ASSESSING THE CAUSES OF SCHEDULE AND COST OVERRUNS IN SOUTH AFRICAN MEGA ENERGY PROJECTS: A CASE OF THE LIMPOPO PROVINCE

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DECLARATION

I declare that this research report is my own, unaided work. It is being submitted in partial fulfilment for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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ABSTRACT

Cost and schedule overruns are the most common challenges in mega construction projects around the globe. The frequency of megaprojects failing to be completed on time and within budget is creating a poor reputation in the construction industry. This research aimed to assess the causes of cost and schedule overruns in the construction of megaprojects in South Africa. The objectives were to identify the local challenges militating against a project's implementation success, to analyse the local conditions that could contribute to project implementation sluggishness, to assess planning and implementation practices in such projects and to assess the local expertise and acumen during the front-end project preparation process.

Quantitative research method was employed. Questionnaires were used to collect data from engineers, quantity surveyors, architects, contractors and project managers. Limitation of the study is that leadership instability at Eskom, the South African public electricity utility company, has occasioned a climate of mistrust to outsiders making assessing informative sources difficult. Data were analysed using mean item score. The analysis indicates that poor site management, inadequate managerial skills, poor monitoring and control, lack of experience, poor financial planning, changes in the scope of work on site, variation orders, omission and errors in the Bill of Quantities, and unstable management structure were the major causes of cost and schedule overruns. Specific solutions that mitigate the causes of schedule and cost overrun should be investigated in future studies.

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Chapter 1: Introduction

1.1 General introduction

A megaproject is defined as a project that costs $1 billion or more (Flyvbjerg, 2014). Megaprojects have emerged in cities and countryside's throughout the world. They are expensive, and they include several risk elements that can cause delays or failures during the project's execution (Ma et al., 2017). In practice, cost and schedule overruns occur in most construction projects, and the extent of the overrun differs significantly from project to project and from country to country (Famiyeh, Amoatey, Adaku and Agbenohevi, 2017). There are many examples of megaprojects that have been unsuccessful despite the best intentions of those managing them. The Sydney Opera House is an example of a project that was over budget and was completed well out of the proposed schedule; it was ten years over schedule, and its construction cost was 1 400 per cent over budget (Flyvbjerg, 2014).

Megaprojects are characterised by their complexity, uncertainty, ambiguity, external influences and extended completion times (Gupta, 2015). The global construction sector is a multi-billion-dollar industry, and it is one of the most labour-intensive industries that create jobs for many people. In South Africa (SA) as in other countries across the world, the construction sector contributes significantly to the country's economy, and in SA the government is the biggest client for the construction industry (Famiyeh et al., 2017). Despite this, the construction industry has a poor reputation as far as completing projects on time and within budget (Aljohani, Ahiaga-Dagbui and Moore, 2017). The common challenges in infrastructure projects are cost overruns and schedule delays (Siemiatycki, 2015).

A construction project is defined to be successful when it is concluded on time, within budget, and of good quality and in accordance to the specifications and to the satisfaction of the client (Musa, 2012). A megaproject that is delivered on time, within budget and specification is typically measured as successful in megaproject management (Flyvbjerg, 2014). Schedule overrun is the most common challenge when

it comes to managing projects even though there are progressive technologies and project management techniques (Famiyeh et al., 2017).

1.2 Problem Formulation

Construction industry is huge, complex, and risky and it requires lots of money (Adugna, 2015). Construction industry represents one of the most important sectors in local economy. Cost and schedule overruns are very common in construction industry. Megaprojects globally are missing the project deadlines (Mukuka, Aigbavboa and Thwala, 2015). Overruns has an adverse influence on the project success in terms of time, cost and quality. Many projects suffers extensive overruns and thereby exceed initial cost estimate. Just like anywhere in the world, South Africa is also experiencing challenges such as delays in completing projects within time and budget. According to Ramabodu and Vester (2013), South Africa has some projects that have suffered cost overruns, such as FIFA 2010 stadiums.

A report by Ernst and Young indicates that more than two-thirds of megaprojects are bedevilled by cost overruns (Ernst and Young, 2014). The construction industry has poor credibility when it comes to completing projects on time and within budget (Aljohani, Ahiaga-Dagbui and Moore, 2017). The number of global megaprojects that are late or over budget is significant. Flyvbjerg, Bruzelius and Rothengatter (2003) conducted the largest and most robust study of cost overruns on a sample of 258 projects in 20 countries on five continents and reported that 9 out of 10 projects experience cost overruns.

The causes of schedule overruns are factors that occur before and during the construction phase that will contribute to the duration of the project (Mukuka, Aigbavboa and Thwala, 2015). These factors can be contractor related, consultant related, client related and/or other external factors. Due to cost and schedule overruns in megaprojects, it was found necessary to identify and assess the main causes of cost and schedule overruns.

1.3 Problem statement

The commonality across the construction industry is the lack of the ability to complete projects on time and within budget. This can be attributed to various factors related to the contractors, the consultants, the project owner, the design, the material and unforeseen project changes. The consequences of failed megaprojects vary from project to project. A better understanding of the actual causes of poor scheduling, costing and projecting is required. Cost and schedule overruns influence negatively on construction industry, hence the necessity to identify and assess the causes of these overruns. The problem examined in this research study was to identify and assess factors affecting cost and schedule overruns in South Africa.

1.4 Research Questions

The following research questions were used to achieve the objectives:

- What are the challenges contributing to the poor implementation of megaprojects in the energy sector?
- How is the economic condition contributing to project implementation sluggishness in the energy sector?
- What criteria is used for implementing megaprojects in the energy sector?
- What are the levels and numbers of local expertise involved in the preparation stages?

1.5 Aim of the study

This study aimed to identify and assess the main causes of schedule and cost overrun in South African megaprojects in the energy sector.

Research main question
What are the causes of schedule and cost overruns in South African megaprojects?

1.6 Research objectives

The research objectives were:

- To identify the local challenges militating against project implementation success.
- To analyse the local climatic conditions that could contribute to project implementation sluggishness.
- To assess the planning and implementation practices of mega construction projects.
- To assess the local expertise and acumen during the front-end project preparation process.

1.7 Contribution of the study

Cost and schedule can be defined as two of the most significant issues relating to megaproject's success. The study contributes to the body of knowledge on the subject of causes of cost and schedule overruns in South African construction industry. We are too ambitious when budgeting for megaprojects. It is common to see construction projects failing to attain their objectives within stated time and cost. Megaprojects face a predicament of being completed late and above budget. Project achievements are usually measured on the basis of time, quality and cost, hence the necessity to overcome schedule and cost overruns on megaprojects. The accomplishment of effective corrective cost and schedule control measures for megaprojects will assist the socio-economic improvement of the country. The findings of this research study are expected to contribute towards the improvement of schedule and cost management in megaprojects in South Africa.

1.8 Scope of the study

Due to limited megaprojects in South Africa, the study was limited to energy sector projects due to their availability. This study concentrates on identifying and assessing the major causes of cost and schedule overrun on megaproject in Limpopo province using Medupi and Kusile power station projects in South Africa. The study further

envisages identifying, analysing and ranking the major causes of megaproject cost and schedule overrun and coming up with a recommendation to minimise these problems.

1.9 Assumptions

Firstly, it is assumed that the novelty of megaprojects has birthed new complexities in project management that have been previously un-encountered.
Secondly, failure by the South African government to meaningfully consult the public in the implementation of megaprojects is the main cause of strikes which impacts negatively on the outcome of the project.
Thirdly, as a result of the data collected, the focus of the analyses and findings represent energy sector mega-projects. However, the findings may be applicable to other sectors of the construction projects industry.

1.10 Limitations and constraints

Limitation

The leadership instability at Eskom, the South African public electricity utility company, has occasioned a climate of mistrust to outsiders making accessing informative sources difficult. Findings of this study are limited to the participants who received questionnaires, therefore choosing the right people is very crucial.

Constraints

The study was also affected by time constraint as there are due dates to submit research report. Conducting interviews face to face with participants requires travelling which needs financial resources which were scarce.

1.11 Structure of the report

Literature review conducted following the identified and approved research problem. Journals and articles are read and information is collected. The information collected together with data collected from questionnaires respondents are deliberated and analysed. The research report is structured in five chapters.

Chapter 1: Introduction

It offers the information about the problem of megaproject cost and schedule overrun, then followed by problem formulation, problem statement, and research questions, Aim of the study and research objectives. It also include assumptions, limitations and constraint of the study. It further covers contribution of the study and scope of the study. This chapter gives a framework of the whole study

Chapter 2: Literature review

The reason for this chapter is to identify the factors as much as possible that causes cost and schedule overrun in megaprojects by looking at previous studies on the same subject. This chapter gives the readers knowledge and ideas on literature reviewed by other researchers on the topic. It also covers literature review on megaproject globally, in developing countries and in South Africa.

Chapter 3: Research design and methods

The chapter discusses the approach used for attaining the needed information to structure research questionnaires, to collect data and also methods of data analysis and ethical consideration. The onion model was used to discuss the research theoretical framework.

