa by Rathenam and Dabup (2017), which concluded that the local community proved to be a major factor on the project that resulted in the projects experiencing delays. The results due to stoppage of works support earlier studies by Oshungade and Kruger (2017) which state if certain wards in the community are not benefiting from employment on the construction project, they stop the work, and this results in project delays until grievances are rectified.

Delays due to land acquisition ranked fifth in external related causes of delays and supports an earlier study by Motlhatlhedi and Nel (2019) where the issue scored 40% as an identified cause of delay in project in South Africa. This is also in agreement with Soni and Punjabi (2018) who found land aquistion as an important cause of project delays.

4.4.3 Discussion of effects of delays in road construction projects

The analysis revealed time overruns, ranking it first with an RII of 0.822 followed by cost overruns with an RII of 0.800. The third ranked effect of delays is disputes and claims between contract parties with an RII of 0.753. This is expected as the impact of the time and cost overruns must be absorbed by the project stakeholders and determining the responsible party leads to issuing of claims and disputes. The effect of stress was ranked fourth with an RII of 0.653. This is also expected because as seen earlier, delays and cost overruns are significant within road construction projects

and create stress for the stakeholders involved. The effect of negative social impact/ bad reputation was ranked fifth with an RII of 0.619 and this is due to the project not being completed on time and benefits whether social or economic not being gained.

The effect of time overruns may not occur on all projects as with non-critical delays that do not impact on the project schedule. However, it was ranked first in this study and is in agreement with studies by Aibinu and Jagboro (2002); Khair, et al. (2016) and Youniss, et al. (2018) who identify time overruns as an effect of project delays in South Africa.

The results show that cost overruns were ranked as the second highest effect of project delays. This is further validated by the responses received and analysed for percentage difference in actual and planned cost in Figure 4.3 and Figure 4.4 above. This finding agrees with Kikwasi (2012); Khair, et al. (2016) and Sunjka and Jacob (2013) who attribute cost overruns to delays due to changes in scope of work, issuing of incomplete drawings, inadequate or lack of planning and monitoring, and contractual claims.

The effect of disputes and claims ranked third supports earlier studies by Aibinu and Jagboro (2002); Ahmed at al. (2002) and Youniss et al. (2018) who identified the same result as an effect of construction project delays. This is due to the delay having budget and schedule implications, and the responsible stakeholder must take responsibility and absorb the consequences of the delay. The identification of the delay leads to disputes and claims occurring.

Stress ranked fourth by respondents as an effect of delays is due to many reasons which include increase in project cost, loss of profits, negative reputation, increased workload to meet schedule amongst other things. This finding is in agreement with Kamanga and Steyn (2013) and Oshungade and Kruger (2017) who state that the need for additional resources, fear of loss and bankruptcy create stress for project stakeholders.

Negative social impact ranked the fifth effect of delays in this study is in agreement with earlier studies by Kikwasi (2012) and Sunjka and Jacob (2013). Due to the project's delay, external stakeholders do not receive the benefits intended from the completion of the project and develop a negative reputation from the project and its

internal stakeholders. The effect of disputes and claims between internal stakeholders can create negative future working relationships and bad reputations for the parties involved.

The Kruskal-Wallis test reveals that there is no statistically significant difference in the score of the top five major effects of road construction project delays amongst the views of all project stakeholders.

4.4.4 Discussion of delay minimising measures

There were two minimising measures ranked first, which are early engagement with the community and improved communication with the community both ranked with an RII of 0.9094. These two methods are linked, and relate, to early and continuous engagement with the communities ensuring that they are heard, and their requests are met through the implementation of the project. These finding are , in agreement with the study by Rathenam and Dabup (2017). It is through communication and engagement with the community that one identifies and understands the needs of the community, the impact the project has on the community and the impact the community can have on the project and influence its outcome.

The third rank minimising measure was improved management of subcontractors with an RII of 0.8844. This result agrees with the findings of Aziz and Abdel- Hakam (2016) and Khoiry et al. (2018). Subcontractors employed to complete a portion of the construction work may not have the technical experience and expertise of the main contractor and therefore require improved management techniques which guide and mentor them. This reduces the delay caused by rework, slow production rates and completion of work using incorrect construction methods.

The fourth ranked measure was effective strategic planning by the contractor with an RII of 0.8719. This finding is similar to the conclusion of Divya and Ramya (2015) and Meena and Babu (2015). Strategic planning ensures that focus is placed on critical items while less critical items are not given as much importance. This ensures that time is not wasted on non- critical aspects during project implementation.

The fifth ranked measure for minimising delays with an RII of 0.8656 was timeous payment by the client to the consultant and contractor. This result supports earlier findings by Mahamid et al. (2012) and Seboru (2015). The timeous payments by the

client will assist the contractors in managing their cash flow and making the required payments for all labour and material resources.

The Kruskal-Wallis test reveals that there is a statistically significant difference in the score of top five delay minimising measure for road construction project delays amongst the views of all project stakeholders.

4.4.5 Discussion of test of hypothesis

The Chi-square test was used to test the hypothesis. The results of the RII ranking of the top five major causes of delays identified in Table 4.5 reveal that four out of five delays are external-related. This was proved to be dependable by the results of the Chi-square test in Table 4.11 and the alternate hypothesis can be accepted. Thus, external-related causes of delays are more significant contributors of construction project delays in South Africa than client, consultant, and contractor related causes.

4.5 Conclusion

This chapter reviewed the data received from respondents in the questionnaire to meet the objectives of the study. The focus areas of the chapter included the analysis of causes of delays in road construction projects, effects of the causes of delays, and measures to minimise the delays. The results were comprehensively addressed and discussed so conclusions and recommendations can be drawn from the study.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the research and highlights the major findings of the research. It also provides a conclusion of the study in respect of the study's objectives and provides recommendations. Finally future research areas identified through this study are mentioned.

5.2 Summary of Major Findings

The study aimed at answering the research questions on the main causes and effects of delays on road construction projects in South Africa, through addressing the following objectives:

1. Identify the most important causes of delay in road construction projects commissioned by SANRAL from the viewpoint of the project stakeholders;
2. Determine the effects of the delays in road construction projects governed by SANRAL;
3. Find out whether external-related causes of delays are more significant contributors to construction project delays in South Africa than client, consultant, and contractor related causes, and;
4. Recommend measures for minimising delays in road construction projects in South Africa.

The major findings are summarised in the sections below.

5.2.1 Summary of major delay causes in road construction projects commissioned by SANRAL from the viewpoint of the project stakeholders

The review of relevant literature about causes of construction delays identified 42 causes of delays. These delays were presented in a pilot questionnaire given to experts in the field of road construction projects. The comments received were evaluated and added to the list resulting in a total of 47 causes of delays categorised into four major groups: client-related, consultant-related, contractor-related, and external-related causes. The causes for each group were analysed statistically and ranked using their Relative Importance Index. The results showed that the five overall causes of delays in road construction projects in South Africa, distributed according to

four from the external related category, one from the client related category and none from the consultant and contractor related categories from a ranking perspective are: unrest by local communities; stoppages of work by construction mafia/ neighbouring communities/ wards; delays due to regulatory approval processes; poor engagement with local community; and lack of acceptance of project by community.

5.2.2 Summary of major effects of delays in road construction projects governed by SANRAL

A total of 15 effects of delays on road construction projects was identified through a review of relevant literature and presented in the questionnaire. The respondents were asked to rank their agreement with the identified effects using the Likert Scale from 1 (strongly disagree) to 5 (strongly agree). The responses received were analysed and ranked using the Relative importance Index and the top five major effects of delays were identified in order of ranking as follows: time overruns; cost overruns; disputes and claims between contract parties; stress; and negative social impact/ bad reputation.

5.2.3 Summary of major measures for minimising delays in road construction projects in South Africa

The research explored measures that could be adopted to minimise delays in South African Road construction projects. A total of 15 minimising techniques were identified and presented in a questionnaire utilising a Likert Scale for respondents to rank. The responses received were analysed and ranked based on the Relative Importance Index. The five major methods of minimising delays were identified in ranking perspective as follows: early engagement with the community; improved communication with community; improved management of subcontractors; effective strategic planning by contractor; and timeous payments to contractor and consultant.