Chapter 4: Results and discussions

The chapter discusses the results of data analysis and the interpretation of the results thereof. It utilizes the available literature and juxtaposes that against the finding

Chapter 5: Conclusion and Recommendations

The chapter synthesises the findings and promulgates the main findings at a higher concise level to give a thrust of the exposition of the research. It speaks directly to the aim of the study as it depicts what was found out after going through different steps to elucidate the problem and provides a better synthesis of the quest of the study.

1.12 Summary

This chapter included general introduction of the study with regards to megaproject definition. It further outlined problem formulation and problem statement. From the problem statement; research questions, aim of the study and research objectives were identified. This chapter also highlighted contribution to the study, scope of the study and assumptions, limitations and constraint. The next chapter includes literature relating to cost and schedule overruns from megaprojects globally, in developing countries and South Africa.

Chapter 2: Literature review

2.1 Introduction

The main purpose of this chapter is to identify the factors that causes megaproject cost and schedule overruns thoroughly through conducting literature review. In the following sections, discussion will include understanding the definitions of cost and schedule overruns. The literature review is divided into three sections on understanding definitions of megaprojects which are megaprojects globally, megaprojects in developing countries and megaprojects in South Africa. It further discusses causes of megaprojects delays and cost overrun, types of delays and how this study relates to previous studies.

2.2 Cost and schedule overruns

A report by Ernst and Young indicates that more than two-thirds of megaprojects are bedevilled by cost overruns (Ernst and Young, 2014). Cost is the budgeted expenditure that the client has decided to commit for the execution of the project (Subramani, Sruthi and Kavitha, 2014). Cost overrun is distinct as the difference between the actual and the estimated costs. According to Vidalis and Najafi (2002), cost overrun is a 'percentage difference between the final completion cost and the contract bid cost' (Shrestha, Burns and Shields 2013, p. 2).

Schedule overrun is described as missing the project deadline. Delivering a project within a scheduled time is a challenge that project managers must overcome. Time overrun is defined as the difference between the construction bid duration and the final completion duration (Shrestha, Burns and Shields, 2013). Mukuka, Aigbavboa and Thwala (2015) describe schedule overrun as the additional time required to complete a given project outside its original intended duration whether compensated for or not. Since both these scenarios are injurious to affordable project execution their causes must be appreciated by implementers.

The construction industry has poor credibility when it comes to completing projects on time and within budget (Aljohani, Ahiaga-Dagbui and Moore, 2017). Cost overruns are also an ongoing problem in megaprojects in other sectors. In the transportation sector,

Flyvbjerg, Bruzelius and Rothengatter (2003) conducted the largest and the most encompassing study of cost overruns on a sample of 258 major roads, tunnels, bridges, urban transit and interurban rail projects in twenty countries on five continents. The study established that nine out of ten megaprojects suffered cost overrun (Siemiatycki 2015, p2.).

Megaprojects are implemented to resolve more than one major problem at a time. Often, megaprojects are specially made to solve infrastructure shortfalls, to alleviate unemployment, and to add new business into a community to the benefit of the community as a whole, the city, the state or even the country (Parrock, 2015).

Numerous megaprojects have been finalised throughout human history and the majority of them had cost and schedule overrun. There have been no improvements over time (Flyvbjerg, 2014).

2.3 Global megaprojects

Construction projects differ in size and can be categorised as ordinary or normal projects, large projects and megaprojects. Megaprojects are very large development projects, and their distinct characteristics are their complexity, the scale of new construction or restoration involved, the multiple developers who are required to produce them, the long time they take to be completed and the high cost of development (Sutherland, Sim and Scott, 2015). They are usually appointed by governments and delivered by private contractors who specialise in design, architectural and construction services (Kardes, Ozturk, Cavusgil and Cavusgil, 2013). According to Othman (2013), megaprojects are commissioned by governments and delivered by national and international participants with varying cultural differences, backgrounds, political systems and languages.

Olaniran et al. (2015) suggested that it is not easy to determine the actual cost until a project is completed. Cost is mostly seen or identified as a criterion for considering a project megaproject (Pitsis et al., 2017). A megaproject is not only big in terms of scope, scale and costs, it is also big in its prospective for politics within the project.

Megaprojects are unique reagrding their level of ambition, lead times, complexity, and stakeholder participation (Pitsis et al., 2017). Thus, managing a megaproject is different from that of other projects. Conceptualising the variables in megaprojects includes the following factors: size, cost, uniqueness, schedule, scope, governance, stakeholders, complexity, risk and optimising value from a social and economic point of view (Pitsis et al., 2017).

A lot of risk elements can cause delays or failures during the megaproject duration (Irimia-Diéguez, Sanchez-Cazorla, and Alfalla-Luque, 2014). Megaprojects affect communities differently, for example, one project may bring around or weaken regional economies (Kardes et al., 2013). Megaprojects are considered as uncertain, complex, politically sensitive and involving many partners. They have extreme deadlines and budget (Dunović, Radujković and Škreb, 2014). Megaprojects with characteristics of having multi-stakeholders, requiring extensive investment, needing complex technologies and having tremendously long lifecycle are much more complicated systems (Zhou and Mi, 2017).

Given that megaprojects are often previously untested, they require management skills and techniques to be able to be implemented successfully. There is cross-institutional complexity as megaprojects involve participants from multiple countries with different languages and institutions (Levitt and Scott, 2016). Megaprojects require substantial amounts of money, labour, and physical and financial resources (Kardes et al., 2013).

Megaprojects are large-scale constructions initiatives that change the look of a place (Kardes et al., 2013). They require many contractors from different countries and they take years to complete. They are categorised into four types; infrastructure (e.g. dams, seaports, railroads, highways, tunnels and bridges), extraction (e.g. minerals, oil and gas), production (e.g. fighter aircraft, chemical plants, power plants and manufacturing plants), and consumptions (e.g. tourist installations, Olympic infrastructure, malls and theme parks) (Brooks, 2014).

Most often, megaprojects are of a global scope as they involve stakeholders from different countries (Kardes et al., 2013). Such projects involve both high risks and uncertainty due to their high complexity and long duration (Othman, 2013).

Megaprojects require high design knowledge and technical skills, competent human resources, professional managerial capabilities and large-scale investments (Othman, 2013). According to Flyvbjerg (2014), he identified that cost overruns of 50 to 100 per cent were common, with cost overruns of over 100 per cent happening frequently. The Big Dig (Central Artery/Tunnel Project, USA) is an example of extremely poor project performance having experienced cost and schedule overruns and a large number of other problems including leaks and design flaws (Brooks, 2014).

Megaprojects have an impact on the economy, the environment and society. There are a number of stakeholders involved in these types of projects. A megaproject attracts a lot of public attention because of the impacts on communities and the large budget involved (Othman, 2013). They are still difficult projects even when they are successful (Mišić and Radujković, 2015). Megaprojects have always struggled with unforeseen events such as regulatory requirements, technical difficulties, financial constraints and politics (Greiman, 2015). They are important to the livelihoods of individuals and the cities (Garemo, Matzinger and Palter, 2015). Megaprojects are usually initiated by governments and delivered by private companies and can cost more than EUR 0.5 billion (Locatelli et al., 2014). Megaprojects feature a definite and temporary organisation throughout project lifecycle (Ma et al., 2017).

Complexity is one of the features that describe megaprojects. Project complexity can be defined as ‘complicated characteristics of a project as a result of composing many interconnected parts within a project’ (He et al. 2015, p.549). Managers and implementing agencies struggle with managing the challenges of megaproject complexity (Mevada and Devkar, 2017).

There is a common view in the literature that megaprojects are a large financial investment, however, they mostly struggle to stay within budget and to be completed on time. Megaprojects are united by their complexity. The implementation of

megaprojects is also a challenge. Generally, megaprojects are initiated and financed by government and delivered by private companies.

2.4 Megaprojects in developing countries

The distinction between developed and developing countries is surrounded by intense debate. Generally, the classification of a country as developed or developing is based on certain measures such as economic development, education and training provision, political stability, technological development, infrastructure and production rate, healthcare, life expectancy and growth rate of the population, and demography and culture issues (Othman, 2013).

When comparing developing and advanced developing countries, there are commonalities in factors affecting megaprojects. Cost and schedule overruns are the common challenges in both types of country (Mišić and Radujković, 2015). Mega construction projects represent a deliberate option towards achieving sustainable development objectives in developing countries (Othman, 2013). However, developing countries have a shortage of design knowledge, technical skills, competent human resources and managerial capabilities (Othman, 2013). These shortages hinder the development of mega construction projects. In addition, the cost of megaprojects is a significant investment for these countries.

i. China

The number of mega construction projects in China has increased in recent years due to rapid urbanisation and these projects are usually very complicated in their nature. China is a leader among the developing countries. What other countries have taken centuries to do, China does in decades (Volodzko, 2016). Some examples of these projects include the national high-speed rail network, the Shanghai Yangshan Deep-Water Port and the Beijing Capital International Airport Terminal 3 project. Cost overruns and schedule delays are affecting and causing low performance in these projects (He et al., 2015). In the five years from 2004 to 2008, China spent more on infrastructure in real terms than in the whole of the 20th century. Also, from 2005 to

2008 China constructed as many kilometres of high-speed railway as Europe did in two decades (Flyvbjerg, 2014). The main challenge with megaprojects in China is their rapid development and rampant corruption (Volodzko, 2016).

ii. India

In India, the need for infrastructure has resulted in the design and execution of large projects regarding scope, size, cost and complexity (Mevada and Devkar, 2017). This has resulted in megaprojects being implemented in almost all infrastructure sectors in India (Mevada and Devkar, 2017). India is gaining a reputation for massive construction projects. Major infrastructure projects in India, as per Construction World (2017), include Metrorail, Chenab Bridge, Banihal Qazigund Road Tunnel and Mumbai's Eastern Freeway. The Global Construction 2030 report predicts that India will become the third largest construction market, after the USA and China, by 2021 (Construction World, 2017). Over the past few decades, India has invested billions of dollars in megaprojects. Some of the projects suffered cost and schedule overruns (Construction World, 2017).

2.5 Megaprojects in South Africa

In South Africa, housing for the urban poor remains a challenge. Housing forms part of megaprojects, however, is usually not the main focus of megaproject development (Sutherland, Sim and Scott, 2015). These homes are built to eradicate the housing backlog and to make sure there is better living environments for the poor. To date, almost three million of these homes have been provided (Turok, 2015). In South Africa, the political, economic and social pressure connected with democracy, housing and human settlements has been elevated to the level of large-scale project development involving local, provincial and national government (Sutherland, Sim and Scott, 2015). The large-scale human settlement projects that reflect a megaproject aims to address sub-standard housing throughout South Africa (Sutherland, Sim and Scott, 2015).

In 2004, the Breaking New Ground (BNG) housing plan was launched to address the government-assisted housing backlogs. Two large-scale human settlement projects

were identified as lead projects, namely, the N2 Gateway project in Cape Town (city of Cape Town) and the Cornubia Integrated Housing Project in Durban (eThekwini municipality). In large cities, megaprojects are used as a 'strategy of international competition to attract capital' and they 'influence the potential of cities as growth engines' (Kennedy 2013, p5.). The N2 Gateway project aimed to address a housing backlog in Cape Town along the N2 highway. Housing and social infrastructure projects are representative of a new generation of megaprojects (Jordhus-Lier, 2015).

In South Africa, large-scale projects are required to address both pro-growth and pro-poor requirements (Sutherland, Sim and Scott, 2015). Large-scale infrastructure projects in South Africa are promoted as having the possibility to drive economic growth, create employment opportunities and ensure that benefits filter down to the poor and disadvantaged (Sutherland, Sim and Scott, 2015). However, using megaprojects as a driver of economic growth and a means of social redistribution is challenging, as the literature reveals the failure of megaprojects in addressing social concerns (Dupont, 2013). It is believed that megaprojects could support the approach of entrepreneurial urbanisation as they channel investments into specific locations within the city (Dupont, 2013).

In KwaZulu-Natal province the three main infrastructure projects were identified to act as a major catalyst to the city's economy over the following ten years; the Dube TradePort, the King Shaka International Airport and the Moses Mabhida Stadium (Robbins, 2015). These projects were aimed to increase business and tourism in the province and reflects on governance experiences associated with megaproject development in South Africa. Megaprojects are worthy of investigation because their comparison with the more regular practices of local actors often provides revealing observations into the exercising of power and influence (Robbins, 2015).

One of the megaproject in two provinces, Kwazulu Natal and Gauteng which is in progress is the New Multi-Product Pipeline. The New Multi-Product Pipeline is South Africa's largest pipeline project. It is designed to transport liquid fuel from Durban to Johannesburg. The pipeline system will transport five grades of refined fuel, and it will provide three pump stations and delivery depots along the route as well as a coastal and

inland fuel terminal. This new facility will provide the capacity to meet the forecasted fuel needs of the inland market by the year 2030 (ARUP, 2012).

(i) Megaprojects in the study case area

There are megaprojects in progress in South Africa in the energy sector being Medupi and Kusile Power Stations for Eskom, the public electricity utility company. Medupi Power Station is a dry-cooled coal-fired power station being built by Eskom near Lephalale in Limpopo province. On completion, it will contain six coal-fired generating units, and each one will produce a gross nominal capacity of 800 megawatts (MW) of electricity. Collectively all the six units of Medupi should be able to produce 4800 MW of power when they go online in 2019. Medupi Power Station, first commissioned in 2007, was designed to fill a major energy hole to remedy Eskom's electricity capacity shortfalls, which had started showing signs of strains in meeting the escalating demand. In April 2007, the initial cost to completion was estimated as R69 billion (Phaahla, 2015).

Kusile Power Station is also a 4800 MW dry-cooled coal-fired power station being built by Eskom close to Kendal Power Station in the Nkangala district of Mpumalanga province. Kusile Power Station has been under construction since 2008, and the initial cost to completion was estimated in April 2007 to be R80.6 billion (Yelland, 2016). The project is still under construction. An indication of the cost to completion for both Medupi and Kusile Power Stations is provided in Table 1.

Table 1: Latest estimated total cost to completion (CTC) for Medupi and Kusile Power Stations as at July 2016. (Adopted from Yelland, 2016)

Item	Medupi	Kusile	Note
Latest declared CTC	R135 billion	R160 billion	Advised by Eskom July 2016
Flue gas desulphurisation	R15 billion	Included in declared CTC	Advised by Eskom September 2014
Interest during construction	R40 billion	R60 billion	Estimate as at July 2016
Settling of contractor claims	R5 billion	R5 billion	Estimate as at July 2016
Total CTC	**R195 billion**	**R225 billion**	Estimate as at July 2016

CTC for Medupi and Kusile Power stations (Yelland, 2016)

2.6 Causes of megaproject delays and cost overrun

The number of global megaprojects that are late or over budget is significant. According to Deloitte African Construction Trends Report (2014), approximately only twenty per cent of megaprojects in Africa reach financial closure and are able to move to execution. The project management team prepares the estimated cost and duration information during the early stages of the project. The report further states that different phases of a construction project are not immune to cost and schedule overruns as these could occur in any stage of the project. However, other studies have reported that cost and schedule overruns occur mainly during the construction stage. For example Assaf and Al-Hejji (2006) reported that 70% of the construction projects in Saudi Arabia are experiencing delay. Flyvbjerg, Bruzelius and Rothengatter (2003) conducted the largest and most robust study of cost overruns on a sample of 258 projects in 20 countries on five continents and reported that 9 out of 10 projects experience cost overruns. Perhaps it is because during the construction stage, unforeseen factors occur and the project budget is mostly expended during this stage (Adugna, 2015).

Megaprojects globally are missing the project deadlines (Mukuka, Aigbavboa and Thwala, 2015). Schedule overrun is very critical to both the contractor and the project owner in terms of money and performance respectively. All project stakeholders are affected by schedule overruns one way or another. The causes of schedule overruns are factors that occur before and during the construction phase that will contribute to the duration of the project (Mukuka, Aigbavboa and Thwala, 2015). These factors can be contractor related, consultant related, client related and/or other external factors.

Construction delay is one of the most common problems in construction projects, as it involves many stakeholders such as clients, contractors, engineers, regulators and politicians (Flyvbjerg, 2014). Schedule overrun is very critical both to the contractor from a financial perspective and to the project owner in terms of performance (Alaghbari et al., 2007). However, all project participants are affected by schedule overruns in one way or the other. In the case of schedule and cost overruns, it may seem as if the professionals are not capable of delivering the project and their reputation may become tainted and the client could lose confidence in them. As for the contractor,

schedule overrun becomes a liability; when the completion period becomes longer, the raw materials may get more costly due to inflation and the labour costs can increase (The Constructor, 2017).

Big infrastructure projects are rising in numbers, and they are financed by national governments and private capital development banks. There is a perception that large projects will produce economies of scale (Ludovique, Szklo and Schaeffer, 2017). However, most megaprojects fail to deliver what was expected. Cost overruns decrease the investment appeal (Flyvbjerg, 2014).

Consistent cost and schedule overruns of megaprojects imply the suboptimal use of the taxpayer's money (Shrestha, Burns and Shields, 2013). Kaming et al., (1997) indicated incomplete design at the time of tender, additional work at owner's request, site/poor soil conditions and changes in owner brief as critical causes of cost overruns. Some of the reasons that contribute to cost and schedule overruns in any project include design error, inadequate scope, the weather, project changes and underestimating the time for completing the project (Shrestha, Burns and Shields, 2013).

Weather attributes such as severe wind, precipitation, floods or hail can delay the project due to reduced visibility to move equipment, delays in the delivery of materials, reduced access to the site for workers, damaged infrastructure, and the loss of electrical power. The project environment also presents challenges for project managers that can contribute to cost and schedule overrun. Such challenges include risks such as political instability (Akanni, Oke and Akpomiemie, 2014).