5.2.4 Summary of hypothesis

The Chi-square test was used to test the research hypothesis. The result of the Chi-square test revealed that while all calculated Chi-square values for the different categories of causes of delays are higher than the critical values, the external- related causes had the highest Chi-square value. Therefore, the hypothesis was true that external-related causes of delays are more significant contributors to construction project delays in South Africa than Client, Consultant, and Contractor related causes.

5.3 Conclusion

This study aimed at identifying the causes and effects of road construction project delays pertinent to the South African road construction environment and presenting measures for minimising these delays. Although there is published literature on the topic under study, very little is published in South Africa and on SANRAL commissioned projects. The published literature also excludes the views of external stakeholders such as public liaison officers and community specialists on the causes and effects of road construction delays. This study addressed these previous gaps and included the views of external project stakeholders and presents findings on the causes and effects of road construction delays in South Africa and methods to minimise delays.

The first objective sought to identify the most important causes of delays in road construction projects commissioned by SANRAL from the viewpoint of the project stakeholders. The top five major causes of road construction project delays included four external-related delays, one client-related delay while there were no consultant and contractor related causes of delays identified. The Kruskal-Wallis test reveals that there was no statistically significant difference in the views of all project stakeholders. This concludes that the major causes of road construction project delays in South Africa are mainly external-related and due to community issues. This includes poor communication with the community and a lack of acceptance of the project that results in unrest and ultimately project delays.

The second objective sought to determine the major effects of delays in South African road construction. The study revealed that the major effects of delays are time overruns and cost overruns. The Kruskal-Wallis test indicates no statistically significant difference in the views of all project stakeholders.

The study aimed at determining whether external-related causes of delays are more significant contributors to construction project delays in South Africa than client, consultant, and contractor related causes. This was tested through the research hypothesis and was tested using the Chi-square test. The results reveal the calculated Chi-square value being greater than the critical value at 4 degrees of freedom and 5% confidence level. It was concluded that external-related causes of delays are more significant than client, consultant and contractor, causes of delays.

The last objective aimed at recommending measures for minimising road construction project delays in South Africa. The research highlighted major delay minimising measures that are centred around addressing community issues and this formed the basis for the recommendations of this research. The research also revealed that timeous payment by the client to the contractor and consultant will assist in reducing construction project delays. The Kruskal- Wallis test reveals a statistically significant difference between the views of stakeholders for the five major delay minimising measures. This is mainly to the 'Other' group that had different views on delay minimising measures.

In summary, the study confirmed that the occurrence of delays in road construction projects in South Africa is an issue and of concern. The main contributor to these delays is external-related causes and involve community issues. Finally, the study provides recommendations in addressing the five major causes of delays in road construction projects in South Africa.

5.4 Recommendations

This section of the study presents the researcher's recommendations that were gathered through the study. The recommendations of this study are:

1. Early involvement of the community in the project through the establishment of community liaison meetings and the establishment of a Public Liaison Committee (PLC) could prove beneficial for the project. Any concerns of the community should be addressed through the PLC without disrupting the project's schedule.
2. Improved management and supervision of site by the contractor to minimise delays on road construction projects. Through improved management and supervision, the contractor can better manage the site staff and subcontractors, ensuring that the most appropriate construction methods are used, work is completed according to drawings and reworks are avoided, ensuring that the project is completed within schedule, on budget and of the quality acceptable to the client.

3. SANRAL should improve its bureaucracy in administrative measures and improve the time it takes to make a decision with regard to the proformas and tendering criteria.
4. Clients should ensure that timeous payments are made to consultants and contractors for completed work. This will assist contractors with cash flow, allow them to pay site staff and subcontractors on time and reduce the identified delays of employee strikes and late payment to subcontractors. It will also assist contractors in the payment of material and for the servicing and maintenance of equipment.
5. Contractors should employ improved strategic planning techniques. This will equip the contractor to identify critical and non-critical aspects on the project's schedule and plan better, allow more time and resources for the critical items. This minimises or reduces the effect should a delay occur on the project.

5.5 Suggestions for Future Research

This section of the chapter presents suggestions for future research. Upon analysis of the data critical findings emerged that aim at offering suggestions for future research. These are:

1. Future research on the involvement of the local community in road construction projects in South Africa.
2. Development of a framework for improved management and supervision of road construction projects in South Africa.
3. The causes of delays due to changes in project management, resolving of claim and funding issues which are important causes of delays and should be investigated.

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APPENDIX A: QUESTIONNAIRE USED IN STUDY

Questionnaire

CAUSES AND EFFECTS OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SOUTH AFRICA

Faheem Vahed

Supervisor:
Prof Abimbola Windapo

June 2021

Introduction

My name is Faheem Vahed and I am conducting research towards a master's degree. I am investigating CAUSES AND EFFECTS OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SOUTH AFRICA and would like to invite you to participate in the project.

This study aims to investigate the causes and effects of delays in road construction projects in South Africa towards a better understanding and improved management of the delays.

Any insights gained from your participation will be extremely useful in explaining the causes and effects on delays in road construction projects in South Africa. It will contribute to the body of knowledge assisting stakeholders in delay identification and mitigating measures that will assist in ensuring that projects are completed within schedule, budget, and quality. This study will assist policymakers such as SANRAL and the National Department of Transport in formulating appropriate strategies that address and reduce road construction delays that can be adopted at a national level.

This research is for submission to the Department of Construction Economics and Management for the fulfilment of the requirement for the award of the MSc in Project Management at the University of Cape Town under the supervision of Professor Abimbola Windapo.

This research does not pose any known risk and participants confidentiality and anonymity will be maintained throughout the study. Data and information received will be exclusively used of research only.

The questionnaire should take 20 minutes to complete, and any queries/ concern can be addressed to me via email on vhdfah001@uct.ac.za.

Thank you for your assistance and participation.

15/07/2021

Faheem Vahed (Researcher)

Prof Abimbola Windapo (Supervisor)
21 July 2021

Instructions

Please complete Section A, B, C and D of the questionnaire. Please read each question and select by ticking the most appropriate box.

Section A: Profile of Respondents and Project Information

Kindly indicate your Gender.

Male	Female

1. Please indicate your age

20-25	26-30	31-35	36-40	41-45	46-50	51-55	55-60	60+

2. Please specify **role in the project/ organization type**

Client	Consultant	Contractor	Other

3. Please specify your **job title/ designation**

Project Manager
Project Leader
Contract Engineer
Design Consultant
Resident Engineer
Construction Manager
Contract Manager
Contracts Engineer
Assistant Resident Engineer
Project Liaison Officer
Community Development Specialist
Other- Specify

4. Please indicate your **number of years of relevant work experience** in the road construction industry (e.g. 20 years) ……

5. Kindly indicate the **number of road construction projects** you were involved in the last five years (e.g 5) ……number

Kindly identify a project you have been involved with in SANRAL over the last five years, and use that information in answering the following questions:

6. Kindly indicate the **province** in which the project was located (e.g KZN)……

7. Please indicate the **type** of project

Capex (New works, Upgrades, Strengthening)
Opex (Periodic Maintenance)
Special Maintenance
Periodic maintenance
Routine road maintenance
Community development

8. Please complete the table below on Project Performance on identified project

	Design Phase	Construction Phase
Planned Cost (ZAR)		
Actual Cost (ZAR)		
Planned Duration (months)		
Actual Duration (months)		

9. Was there delay on the project identified during the design phase?

   Yes

   No

   If yes, for how long was the project delayed (e.g. months).....

10. Was there delay on the project identified during the construction phase?

    Yes

    No

    If yes, for how long was the project delayed (e.g. months).....

11. What percentage of the project was subcontracted (e.g 30%)

Design phase	
Construction Phase	

Section B: Causes of Delay

The following are causes of delay of construction projects. Kindly indicate your **level of agreement** with each of these causes of delays on a Likert scale of 1 to 5, where 1= Strongly Disagree; 2= Disagree; 3= Undecided; 4= Agree and 5= Strongly Agree

1. Client Related causes of delay

	Causes of delay	1	2	3	4	5
1.	Delay in payment by client					
2.	Changes in project scope by the client					
3.	Changes in design by the client					
4.	Delay in reviewing and approving drawings and documentation					
5.	Delay in decision making by client					
6.	Poor communication by client					
7.	Delays due to regulatory approval processes					
8.	Delays as a result of Employer Risk in terms of the FIDIC Conditions of Contract for Construction Work					
9.	Other please specify.					

2. Consultant Related causes of delay

	Causes of delay	1	2	3	4	5
1.	Delays in performing inspections and testing					
2.	Delays in implementing changes to scope of work					
3.	Delays in preparing design, drawings and documentation					
4.	Errors in the contract documentation					
5.	Inadequate experience/skills of consultants					
6.	Unclear and inadequate details in construction drawings					
7.	Poor communication between client and contractor					

8.	Changes in design during construction					
9.	Conflict between consultant and contractor					
10.	Other please specify.					

3. Contractor Related causes of delay

	Causes of delay	1	2	3	4	5
1.	Cash flow difficulties by the contractor					
2.	Poor management and supervision by contractor					
3.	Poor management of subcontractors					
4.	Late payment to subcontractors					
5.	Inefficient planning and scheduling of project					
6.	Poor management of materials					
7.	Delay in material delivery					
8.	Shortage of materials in market					
9.	Change in material type during construction					
10.	Poor management of equipment					
11.	Equipment breakdown					
12.	Low level of equipment operator's skill					
13.	Unavailability of equipment					
14.	Inadequate contractor experience					
15.	Low level of productivity					
16.	Technical issues faced by contractor					
17.	Improper construction methods					
18.	Rework due to mistakes during construction					
19.	Employee Strikes					
20.	Other please specify.					

4. External Related causes of delay

	Causes of delay	1	2	3	4	5
1.	Poor engagement with local community					
2.	Lack of acceptance of project by community					
3.	Unrest by local communities					
4.	Stoppages of work by construction mafia/ neighbouring communities/ wards					
5.	Changes in government laws and regulations					
6.	Political interference					
7.	Delays in obtaining permits/ approvals from DFFE/ DMR					
8.	Land acquisition delays					
9.	Municipal bylaw approvals					
10.	Extreme weather conditions and other natural disasters					
11.	Unforeseen ground conditions					
12.	Other please specify.					

Section C: Effects of Delay

The following are effects of delay of construction projects. Kindly indicate your level of agreement with each of these effects on a scale of 1 to 5, where 1= Strongly Disagree; 2= Disagree; 3= Undecided; 4= Agree and 5= Strongly Agree

	Effects of delay	1	2	3	4	5
1.	Cost overruns					
2.	Time overruns					
3.	Disputes between contract parties					
4.	Claims					
5.	Mediation					
6.	Adjudication					
7.	Litigation					
8.	Idling of resources					
9.	Total project abandonment					
10.	Termination of contract					
11.	Delay by client in paying back loans					
12.	Delay in Profits					
13.	Business Rescue					
14.	Bankruptcy					
15.	Poor quality of work due to rushing					
16.	Negative relationship development between client consultant and contractor					
17.	Negative social impact/ Bad reputation					
18.	Others, please specify					

Section D: Measures to minimise Delay on construction projects

The following lists measures taken to minimise delays on construction projects available in literature. Kindly indicate your **level of agreement** with each of these measures employed to minimise delay on a Likert scale of 1 to 5, where 1= Strongly Disagree; 2= Disagree; 3= Undecided; 4= Agree and 5= Strongly Agree

	Measures to minimise delays	1	2	3	4	5
1.	Effective management of construction site and supervision by contractor through site diaries					
2.	Effective strategic planning by contractor					
3.	Early engagement with the community					
4.	Improved communication with community					
5.	Improved management of subcontractors					
6.	Employing appropriate construction methods					
7.	Adherence to construction specifications					
8.	Establishing clear communication channels					
9.	Improved collaboration between client, consultant and contractor					
10.	Ensure adequate training of project staff					
11.	Contractor to plan to unforeseen delays eg strikes					
12.	Contractor to develop contingency plans in the event of strikes, shortage of material					
13.	Contractor to ensure they have sufficient funding before starting the project					
14.	Consultants to ensure that drawings and documentation are submitted on time without any errors					
15.	Clients and consultants to approve variation orders on time					
16.	Timeous payment to contractor and consultant					
17.	Other please specify					

APPENDIX B: SUMMARY OF RESPONSES RECEIVED

CAUSES AND EFFECTS OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SOUTH AFRICA

64	27:42	Closed
Responses	Average time to complete	Status

1. Kindly indicate your Gender

Male	45
Female	19

2. Please indicate your age

64

Responses

Latest Responses

"64"

"28"

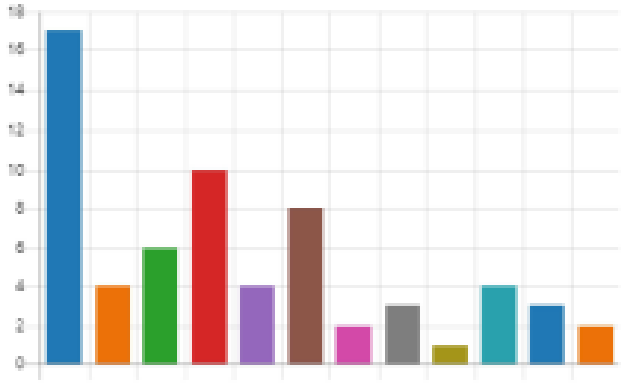
"60"

3. Please specify **role in the project/ organization type**

Client	21
Consultant	24
Contractor	13
Other	6

4. Please specify your **job title/ designation**

Project Manager	17
Project Leader	4
Contract Engineer	6
Design Consultant	10
Resident Engineer	4
Construction Manager	8
Contract Manager	2
Contracts Engineer	3
Assistant Resident Engineer	1
Project Liaison Officer	4
Community Development Spe...	3
Other- Specify	2



5. Please indicate your **number of years of relevant work experience** in the road construction industry (e.g. 20 years)

64

Responses

Latest Responses

"40"

"4"

"36 years"

6. Kindly indicate the **number of road construction projects** you were involved in the last five years (e.g. 5 years)

Insights

64

Responses

Latest Responses

"12"

"1"

"12"

3 respondents (5%) answered **projects** for this question.

7. Kindly indicate the **province** in which the project was located (e.g. KZN)

Insights

57

Responses

Latest Responses

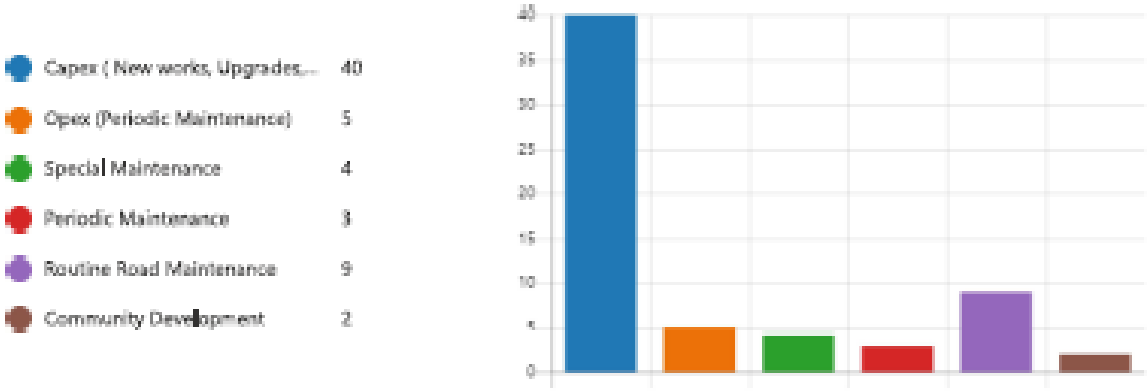
"EC"

"WC"

"KZN"

11 respondents (20%) answered **Eastern Cape** for this question.

8. Please indicate the **type** of project



9. Please state the **Planned Cost (ZAR)** of the project during the **Design Phase**

Insights

42

Responses

Latest Responses

"R100000"

"R10 000 000"

"R1.4 Billion"

5 respondents (**12%**) answered **mil** for this question.