There have been a number of studies conducted that have examined the causes of delays in all types of construction projects, not necessarily megaprojects. Findings have revealed causes such as delays in the approval of shop drawings, delays in contractor's payments that due to cash flow problems impact the project progress, design changes, conflicts in work schedules of the subcontractors, slow decision-making, design errors, labour shortage and insufficient labour skills (Musa, 2012). A study by Alaghbari et al. (2007) identified causes of schedule overrun on construction projects in Malaysia as follows; slowness in making decisions, slow to give instructions, lack of material on

market and poor site management. A study examining the construction industry of Lebanon identified causes for delays in projects from the owner's viewpoint and identified that the contractors, architect and engineering firms with respect to project management issues, contractual relationships and financial issues are contributors to the delays of a project (Musa, 2012).

Research conducted in Hong Kong identified that causes of delay in construction include non-existence of effective communication and also possible preconceptions. In another study, the top ten noteworthy causes of delays namely owner intrusion, inadequate contractor expertise, financing and payments, labour efficiency, slow decision-making, improper planning and subcontractors were identified (Musa, 2012). Findings from another study identified five factors causing delays in construction projects in Hong Kong; poor site administration and management, unanticipated ground conditions, slow decision making by all project teams, employer-initiated variations and essential variation of works (Adugna, 2015).

Furthermore, the following factors caused delays in building construction projects in Malaysia; contractor's financial problems that result in the shortage of construction materials on site, owner's financial problems and slowness in decision making, consultant's poor supervision and delays in issuing instructions, and external factors such as materials shortage and poor site condition (Musa, 2012). Additional factors that have been identified as the main causes of cost and delay overruns in Malaysia are poor scheduling and control of time, delays in the preparation of design documents, ineffective communication between stakeholders, changes in laws and regulations, low labour productivity and the lack of knowledge in executing methods (Tahir et al., 2017).

2.7 Causes of cost and schedule overruns in construction projects in South Africa

Just like anywhere in the world, South Africa is also experiencing challenges such as delays in completing projects within time and budget. According to Ramabodu and Vester (2013), South Africa has some projects that have suffered cost overruns. To mention a few of FIFA 2010 stadiums, Soccer city in Johannesburg with 174% cost

overrun, Green point stadium in Cape Town with 483% cost overrun and Moses Mabhida stadium in Durban with 267% cost overrun (Ramabodu and Vester, 2013).

Olatunji (2010) conducted a study on the causes of delays in project delivery in five provinces of South Africa and the findings indicated that factors which contributes to project delays in South Africa were management style, lack of reviews of design, inadequate motivation of workers, economic policies, lack of adequate planning, lack of speedy payment to contractors, and quality of management during design and construction.

Another study conducted by Ramabodu and Vester (2013) on factors that influence cost overruns in public sector megaprojects found that the most crucial factors were, change in scope of work on site, incomplete design on tender stage, extension of time with cost, lack of cost plan and monitoring of funds, delays in pricing variation orders and changes in the scope.

Moreover, Adugna (2015) conducted a study on causes of delay and cost overrun in office construction projects in the eThekwini Municipal area and the findings were that the most crucial causes are contractor's cash flow problems, delay in progress payments by the client, poor site supervision and management by contractor, inefficient quality control by the contractor during construction and contractor's difficulties in financing the project.

2.8 Types of delays

Megaprojects face many challenges that cause them not to be completed on time. Some of the delays that happen in megaprojects may not be any parties fault, however, they still contribute to cost and schedule overruns of the project.

Delays in megaprojects may be caused by the employer or the contractor or in some instances by a factor beyond any person's control. There are three types of delays namely excusable, non-excusable and concurrent (Kaming et al., 1997). Excusable delays are further categorised as compensable or non-compensable (Figure 1).

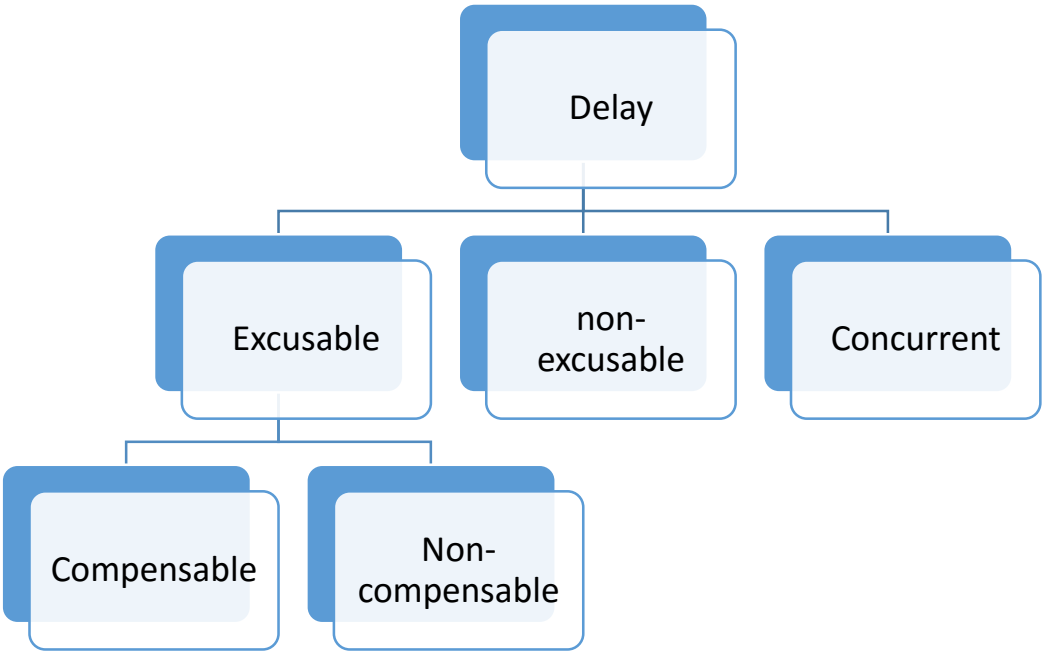

Figure 1: The categorisation of megaproject delay-types (Hamzah et al., 2011).

i. Excusable delays

Excusable delays are caused by events that are unforeseen and not as a direct result of an action by the contractor or the owner (Adugna, 2015). Thus, in this instance, neither the contractor nor the owner is liable or negligent. Excusable delays include labour unrest, floods, fires, and earthquakes, changes initiated by the owner, errors and omissions in the plans or specifications, differing site conditions and intervention by outside parties (Akanni et al., 2014; Lepage, 2017). As the contractor does not have any control over the delay, the contractor is entitled to an extension of time or compensation or both as per the terms and conditions of the contract (The Constructor, 2017).

ii. Non-excusable delays

Non-excusable delays are those that are within the control of the contractor but are not accepted by the owner (The Constructor, 2017). In these cases, the contractor is fully responsible for the activity delays imposed by the contractor or its suppliers and the fault does not lie with the owner. Non-excusable delays include failure to complete the work within the allocated time, late performance by the subcontractors, late performance by the suppliers, or failure of the contractor to provide sufficient

manpower to complete work on time (Lepage, 2017). Such actions do not give a contractor the entitlement to an extension of time. The contractor has to make up time by acceleration or compensate the owner. This means that no additional funds and no additional time are granted to the contractor (Hamzah et al., 2011).

iii. Concurrent delays

A concurrent delay is when one delay happens at the same time as another delay resulting in several activities simultaneously or individually affecting the completion of the construction project (The Constructor, 2017). In this instance, a project overrun period is caused by two or more delay causes that are nearly equal in contributing strength. Concurrent delays occur when two or more parties are at fault. These delay-types are complicated as more than one factor can delay the project at the same time or in overlapping periods of time (Hamzah et al., 2011). Nonetheless, not all of these events entitle the contractor to claim for financial compensation or extension of time (The Constructor, 2017).

iv. Compensable delays

Compensable delays are caused by the owner or the owner's representatives and results in some compensation for the delay of the project. This means that the contractor is compensated for the extension of time or cost reimbursement or both. (Hamzah et al., 2011).

2.9 How this study relates to previous studies

Megaprojects, or large construction projects, involve overpowering risks that cannot be predicted and sufficiently alleviated (Ludovique et al., 2017). The literature has indicated that there are challenges within megaprojects in relation to their completion both within budget and on scheduled time with a nine out of ten megaprojects being completed late and over budget (Flyvbjerg, 2014). Poorly managed projects add unnecessary and significant cost to South African taxpayers. In this study, the causes of cost and schedule overrun in South African megaprojects were assessed. Although

similar studies have been conducted previously, these have focused on infrastructure projects and not necessarily on megaprojects, thereby making the current study unique. In this study, local expertise and acumen during the front-end project preparation will be assessed specifically, as this has previously been identified as a cause of delays in megaprojects (Niazi and Painting, 2017).