10. Please state the **Actual Cost (ZAR)** of the project during the **Design Phase**

Insights

42

Responses

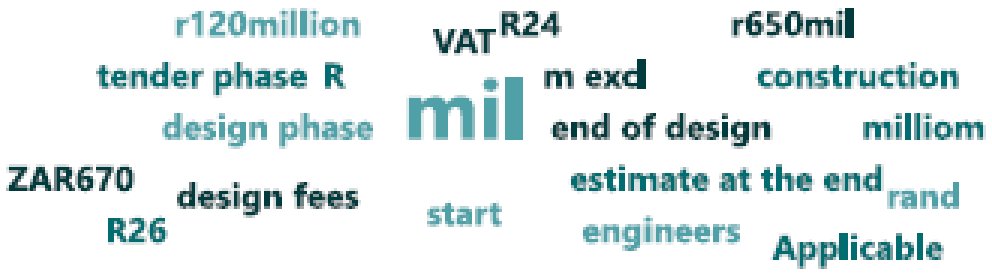
Latest Responses

"R100000"

"R10 000 000"

"R1.4 billion"

5 respondents (12%) answered **mil** for this question.



11. Please state the **Planned Cost (ZAR)** of the project during the **Construction Phase**

Insights

48

Responses

Latest Responses

"IMPLEMENTATION NOT COMMENCED"

"900 000 000"

"R1.4 billion"

5 respondents (11%) answered **mil** for this question.

12. Please state the **Actual Cost (ZAR)** of the project during the **Construction Phase**

Insights

50

Responses

Latest Responses

"IMPLEMENTATION NOT COMMENCED"

"R1bn"

"Still to be confirmed, still 3 years to go"

4 respondents (**8%**) answered **mil** for this question.

13. Was there any **delay** on the project identified during the **Design Phase**?

Insights

47

Responses

Latest Responses

"NO"

"No"

"18 months"

12 respondents (**27%**) answered **months** for this question.

14. Was there any **delay** on the project identified during the **Construction Phase**?

Insights

52

Responses

Latest Responses

"NO"

"Yes, 6 months"

"We estimate a delay of 12 months due to lack of access to certain pro...

15. What percentage of the project was **subcontracted** during the **Design Phase**

35

Responses

Latest Responses

"0"

"0%"

"20%"

16. What percentage of the project was **subcontracted** during the **Construction Phase**

52

Responses

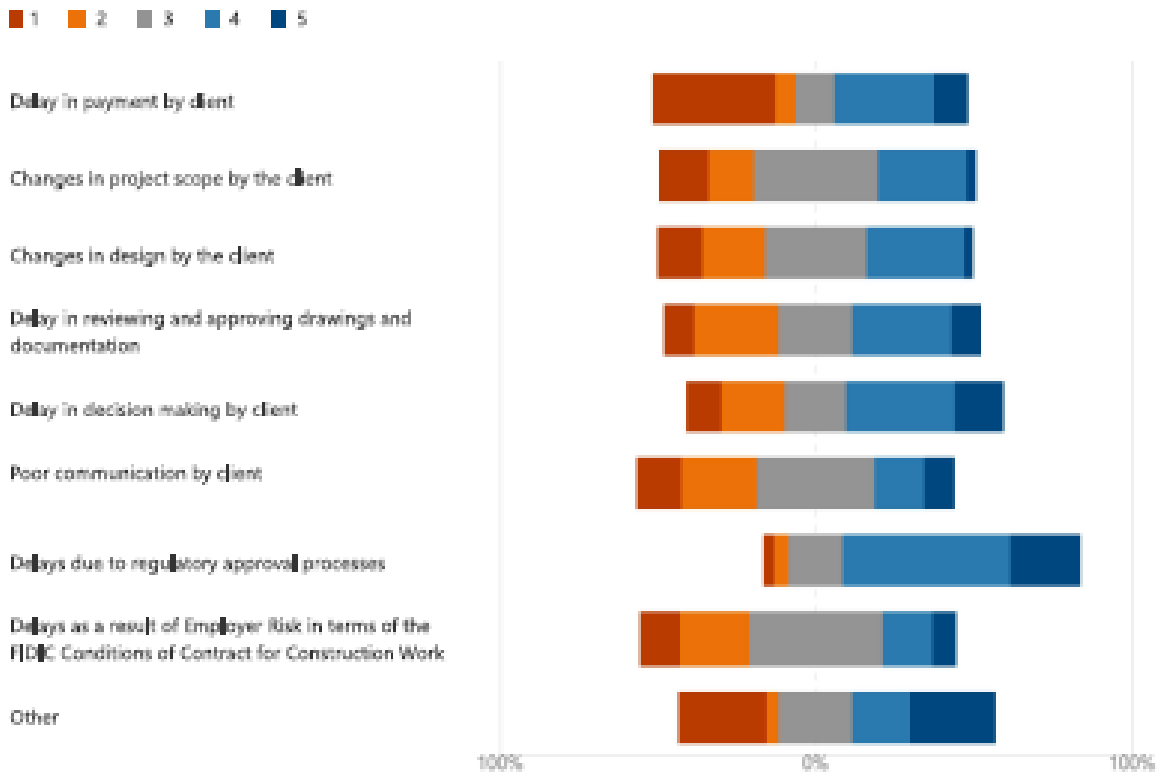
Latest Responses

"IMPLEMENTATION NOT COMMENCED"

"25%"

"30% is the target for CPG"