2.10 Megaprojects: Schedule and cost elements

Further to understanding the key definitions of megaprojects, it was considered important to view and understand megaprojects from the cost and schedule side. Megaprojects are defined as projects with a total budget of USD$1 billion dollars and higher. There are many examples in the literature of megaprojects that have failed due to cost and schedule overrun (Flyvbjerg, 2014). Generally, megaprojects are politically driven, as there are widespread political influences in large-scale construction projects. Megaprojects keep on repeating the same mistakes of poor performance.

Megaprojects have the following complexity criteria:

- A significant number of stakeholders
- A large number of interfaces
- Challenging project location
- Inadequate supply of resources
- Unfamiliar technology
- Difficult regulatory constraints
- Extensive infrastructure requirements
- Geographically detached teams

Significant political, economic, environmental, or social influence

2.11 Conclusion

There is a common view that megaprojects cost $1 billion and more and that they are complex. Cost and schedule overrun are a challenge to megaprojects and construction projects as a whole. Project success is rarely common globally due to schedule and cost overrun. It was also identified that megaprojects are politically driven and that they

involve many stakeholders. Types of delays were outlined, and the gaps identified was that the factors that impact the outcome of megaprojects are not ranked by their severity, and the current literature does not provide specific solutions to mitigate such factors. The next chapter will be focusing on research design and method used for the study.

Chapter 3: Research design and methods

3.1 Research design

Research design refers to a system of beliefs and assumptions about the development of knowledge (Saunders, Lewis and Thornhill, 2016). The research onion illustrates the stages and an effective progression for the development of a research strategy. According to Saunders, Lewis and Thornhill, (2016) the below philosophies are defined and form the first layer of the onion model (Figure 2):

- Positivism shows the position that social entities exist in reality external to social actors concerned with their existence.
- Critical realism relies on the idea of independence of reality from the human mind. It also focuses on explaining what we observe and experience.
- Interpretivism perceives that social phenomena are created from perceptions and consequent actions of those social actors concerned with their existence.
- Postmodernism gives emphasis to the role of language and the of power relations.
- Pragmatism accepts concepts to be relevant only if they support action.

This study adopted positivism because the data was collected and the findings were quantifiable.

3.2 The research approach

The second layer of the research onion identifies three main approaches to theory development namely deduction, induction and abduction (Figure 2). According to Saunders, Lewis and Thornhill, (2016), the approaches are defined as follows:

- Deduction reasoning starts with a general theory, statement, or hypothesis and then works its way down to a conclusion based on evidence.
- Induction reasoning starts with a small observation or question and works its way to a theory or understanding or exploration by examining the related issues. Data are collected, and a theory developed as a result of the data analysis.

- Abduction combines both deduction and induction. Data are used to explore an occurrence, identify themes and explain patterns and also generate new or modify existing theory.

This study is essentially deductive in its approach as there is an existing theory. There is literature available to back up the theory of cost and schedule overruns, therefore the theory will be tested and conclusion is derived logically. The knowledge gained through observation and measurement is dependable.

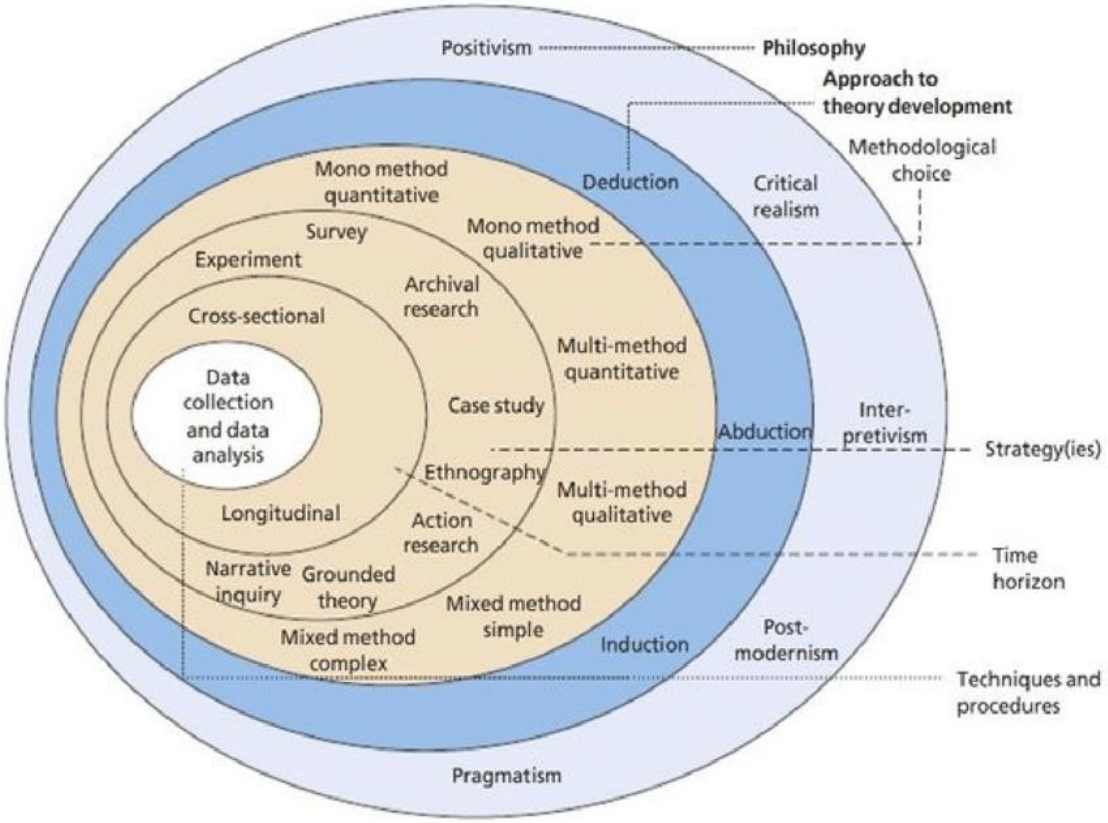

Figure 2: The Research Onion. (Saunders, Lewis and Thornhill, 2016)

3.3 Research methodology

There are three main methodological choices in research design (third layer of the research onion) namely qualitative, quantitative and mixed methods (Figure 2). 'Qualitative research is a research strategy that usually emphasizes on words rather than quantification in the collection of data and analysis of it.' (Hammersley 2013, p12.). Qualitative is often associated with an interpretive philosophy. It is exploratory research and seeks to explain how and why a particular phenomenon or programme operates as

it does in a particular context. It is used to gain an understanding of underlying reasons, opinions, and motivations. Qualitative data is often gathered through individual interviews and focus group discussions using semi-structured or unstructured focus guides (Saunders, Lewis and Thornhill, 2016). Quantitative design is different from qualitative design in a sense that it uses numbers to represent the findings of the study. Quantitative is generally associated with a positivism and deductive approach where the focus is on using data to test a theory. It uses measurable data to formulate facts and uncover patterns in research (Saunders, Lewis and Thornhill, 2016). Mixed methods combine the use of qualitative and quantitative.

This study adopted a quantitative method as quantitative attempts to produce real answers from hard data as there are few megaprojects in South Africa.

3.4 Research strategy

The fourth layer of the onion focuses on strategies, which includes experiment, survey, archival research, case study, ethnography, action research, grounded theory and narrative inquiry (Figure 2). This study adopted a survey because surveys are used to explore particular issues, describe a phenomenon, determine preferences and ascertain reasons (Tan, 2008). Survey strategy is usually used with the deductive approach. Survey methods can be explained as questioning individuals on a topic and then describing their responses.

3.5 Time horizon

The fifth layer of the onion focuses on time horizons with two horizons, the cross-sectional and the longitudinal (Figure 2). Due to time constraint, cross-sectional horizon was adopted in this study as it is often associated with survey strategy (Saunders, Lewis and Thornhill, 2016). Cross-sectional is quick to conduct and multiple outcomes can be analysed to create new theories or in-depth research. Longitudinal time horizon main strength is to study change and development. Longitudinal studies goes on for a longer period of time and they require a large sample (Saunders, Lewis and Thornhill, 2016).

3.6 Data collection procedure

The final layer of the onion focuses on techniques and procedures. The areas identified are data collection and data analysis (Figure 2). In this study, data was collected through a questionnaire that was forwarded to participants via email and responses were then analysed.

3.7 Target population

According to Burns and Grove (1993), population is defined as the total of all individuals who meet the sample criteria for inclusion in the study. Target population is defined as individuals to whom survey relates. Built environment professionals and contractors involved within megaproject in Limpopo province were the targeted population. The built environment professionals includes engineers, Architects, Quantity surveyors and project managers. This was accomplished with questionnaires distributed to 51 built environment professionals and contractors within megaproject in Limpopo, South Africa.

3.8 Sampling method

For all research questions where it is impossible to collect data from the entire population, a sample need to be selected. Sampling techniques are divided into two types namely, probability and non-probability. According to Saunders, Lewis and Thornhill (2016), probability sampling is associated most commonly with survey research strategy. Non-probability sampling is a sampling technique where the samples are gathered in a process that does not give all the individuals in the population equal chances of being selected. Purposive sampling is when one use his/her own judgement to select cases that will best enable one to answer research questions and meet the objectives. It is suitable when working with small samples such as in case study research or when selecting cases that are particularly informative (Saunders, Lewis and Thornhill, 2016). For this study, non-probability purposive sampling technique was adopted due to limited time and budget and since there are few megaprojects in Limpopo, it was appropriate to use this method.

3.9 Research area

The Limpopo province is located in the northern part of South Africa neighbouring Botswana, Mozambique and Zimbabwe (highlighted in red, Figure 3). It is home to approximately 5.4 million people, and it has an area of nearly 125.8 km^2 (Census, 2011).

Figure 3: Location of Limpopo province, South Africa (Census, 2011).

3.10 Data collection methods

Methods of research refer to those methods a researcher uses in performing research operations (Saunders, Lewis and Thornhill, 2016). The methodology adopted in this research provides the processes that are necessary to obtain the information needed to structure the research questionnaire, collect the data, analyse the data, and interpret and present the results.

Research can be descriptive or exploratory. Exploratory research aims to explore or search through a situation to provide acumens and understanding. Descriptive research is used to gain an accurate profile of events, persons or situations (Saunders, Lewis and Thornhill, 2016). The research questions that were used in this study were designed to explore the causes of cost and schedule overruns in South African megaprojects. The research can be categorised as exploratory, descriptive and correlational. This research is exploratory as it is initiated from practical problems of cost and schedule overruns. It is also descriptive as it tries to describe the causes of cost and schedule overruns in megaprojects.

The data used in this study were derived from both primary sources and a literature review. Primary data was obtained through a survey using online questionnaires with Qualtrics software. A questionnaire is a list of questions intended to gather information from individuals regarding their views on a particular issue of interest (McLeod, 2018). In this study, the questionnaire was designed to gather information on the possible causes of cost and schedule overrun from built environment teams dealing with megaprojects. An online questionnaire was used because of their convenience, cost-and time-effectiveness compared to face-to-face interviews given that the respondents were spread widely throughout the Limpopo province. The survey was carried out amongst consultants, project managers and contractors. The questionnaires had 26 questions and were distributed to 51 participants.

3.11 Methods for data analysis

The purpose of data analysis is to reduce the information gathered to a manageable and interpretable form for the formation of relations between research problems so that appropriate conclusions can be reached (Agyepong, 2014). When data is analysed, it can be presented in a more meaningful way. Quantitative data analysis was used in this study. The study made use of documents available online related to causes of cost and schedule overrun in construction projects.

There are different types of analysis methods and some of them are as follows:

- Mean: This is an arithmetic mean mostly known as ‘the average’. It is the sum of a list of numbers divided by the number of items on the list. It is useful in determining the overall trend of a data set (Dillard, 2015). Standard deviation: Standard deviation is the measure of the spread of data around the mean. A high standard deviation signifies that data is spread more widely from the mean, and a low standard deviation indicates that more data align with the mean. It is useful for determining the dispersion of data points (Dillard, 2015).
- Regression: Regression models the relationships between the dependent and explanatory variables (Statgraphics Technologies, Inc., 2009).
- Sample size determination: When measuring a large data set or population, like workforce, you don’t always need to collect information from every member of the population (Dillard, 2015).

- Hypothesis testing: Hypothesis testing commonly known as t testing, assesses if a certain premise is actually true for the data set or population (Dillard, 2015).

A mean method was chosen for this study to determine the overall trend of the data set and a seven-point Likert scale was used to assess the cause of cost and schedule overruns for the megaprojects surveyed. The adopted scale was as follows:

1 = strongly disagree
2 = disagree
3 = somewhat disagree
4 = neither agree nor disagree
5 = somewhat agree
6 = agree
7 = strongly agree

The seven-point scale was transformed to a mean item score (MIS) for each of the factors leading to cost and schedule overruns as assessed by the respondents. The indices were then used to determine the rank of each item. The ranking made it possible to compare the importance of factors as rated by the respondents. The mean item score (MIS) was calculated for each item as follows:

$$\text{MIS} = \frac{1n1+2n2+3n3+4n4+5n5+6n6+7n7}{\sum N}$$

Where:
n1 = number of respondents for strongly disagree
n2 = number of respondents for disagree
n3 = number of respondents for somewhat disagree
n4 = number of respondents for neither agree nor disagree
n5 = number of respondents for somewhat agree
n6 = number of respondents for agree
n7 = number of respondents for strongly agree
N = total number of respondents

3.12 Ethical consideration

Ethics are moral principles that manage a person's behaviour, and they affect how people make choices and lead their lives (BBC-Ethics, 2014). Ethics is concerned with what is good for individuals and society (BBC-Ethics, 2014). Ethics refers to rational standards of right and wrong that suggest what humans should generally do regarding rights, obligations, and benefits to society, fairness or specific qualities (Velasquez et al., 2010).

Research ethics is specifically interested in the analysis of ethical issues that are raised when people are involved as participants in research. The objectives thereof are to protect the human participants, to ensure that the research is conducted in a manner that serves the interest of the individuals, groups and society as a whole, and to ensure confidentiality and the process of informed consent (Walton, 2015).

Ethical issues are the concerns and predicaments that arise over the proper way to execute research, and ensure that harmful conditions are not created for the people involved in the research process. In this study, the participants were informed that their participation was voluntary and that they had the right to withdraw from the study. They were also informed that their privacy was to be respected and that everything they shared was treated as confidential.

Ethical considerations are important. This research followed and considered prescribed ethical considerations. The research proposal went through internal ethical evaluation and clearance. This involved submission of an ethics clearance application to the ethics committee of the School of Economics and Management at the University of the Witwatersrand for consideration and approval. The application was approved before data was collected (Appendix B).

3.13 Constraints of the study

Time constraints make it impossible to conduct physical interviews. Participants are not always available which makes it a challenge to conduct physical interviews. Also the cost of travelling to the participants can be a challenge.

3.14 Conclusion

In this chapter the research design was discussed, including research approach, population, sampling, and research area. Ethical considerations and data analysis method were also identified. The next chapter of the study will present results and discussions.

Chapter 4: Results and discussions

4.1 Introduction

This chapter presents the results of data attained from questionnaires which were distributed to the research participants in Limpopo. Participants included professionals in construction industry such as architects, quantity surveyors, engineers and project managers. A twenty-six question survey (Appendix C) was used to rank the identified causes of cost and schedule overrun, and to find the critical factors so that attention can be given to these with the aim of minimising the causes of cost and schedule overrun in South African megaprojects.

4.2 Summary of questionnaire responses

4.2.1 Questionnaire survey results

Questionnaires were distributed to participants via email. Follow-up reminders were sent by email to encourage and remind participants to take part in the survey by completing the questionnaires. The questionnaires were aimed to be distributed to individuals involved in megaprojects only, however, they were also distributed to individuals involved in construction projects above 1 billion in rands.

4.2.2 Questionnaire distributions

Table 2: Questionnaire distribution and responses

Description	Discipline	Number distributed	Number of respondents	percentage of responses received	percentage of responses from total
Consultants	Architects	12	5	42%	29%
	Quantity Surveyors	11	3	27%	18%
	Engineers	20	5	25%	29%
	Project Managers	4	4	100%	24%
	Contractors	4	0	0%	0
Total		**51**	**17**	**33%**	**100%**

From the 51 participants that the questionnaires were distributed to only 17 responses were received. Five people opted not to participate and 29 did not respond despite the reminder email. Thirteen consultants (five architects, three quantity surveyors, five engineers) and four project managers responded. The total response rate was 33% (Table 2). No contractors responded even though questionnaires and reminder were sent to them. The responses were analysed together as these projects are experiencing the same challenges.

4.2.3 Respondents work experience

The questionnaire was sent to architects, quantity surveyors, engineers, contractors and project managers in the construction industry. They were found by searching for current South African larger construction projects and megaprojects. This had limitations when generalising the view of cost and schedule overruns for the whole population of construction professionals in South Africa. The majority of the participants had worked for more than ten years in the construction industry. Therefore, it was assumed that the information regarding cost and schedule overruns by the respondents was more reliable. In addition, it was possible from the responses to see the different opinions of architects, quantity surveyors, engineers, contractors and project managers with respect to cost and schedule overruns.

Table 3: Respondents work experience

No. of years (work experience)	Architect	Quantity Surveyor	Engineer	Project Manager	Total
1 – 5 years		1			1
6 – 10 years				2	2
11 – 15 years	1	2	3	2	8
16 – 20 years	1		2		3
21 years and above	3				3
Total respondents	**5**	**3**	**5**	**4**	**17**

The work experience of the questionnaire respondents ranges from 1 to more than 21 years. Of the five architects who responded, three have more than 21 years of work experience, one has work experience of 16-20 years, and one has 11-15 years of work experience. Three quantity surveyors responded, two of whom have 11-15 years of work experience and one with 1-5 years of experience. Two of the engineers who

responded have work experience of 16-20 years, whilst three have 11-15 years of experience. Two project managers who responded have work experience of 6-10 years, and the remaining two have 11-15 years of experience (Figure 4 and table 3).