17. Client Related Delays



18. If "Other", please specify

Insights

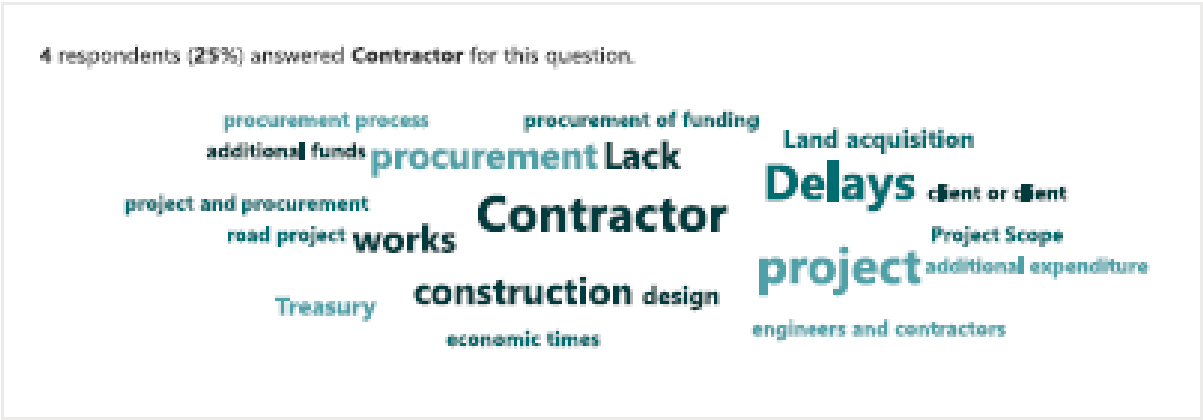
18

Responses

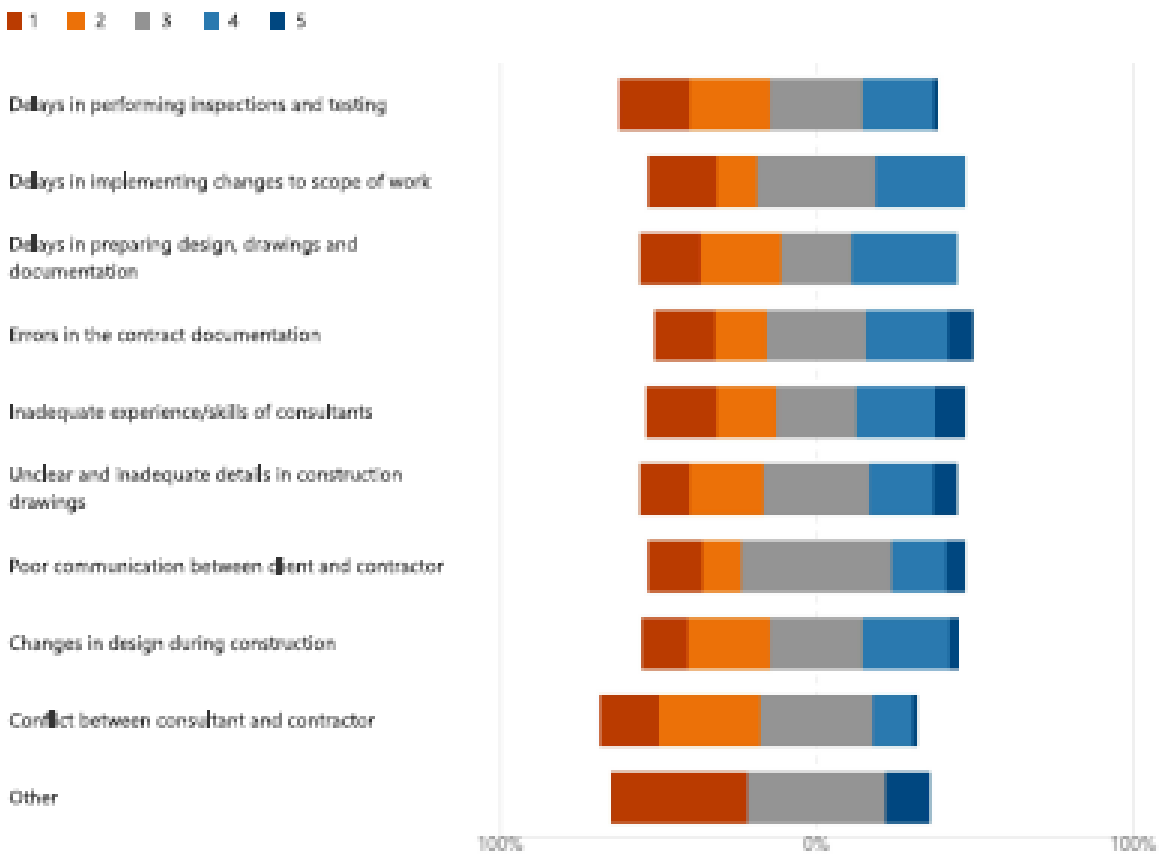
Latest Responses

"N/A"

"Land Acquisition"



19. Consultant Related Delays



20. If "Other", please specify

5 Insights

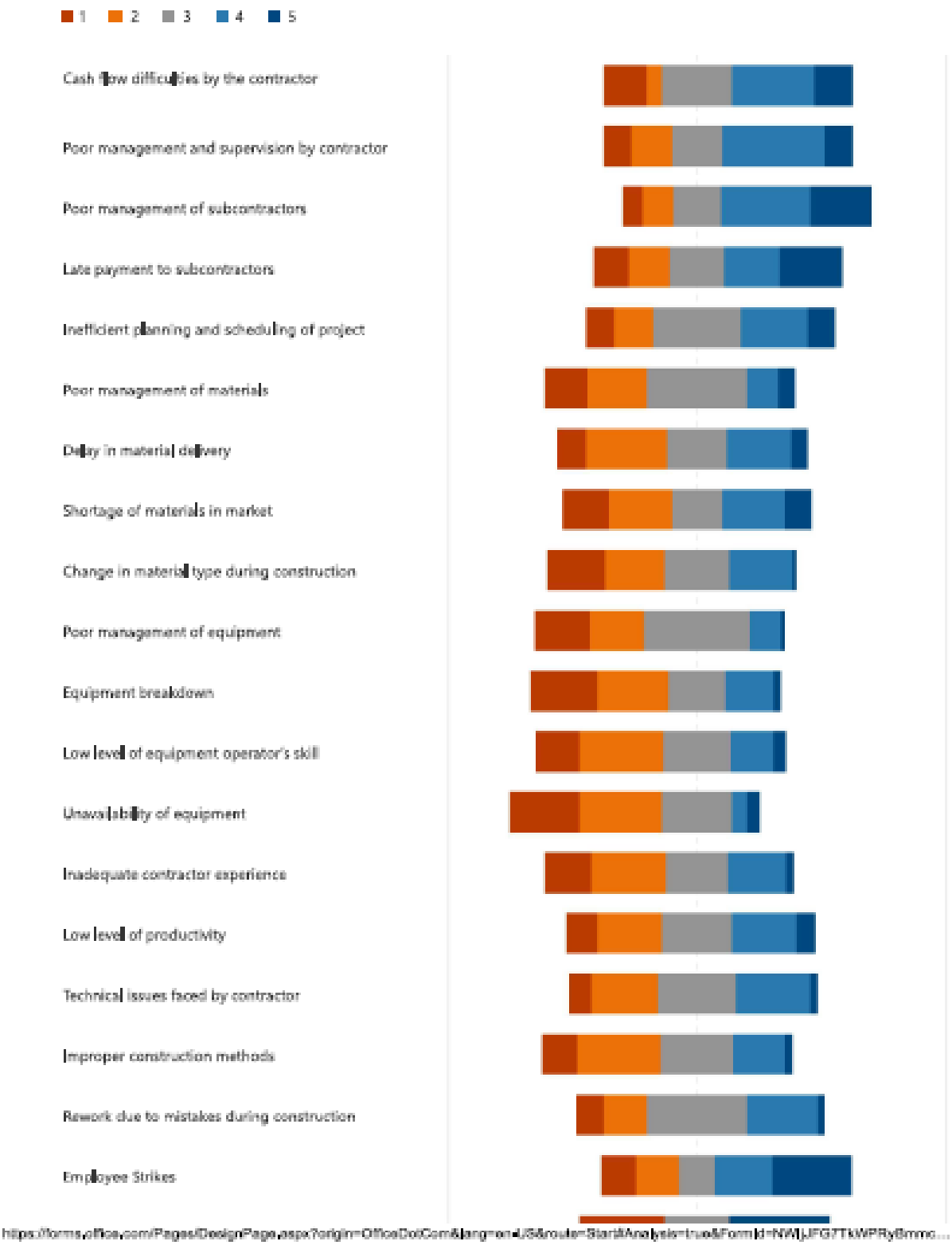
Responses

Latest Responses

1 respondents (20%) answered **SMMEs for participaytion** for this question.

economic factors specification a challenge
normal SMMEs for participaytion time
new socio-economic demand by SMMEs
community unrest

21. Contractor Related Delays



22. If "Other", please specify

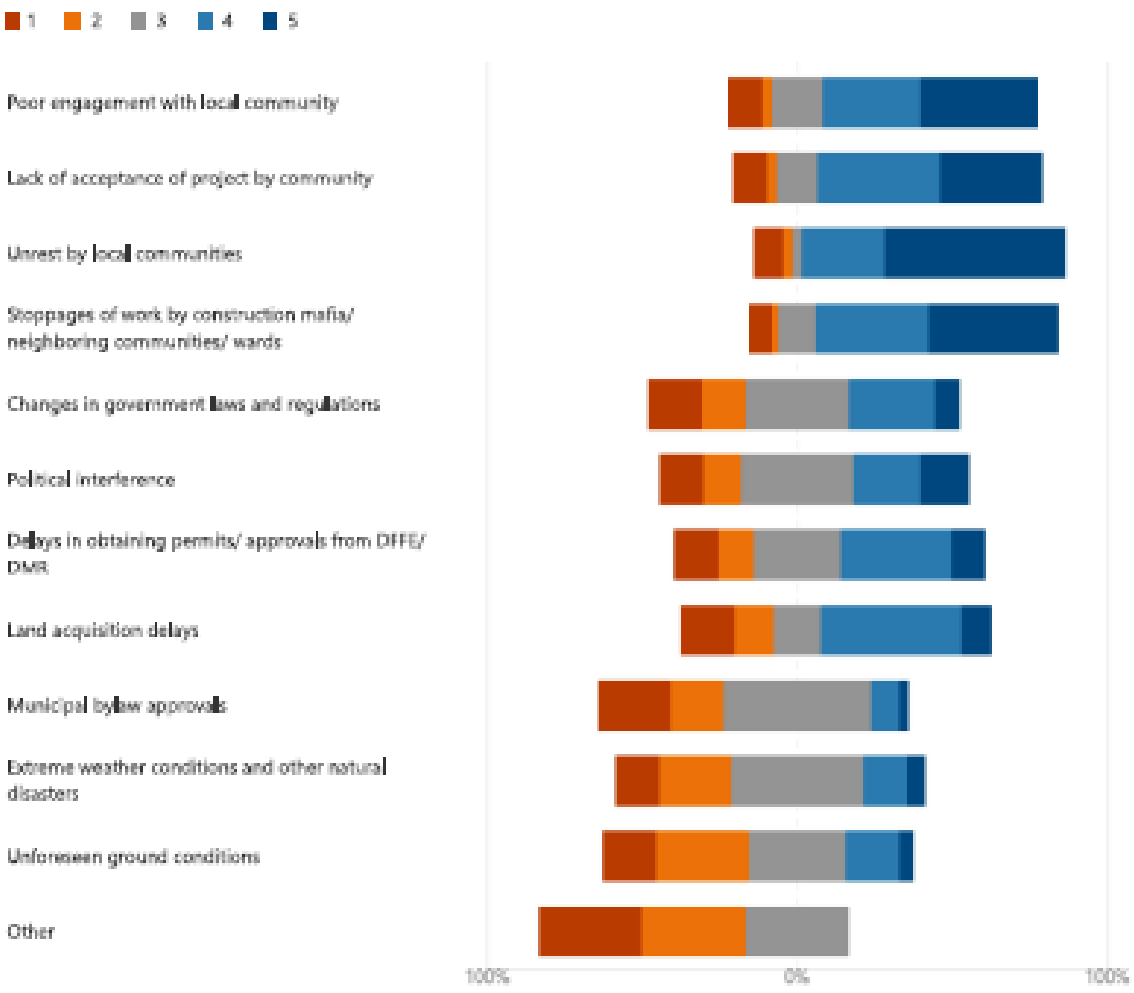
13 Responses

Insights

Latest Responses

2 respondents (15%) answered **Community strikes** for this question.