A total of three participants have more than 21 years of experience, three have 16-20 years of experience, eight have 11-15 years of experience, two with 6-10 years of experience and only one with 1-5 years of experience (Table 3). The greater majority of the participants have more experience in the construction industry.

4.2.4 Respondents position in the company

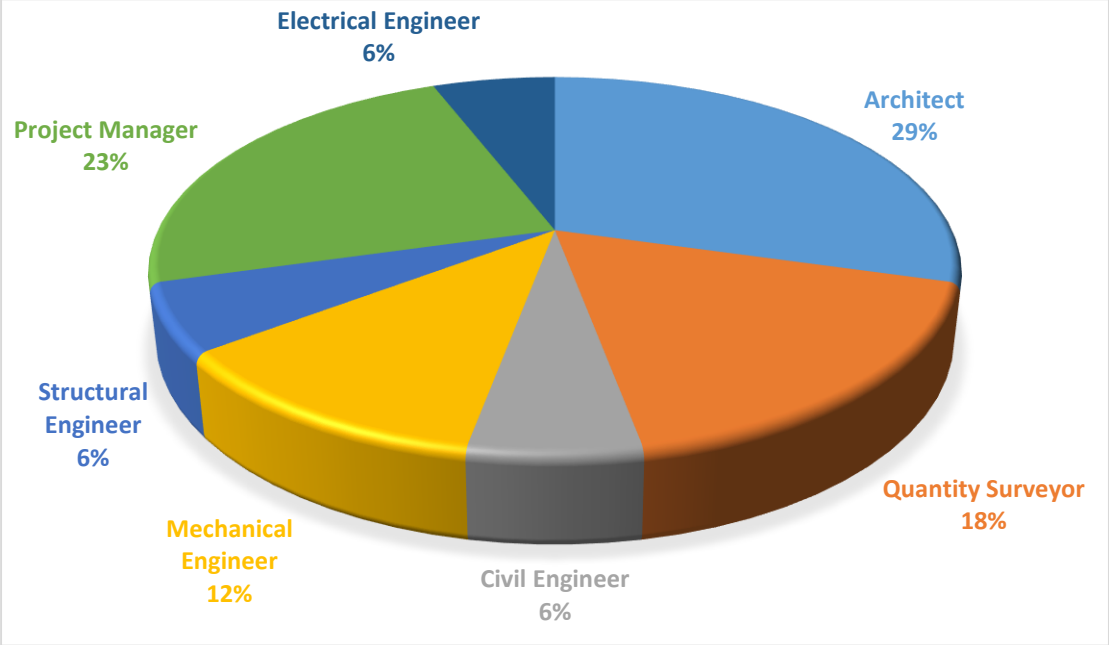

Figure 4: Percentage distribution of respondents' profession.

Of the respondents, 29% were architects, 23% were project managers, 18% were quantity surveyors, 12% were mechanical engineers and civil engineers respectively, and 6% were electrical engineers and structural engineers respectively (Figure 5).

4.3 Data analysis

i. Challenges militating against megaproject implementation success in Limpopo, South Africa

- Factors causing Schedule overrun

The results indicate that client slow decision making with MIS (5.76) and shortage of skilled labour with MIS (5.76) are ranked the number one factors that cause schedule overrun in study area megaprojects. This is followed by poor planning and scheduling with MIS (5.71), which is ranked second. Design changes with MIS (5.41) is ranked number three, whilst delay in work approval with MIS (5.29) is ranked number four followed by shortage of manpower with MIS (5.24) at number five (Table 4). The local situations that could contribute to project implementation sluggishness in South Africa are similar to those that have been identified in previous studies.

Table 4: Factors causing schedule overrun ranked using mean item score (MIS)

Factors	MIS	Rank
Incomplete drawings	4.25	8
Design changes	5.41	3
Client slow decision making	5.76	1
Late issue of instructions	4.82	6
Shortage of skilled labour	5.76	1
Poor planning and scheduling	5.71	2
Labour unrest	4.53	7
Shortage of manpower	5.24	5
Delay in work approval	5.29	4

- Factors causing Cost overrun

Inaccurate material estimate with MIS (3.76) is the number one ranked factor causing cost overrun in study area megaprojects. This is followed by shortage of skilled labour with MIS (3.65) which is ranked second, client's late contract award with MIS (3.35) is ranked third, and the fourth ranked is increase in material cost with MIS (3.06) in Table 5.

Table 5: Factors causing cost overrun ranked using mean item score (MIS)

Factors	MIS	Rank
Increase in material cost	3.06	4
Inaccurate material estimate	3.76	1
Shortage of skilled labour	3.65	2
Client's late contract award	3.35	3

ii. Conditions that could contribute to megaproject implementation sluggishness in Limpopo, South Africa

Site Conditions

- Responses to the question: 'Do you think the following affects the outcome of megaprojects? Site condition'

As indicated on table 6, responses revealed that unforeseen ground condition with MIS (5.53) is the factor which affect the outcome of megaproject.

Table 6: Site condition factor affecting megaproject

Factor	MIS
Unforeseen ground conditions	5.53

Weather

- Responses to the question: 'Do you think the following affects the outcome of megaproject? Weather'

Harsh weather conditions with MIS (4.94) is another factor that contributes to project implementation sluggishness in Limpopo (Table 7).

Table 7: Weather factor affecting megaproject

Factor	MIS
Harsh weather conditions	4.94

Material related

- Responses to the question: 'Do you think the following affects the outcome of megaproject? Material related'

Table 8 indicates that poor material planning with MIS (6.24) was ranked one, other factors which includes (slow decision making, knowledge of specifications, material ordering, approved materials, increase in material cost and market unavailability) was ranked second with MIS (5.57). Shortage of equipment with MIS (5.24) was ranked third.

Table 8: Participant responses to the question: Do you think the following affects the implementation of the Megaproject? Material related'

Factors	MIS	Rank
Shortage of equipment	5.24	3
Poor material planning	6.24	1
Other	5.57	2

iii. Planning and implementation of mega construction projects

Planning of megaprojects in South Africa

Table 9 shows that the greatest proportion (47%) of the respondents were somewhat satisfied with the planning of megaprojects in Limpopo. The second highest response was 24% of respondents who were somewhat dissatisfied with the planning of megaprojects in Limpopo.

Table 9: Participant responses to the question 'How satisfied are you with the planning of megaprojects in South Africa?'

Response	Number of respondents	Percentage respondents (%)
Extremely satisfied	2	12
Somewhat satisfied	8	47
Neither satisfied nor dissatisfied	1	6
Somewhat dissatisfied	4	24
Extremely dissatisfied	2	12

Implementation of megaprojects in South Africa

The greatest proportion (47%) of respondents were somewhat dissatisfied, whilst 24% of respondents were somewhat satisfied with the implementation of megaprojects in Limpopo (Table 10).

Table 10: Participant responses to the question 'How satisfied are you with the implementation of megaprojects in South Africa?'

Response	Number of respondents	Percentage respondents (%)
Extremely satisfied	2	12
Somewhat satisfied	4	24
Neither satisfied nor dissatisfied	1	6
Somewhat dissatisfied	8	47
Extremely dissatisfied	2	12

iv. Local expertise and acumen during the front-end project preparation process

The participants were asked to respond to thirteen factors that contribute to the implementation of a megaproject. The responses revealed that changes in scope of work on site with MIS (4.29), Contractual claims with MIS (4.29) and variation orders with MIS (4.29) were ranked number one. Omissions and errors in the bill of quantities with MIS (3.94) was ranked second; lack of cost planning & monitoring of funds, delay in costing variations & additional works, Unexpected conditions on site and delays in issuing information to contractors all with MIS (3.88) were ranked third; Incomplete design at time of tender with MIS (3.76) was ranked fourth; ignoring items with abnormal rates with MIS (3.65) was ranked fifth; communication barrier with MIS (3.63) was ranked sixth; provisional bill of quantities with MIS (3.53) was ranked seventh and importing materials was ranked eighth with MIS (3.41).Table 11: Participant responses to the question 'How important do you think the following contribute to the implementation outcome of the megaproject?'

Table 11: Factors contributing to outcome of megaprojects ranked using mean item score

Factors	MIS	Rank
Changes in scope of work on site	4.29	1
Incomplete design at time of tender	3.76	4
Contractual claims (extension of time with cost)	4.29	1
Lack of cost planning and monitoring of funds	3.88	3
Delay in costing variations and additional works	3.88	3
Variations orders	4.29	1
Provisional BoQ	3.53	7
Unexpected conditions on site	3.88	3
Importing materials	3.41	8
Delays in issuing info to contractor	3.88	3
Communication barrier	3.63	6
Ignoring items with abnormal rates	3.65	5
Omission and errors in the BoQ	3.94	2

Local expertise

- In response to the question 'Do you think we have enough local expertise in Limpopo, South Africa?'

Table 12: Participant responses to the question 'Do you think we have enough local expertise in Limpopo, South Africa?'