23. External Related Delays



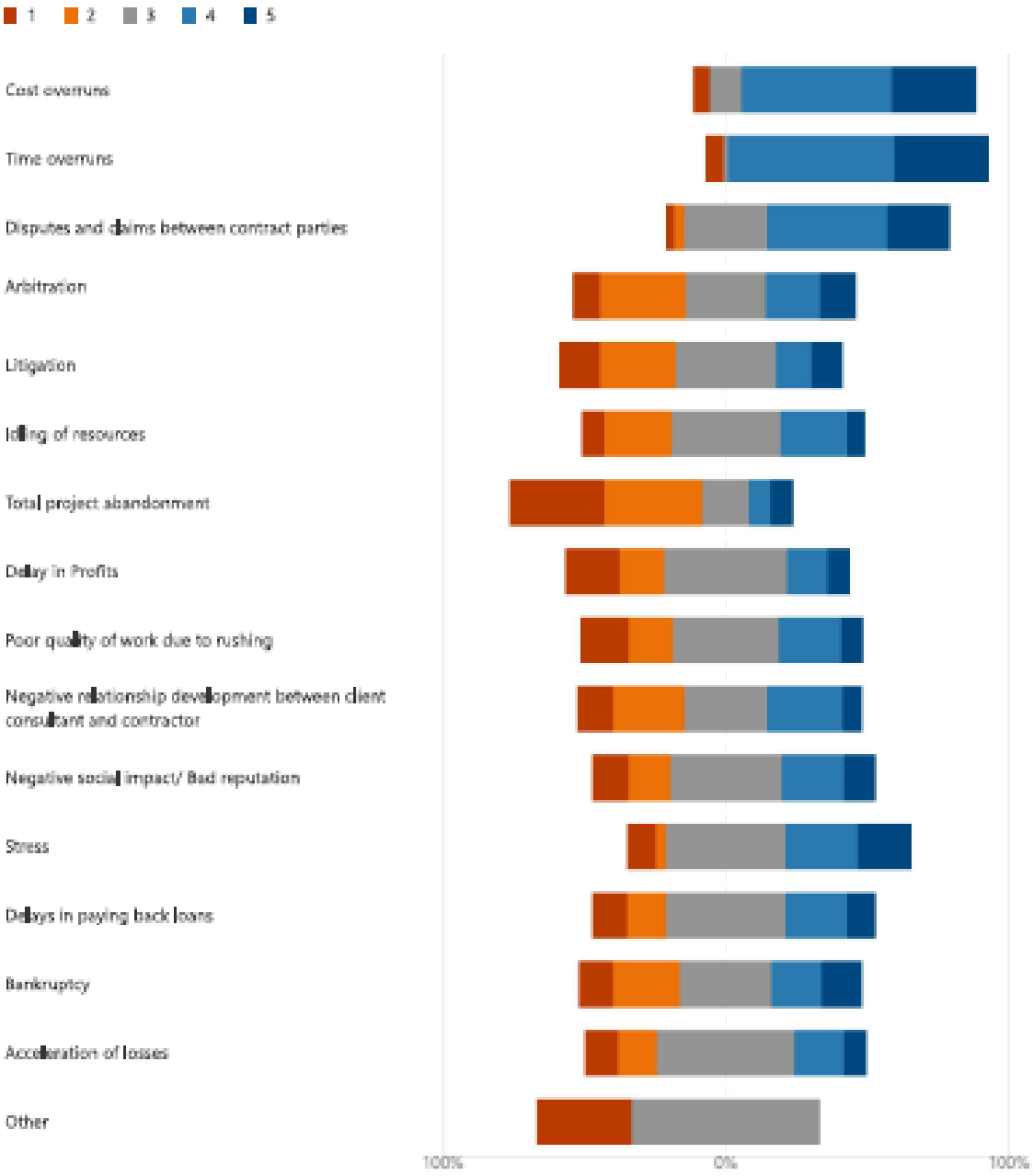
24. If "Other", please specify

2

Responses

Latest Responses

25. Effects of delays on road construction projects



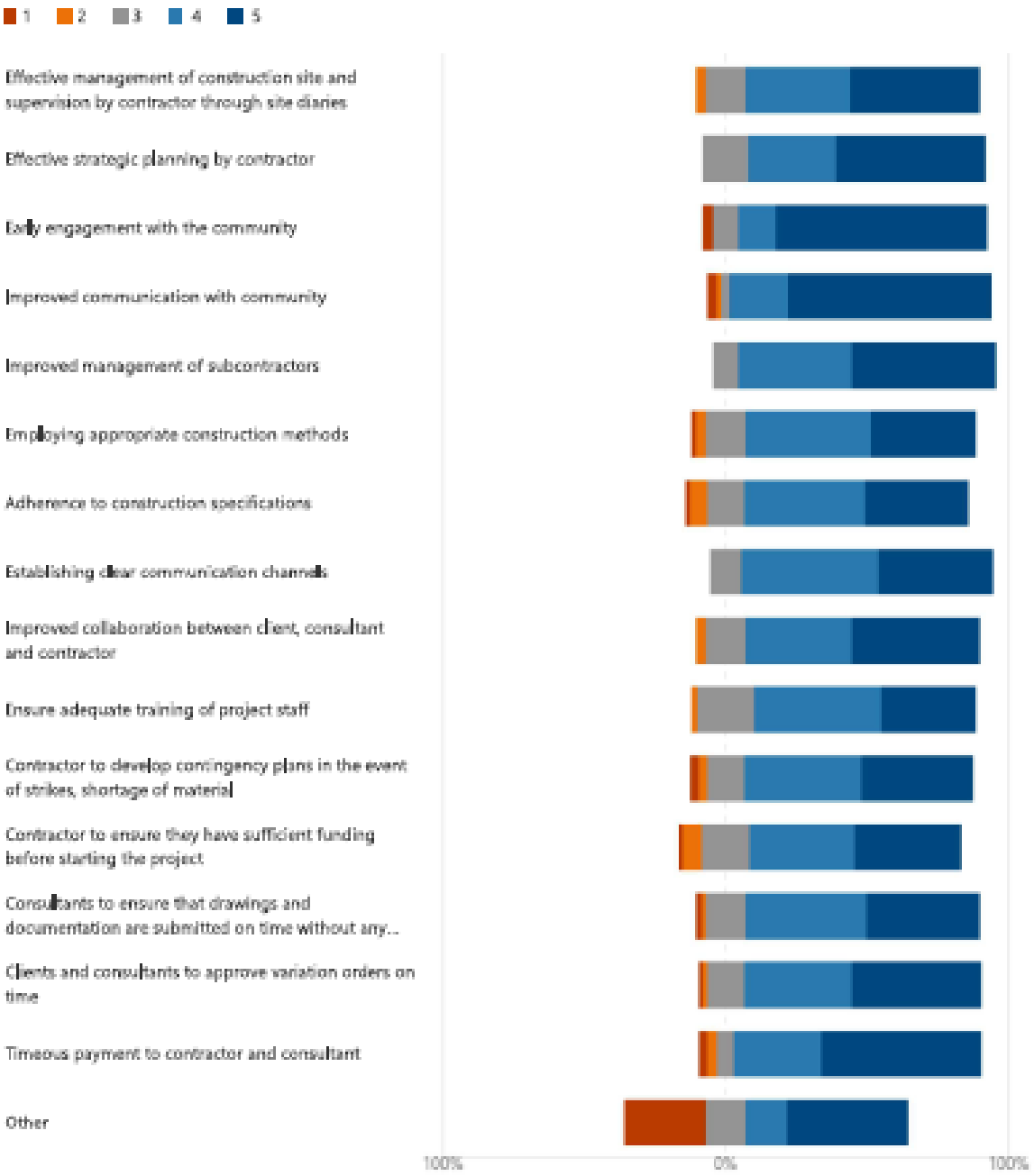
26. If "Other", please specify

2

Responses

Latest Responses

27. Measures to minimize delays



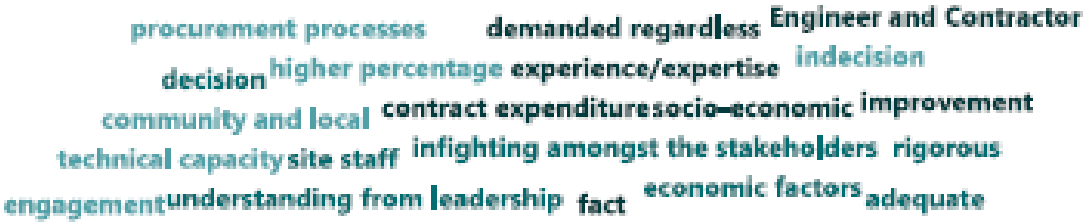
28. If "Other", please specify

6 Insights

Responses

Latest Responses

1 respondents (17%) answered **contract expenditure** for this question.



APPENDIX C: UCT ETHICAL CLEARENCE

Application for Approval of Ethics in Research (EiR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

ETHICS APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/ebe/research/ethics1

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		Faheem Vahed
Department		Faculty of Engineering and Built Environment
Preferred email address of applicant:		VHDFAH001@uct.ac.za
If Student	Your Degree: e.g., MSc, PhD, etc.	MSc
	Credit Value of Research: e.g., 60/120/180/360 etc.	60
	Name of Supervisor (if supervised):	Abimbola Windapo
If this is a researchcontract, indicate the source of funding/sponsorship		
Project Title		CAUSES AND EFFECTS OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SOUTH AFRICA

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

APPLICATION BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Faheem Vahed		21/06/2021
SUPPORTED BY	Full name	Signature	Date
Supervisor (where applicable)	Abimbola Windapo		21 June 21

APPROVED BY	Full name	Signature	Date
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (Including Honours).	Dr. Frank K. Ametefe		06/07/2021
Chair: Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the questions in Section 1.	Dr. Frank K. Ametefe		06/07/2021

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APPENDIX D: SANRAL APPLICATION TO CONDUCT RESERACH

	12/9/2 R.061-070-2021/1		
Reference:	# (EDMS 9489847)	Fax Number:	
Date:	27 July 2021	Direct Line:	+27 (0) 60 998 7340
Email:	Vahedf@nra.co.za	Website:	www.nra.co.za

SANRAL
BUILDING SOUTH AFRICA THROUGH BETTER ROADS

Dear Sir/ Ma'am

INTRODUCTION LETTER FOR MASTERS STUDENT TO COMPLETE MASTERS DISSERTATION: CAUSES AND EFFECTS OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SOUTH AFRICA

I am Faheem Vahed, currently employed as a Project Manager in Training (ECSA candidate engineer) and I am registered for a Masters Degree in Project Management (UCT). This correspondence contains information relating to the research which I am pursuing as part of the degree. My research topic, "**CAUSES AND EFFECTS OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SOUTH AFRICA**" requires your input.

This study aims to investigate the causes and effects of delays in road construction projects in South Africa towards a better understanding and improved management of the delays. Any insights gained will be extremely useful in explaining the causes and effects on delays in road construction projects in South Africa. It will contribute to the body of knowledge assisting stakeholders in delay identification and mitigating measures that will assist in ensuring that projects are completed within schedule, budget, and quality. This study will assist policymakers such as SANRAL and the National Department of Transport in formulating appropriate strategies that address and reduce road construction delays that can be adopted at a national level.

The research questionnaire assesses the perception of clients (SANRAL Project Managers), consultants, contractors and other project stakeholders on the causes and effects of road construction delays in South Africa and their perception of proposed measures to minimize identified delays. To improve on the quality of the questionnaire, it was reviewed by an experienced research supervisor and senior construction managers working for SANRAL. The questionnaire should take 20 minutes to complete and can be accessed through the link below:

https://forms.office.com/Pages/ResponsePage.aspx?id=NWIjJFG7TkWPRyBmmcfjO5TIPPTsD_VAgm9e3bly_jBUNloxQVFDOU9YR0ZaTUhWV0FVS0s5UlVFVS4u

The questionnaire, information sheet and consent form will be sent to SANRAL Project Managers via their SANRAL emails, and they will be requested to forward it to consultants and contractors. Knowledge bodies such as SARF and SAICE have been contacted to assist in sending the questionnaire to their members for completion.

This research does not pose any known risk and is for the submission to the Department of Construction Economics and Management for the fulfilment of the requirement for the award of the MSc in Project Management at the University of Cape Town under the supervision of Professor Abimbola Windapo. Participant's confidentiality and anonymity will be maintained throughout the study. Any data and information received will be exclusively used of research only. An ethics approval from the university is attached in Appendix A. Information sheet and consent form is attached in Appendix B.

Any queries/ concern can be addressed to me via email on vhdfah001@uct.ac.za/ vahedf@nra.co.za/ faheemvahed@gmail.com.

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Fax +27 (0) 41 492 0201 | Email info@sanral.co.za | Visit us at www.sanral.co.za

Thank you in anticipation of your assistance and valued participation.

Yours sincerely
FAHEEM VAHED
RESEARCHER

SUPPORTED/ NOT SUPPORTED

-- **----------**
HEIDI A. HARPER-GENERAL MANAGER SKILLS DEVELOPMENT
DATE Wednesday, 04 August 2021

APPENDIX E: CALCULATION OF RII

1. Client- related causes

Question	1	2	3	4	5	Total	N	A*N	RII	Rank
Delay in payment by client	25	8	24	80	35	172	64	320	0.538	8
Changes in project scope by the client	10	18	75	72	10	185	64	320	0.578	5
Changes in design by the client	9	24	63	80	10	186	64	320	0.581	4
Delay in reviewing and approving drawings and documentation	6	34	45	80	30	195	64	320	0.609	3
Delay in decision making by client	7	26	36	88	50	207	64	320	0.647	2
Poor communication by client	9	30	72	40	30	181	64	320	0.566	7
Delays due to regulatory approval processes	2	6	33	136	70	247	64	320	0.772	1
Delays as a result of Employer Risk in terms of the FIDIC Conditions of Contract for Construction Work	8	28	81	40	25	182	64	320	0.569	6
Other	6	2	15	16	30	69	64	320	0.216	9

2. Consultant- related causes

Question	1	2	3	4	5	Total	N	A*N	RII	Rank
Delays in performing inspections and testing	14	32	57	56	5	164	64	320	0.513	8
Delays in implementing changes to scope of work	14	16	72	72	0	174	64	320	0.544	6
Delays in preparing design, drawings and documentation	12	32	45	84	0	173	64	320	0.541	7
Errors in the contract documentation	12	20	63	64	25	184	64	320	0.575	1
Inadequate experience/skills of consultants	14	24	48	64	30	180	64	320	0.563	3
Unclear and inadequate details in construction drawings	10	30	63	52	25	180	64	320	0.563	3
Poor communication between client and contractor	11	16	90	44	20	181	64	320	0.566	2
Changes in design during construction	10	32	54	72	10	178	64	320	0.556	5
Conflict between consultant and contractor	12	40	69	32	5	158	64	320	0.494	9
Other	3	0	9	0	5	17	64	320	0.053	10

3. Contractor- related causes

Question	1	2	3	4	5	Total	N	A*N	RII	Rank
Cash flow difficulties by the contractor	11	8	54	84	50	207	64	320	0.647	5
Poor management and supervision by contractor	7	20	42	104	35	208	64	320	0.650	4
Poor management of subcontractors	5	16	36	92	80	229	64	320	0.716	1
Late payment to subcontractors	9	20	45	56	80	210	64	320	0.656	3
Inefficient planning and scheduling of project	7	20	66	72	35	200	64	320	0.625	6
Poor management of materials	11	30	78	32	20	171	64	320	0.534	12
Delay in material delivery	7	40	45	72	20	184	64	320	0.575	10
Shortage of materials in market	12	32	39	64	35	182	64	320	0.569	11
Change in material type during construction	15	30	51	64	5	165	64	320	0.516	15
Poor management of equipment	14	28	81	32	5	160	64	320	0.500	17
Equipment breakdown	17	36	45	48	10	156	64	320	0.488	18
Low level of equipment operator's skill	11	44	51	44	15	165	64	320	0.516	15
Unavailability of equipment	18	42	54	16	15	145	64	320	0.453	19
Inadequate contractor experience	12	38	48	60	10	168	64	320	0.525	14
Low level of productivity	8	34	54	64	25	185	64	320	0.578	9
Technical issues faced by contractor	6	34	60	76	10	186	64	320	0.581	8
Improper construction methods	9	42	57	52	10	170	64	320	0.531	13
Rework due to mistakes during construction	7	22	78	72	10	189	64	320	0.591	7
Employee Strikes	9	22	27	60	100	218	64	320	0.681	2
Other2	5	0	12	0	30	47	64	320	0.147	20

4. External-related causes

Questions	1	2	3	4	5	Total	N	A*N	RII	Rank
Poor engagement with local community	7	4	33	80	120	244	64	320	0.763	3
Lack of acceptance of project by community	7	6	24	100	105	242	64	320	0.756	4
Unrest by local communities	6	4	6	68	185	269	64	320	0.841	1
Stoppages of work by construction mafia/ neighboring communities/ wards	5	2	24	92	135	258	64	320	0.806	2
Changes in government laws and regulations	11	18	63	72	25	189	64	320	0.591	8
Political interference	9	16	69	56	50	200	64	320	0.625	7
Delays in obtaining permits/ approvals from DFFE/ DMR	9	16	54	88	35	202	64	320	0.631	6
Land acquisition delays	11	16	30	116	30	203	64	320	0.634	5
Municipal bylaw approvals	15	22	90	24	10	161	64	320	0.503	11
Extreme weather conditions and other natural disasters	9	30	81	36	20	176	64	320	0.550	9
Unforeseen ground conditions	11	38	60	44	15	168	64	320	0.525	10
Other3	2	4	6	0	0	12	64	320	0.038	12

5. Effects of delays

Question	1	2	3	4	5	Total	N	A*N	RII	Rank
Cost overruns	4	0	21	136	95	256	64	320	0.800	2
Time overruns	4	0	6	148	105	263	64	320	0.822	1
Disputes and claims between contract parties	2	4	57	108	70	241	64	320	0.753	3
Arbitration	6	38	54	52	40	190	64	320	0.594	6
Litigation	9	34	69	32	35	179	64	320	0.559	12
Idling of resources	5	30	75	60	20	190	64	320	0.594	6
Total project abandonment	21	44	30	24	25	144	64	320	0.450	15
Delay in Profits	12	20	81	40	25	178	64	320	0.556	13
Poor quality of work due to rushing	11	20	72	56	25	184	64	320	0.575	10
Negative relationship development between client consultant and contractor	8	32	57	68	20	185	64	320	0.578	9
Negative social impact/ Bad reputation	7	18	78	60	35	198	64	320	0.619	5
Stress	7	6	90	56	50	209	64	320	0.653	4
Delays in paying back loans	6	30	78	48	25	187	64	320	0.584	8
Bankruptcy	11	32	60	40	35	178	64	320	0.556	13
Acceleration of losses	7	24	96	36	20	183	64	320	0.572	11
Other4	1	0	6	0	0	7	64	320	0.022	16

6. Delay minimising measures

Question	1	2	3	4	5	Total	N	A*N	RII	Rank
Effective management of construction site and supervision by contractor through site diaries	0	4	27	92	150	273	64	320	0.853	6
Effective strategic planning by contractor	0	0	30	84	165	279	64	320	0.872	4
Early engagement with the community	2	0	18	36	235	291	64	320	0.909	1
Improved communication with community	2	2	6	56	225	291	64	320	0.909	1
Improved management of subcontractors	0	0	18	100	165	283	64	320	0.884	3
Employing appropriate construction methods	1	4	27	112	120	264	64	320	0.825	11
Adherence to construction specifications	1	8	24	112	115	260	64	320	0.813	14
Establishing clear communication channels	0	0	24	124	125	273	64	320	0.853	6
Improved collaboration between client, consultant and contractor	0	4	27	92	150	273	64	320	0.853	6
Ensure adequate training of project staff	0	2	39	112	110	263	64	320	0.822	12
Contractor to develop contingency plans in the event of strikes, shortage of material	2	4	24	108	125	263	64	320	0.822	12
Contractor to ensure they have sufficient funding before starting the project	1	8	33	96	120	258	64	320	0.806	15
Consultants to ensure that drawings and documentation are submitted on time without any errors	1	2	27	112	125	267	64	320	0.834	10
Clients and consultants to approve variation orders on time	1	2	24	96	150	273	64	320	0.853	6
Timeous payment to contractor and consultant	2	4	12	84	175	277	64	320	0.866	5
Other	2	0	3	4	15	24	64	320	0.075	16

APPENDIX F: CALCULATION OF KRUSKAL- WALLIS TEST

1. Kruskal-Wallis test for significance in views of project stakeholders on major causes of delays

Project Stakeholder	N	Mean
Client	21	33.05
Consultant	24	31.92
Contractor	13	34.92
Other	6	27.67
Total	64	

2. Kruskal-Wallis test for significance in views of project stakeholders on major effects of delays

Project Stakeholder	N	Mean
Client	21	39.55
Consultant	24	29.44
Contractor	13	30.62
Other	6	24.17
Total	64	

3. Kruskal-Wallis test for significance in views of project stakeholders on major delay minimising measures

Project Stakeholder	N	Mean
Client	21	24.05
Consultant	24	34.75
Contractor	13	36.46
Other	6	44.50
Total	64	

APPENDIX G: CALCULATION OF CHI-SQUARE

1. Client-related causes

Number	Observed	Expected	(O-E)	$(O-E)^2$	$(O-E)^2/E$
1	1	12.8	-11.8	139.24	10.88
2	17	12.8	4.20	17.64	1.38
3	23	12.8	10.2	104.04	8.13
4	20	12.8	7.20	51.84	4.05
5	3	12.8	-9.80	96.04	7.50
Total	64				31.94

2. Consultant-related causes

Number	Observed	Expected	(O-E)	$(O-E)^2$	$(O-E)^2/E$
1	10	12.8	-2.80	7.840	0.61
2	11	12.8	-1.80	3.24	0.25
3	29	12.8	16.2	262.44	20.50
4	14	12.8	1.20	1.2	0.11
5	0	12.8	-12.8	163.84	12.80
Total	64				34.28

3. Contractor-related causes

Number	Observed	Expected	(O-E)	$(O-E)^2$	$(O-E)^2/E$
1	2	12.8	-10.8	116.64	9.11
2	18	12.8	5.2	27.04	2.11
3	31	12.8	18.2	331.24	25.88
4	12	12.8	-0.8	0.64	0.05
5	1	12.8	-11.8	139.24	10.88
Total	64				48.03

4. External-related causes

Number	Observed	Expected	(O-E)	$(O-E)^2$	$(O-E)^2/E$
1	2	12.8	-10.8	116.64	9.11
2	7	12.8	-5.8	33.64	2.63
3	27	12.8	14.2	201.64	15.75
4	27	12.8	14.2	201.64	15.75
5	1	12.8	-11.8	139.24	10.88
Total	64				54.13