Response	Number of respondents	Percentage respondents (%)
Definitely yes	6	35
Probably yes	6	35
Might or might not	1	6
Probably not	2	12
Definitely not	2	12

35% of the participants believe that we definitely have enough local expertise and a further 35% think that we probably have enough local expertise. Whereas 12% think that we probably don't have enough local expertise and another 12% definitely thinks we do not have enough local expertise.

Factors affecting megaproject management

- In response to the question 'Do you think the following affects the implementation of the megaproject? Management'

Table 13: Factors affecting megaproject management

Factors	MIS	Rank
Poor site management	6.71	1
Inadequate managerial skills	6.65	2
Poor planning and control	6.53	3
Slow decision making	6.18	4

Table 13 reveals responses from participants that poor site management with MIS (6.71) was ranked first, inadequate managerial skills with MIS (6.65) was ranked second, poor planning and control with MIS (6.53) was ranked third and lastly slow decision making with MIS (6.18) was ranked fourth.

4.3.1 How responses are interpreted

The participant's responses were ranked according to their mean item score (MIS). A MIS range of 3.5-5.0 is denoted a higher rank, a MIS range of 2.5-3.4 is denoted a mid-rank, and a MIS of 1.0-2.4 is given a low rank (Min, 2012).

4.3.2 Factors militating against megaproject implementation success

From Table 14, the results indicates that poor site management with MIS (6.71) is ranked first, inadequate managerial skills with MIS (6.65) is ranked second, poor monitoring and control with MIS (6.53) is ranked third, lack of experience with MIS (6.29) is ranked fourth, poor financial planning with MIS (6.06) is ranked fifth, changes in scope of work on site and variation orders with MIS (4.29) were ranked sixth. Omission and errors in the Bill of quantities with MIS (3.94) was ranked seventh.

Table 14: Factors that are militating against megaproject implementation success.

Rank	MIS	Factors
1	6.71	Poor site management
2	6.65	Inadequate managerial skills
3	6.53	Poor monitoring and control
4	6.29	Lack of experience
5	6.06	Poor financial planning
6	4.29	Changes in scope of work on site
6	4.29	Variation orders
7	3.94	Omissions and errors in the Bill of Quantities

4.3.3 Top 5 Factors affecting the implementation of megaproject in study area

The top five ranked factors affecting the implementation of megaproject in South Africa are poor site management (ranked first) with MIS (6.71), inadequate managerial skills (ranked second) with MIS (6.65), poor monitoring and control (ranked third) with MIS (6.53), unstable management structure (ranked fourth) with MIS (6.41), and poor organisation structure and lack of experience that are both ranked fifth with MIS (6.29) (Table 15).

Table 15: Overall ranking and group ranking of the factors that affect the implementation of megaprojects.

Group	Factors affecting outcome of Megaproject	MIS	Rank	Overall Rank
Communication factors	Lack of communication between contractor and client	5.47	2	17
	Inefficient communication	5.82	1	10
Management	Poor site management	6.71	1	1
	Inadequate managerial skills	6.65	2	2
	Poor monitoring and control	6.53	3	3
	Slow decision making	6.18	4	7
Personnel	Shortage of managerial and supervisory staff	6.12	3	8
	Shortage of skilled labour	6.24	2	6
	Lack of experience	6.29	1	5
	Low motivation	5.41	4	18
Organizational	Unstable management structure	6.41	1	4
	Poor organization structure	6.29	2	5
Planning	Client initiated change order	5.71	2	12
	Inadequate design specification	5.82	1	10
	Rework	5.71	2	12
	Poor labour planning	5.59	3	14
Site conditions	Unforeseen ground conditions	5.53		16
Weather	Harsh weather conditions	4.94		20
Project related	Project complexity	5.65	1	13
	Project duration	4.94	2	20
Material related	Shortage of equipment	5.24	2	19
	Poor material planning	6.24	1	6
Other	Slow decision making, knowledge of specifications, material ordering, approved materials, increase in material cost and market unavailability	5.57		15
Process related	Poor procedures	5.76		11
Financial	Delayed payment to contractors/consultants	6.24	1	6
	Poor financial planning	6.06	2	9
Price related	Price increase	4.94		20

4.3.4 Consultants ranking on causes of schedule overrun in study area

There is a common agreement between the consultants working on megaprojects in South Africa regarding the top three causes of schedule overrun. Shortage of skilled labour, poor planning and scheduling, and client slow decision making were rated as the top three causes by the architects, quantity surveyors, engineers and project managers who participated in the survey. Shortage of skilled labour was ranked first by the architects with MIS (6.40) and second by both the engineers and project managers with MIS (6.00). Poor planning and scheduling was ranked first by the project managers with MIS (6.25) and by the quantity surveyors with MIS (6.00), and third by the architects with MIS (5.80). Client slow decision making was ranked first by the engineers with MIS (6.20) and second by the architects with MIS (6.00) and quantity surveyors with MIS (5.33) (Table 16).

Table 16: Ranking of the causes of schedule overrun factors per discipline using mean item score (MIS)

Discipline	**Architect**		**Quantity surveyor**		**Engineer**		**Project manager**	
Factors	**MIS**	**Rank**	**MIS**	**Rank**	**MIS**	**Rank**	**MIS**	**Rank**
Incomplete drawings	3.60	8	5.00	3	4.60	7	4.00	6
Design changes	4.80	6	5.33	2	5.80	3	5.75	3
Client slow decision making	6.00	2	5.33	2	6.20	1	5.25	5
Late issue of instruction	4.40	7	4.67	4	4.80	6	5.50	4
Shortage of skilled labour	6.40	1	4.00	5	6.00	2	6.00	2
Poor planning and scheduling	5.80	3	6.00	1	5.00	5	6.25	1
Labour unrest	4.80	6	4.67	4	3.40	8	5.50	4
Shortage of manpower	5.60	4	4.67	4	5.00	5	5.50	4
Delay in work approval	5.20	5	4.00	5	5.40	4	6.25	1

4.3.5 Consultants ranking on causes of cost overrun in study area

According to the consultants who participated in this study, inaccurate material estimate, shortage of skilled labour and client's late contract award are regarded as the main causes of cost overrun in megaprojects in Limpopo. Inaccurate material estimate is ranked as the first cause of cost overrun by the architects with MIS (4.60) and engineers with MIS (4.40) who participated in this study. Whereas, the project managers ranked it second with MIS (3.00) and the quantity surveyors ranked it third with MIS (2.33). Shortage of skilled labour is ranked first with MIS (4.00) by the project managers and second by engineers with MIS (4.20). The architects and quantity surveyors both ranked shortage of skilled labour as the third most important cause of cost overrun with MIS (3.60 and 2.33) respectively. Client's late contract award was ranked first by the quantity surveyors with MIS (3.67), second by the architects with MIS (4.00), and third by both the engineers with MIS (3.20) and project managers with MIS (2.50) (Table 17).

Table 17: Ranking of the causes of cost overrun factors per discipline using mean item score (MIS)

Discipline	**Architect**		**Quantity surveyor**		**Engineer**		**Project manager**	
Factors	**MIS**	**Rank**	**MIS**	**Rank**	**MIS**	**Rank**	**MIS**	**Rank**
Increase in material cost	3.20	4	3.00	2	3.00	4	3.00	2
Inaccurate material estimate	4.60	1	2.33	3	4.40	1	3.00	2
Shortage of skilled labour	3.60	3	2.33	3	4.20	2	4.00	1
Client's late contract award	4.00	2	3.67	1	3.20	3	2.50	3

4.4 Discussion of the results

4.4.1 Objective 1 findings

First research finding was to identify the challenges militating against project implementation success.

Findings from the questionnaire indicated that poor site management, inadequate managerial skills, poor monitoring and control, lack of experience, poor financial planning, and changes in scope of work on site, variation orders and omission & errors in the bill of quantities were the top seven challenges militating against project implementation success. Further findings indicated that client slow decision making, shortage of skilled labour, poor planning and scheduling, design changes, delay in work approval and shortage of manpower were the top five causes of schedule overrun. Whereas inaccurate material estimate, shortage of skilled labour, client's late contract award and increase in material cost were the causes of cost overrun.

A study done by Ramaloko, Ibrahimu and Nwobodo-Anyadiegwu (2018) revealed that design changes, poor planning, fluctuation of prices of project material and irregularities in contract documentation were the causes of cost overrun. Another study by Baloyi and Bekker (2011) revealed that design changes, material shortage, inadequate planning, poor site management, slowness of owner decision-making, scope changes, incomplete drawings, shortage of skilled labour, poor planning & scheduling, shortage of manpower, change orders by client during construction, delay in work approval, inaccurate material estimates and client late contract award were identified as causes of cost and schedule overruns. The research objective was achieved from both literature and questionnaire.

4.4.2 Objective 2 findings

Second research objective was to analyse the local climatic conditions that could contribute to project implementation sluggishness.

Findings revealed that unforeseen ground conditions, harsh weather condition, shortage of equipment, poor material planning, slow decision making, knowledge of

specifications, material ordering, market unavailability contributes to project implementation sluggishness.

A study by Tahir et al. (2017) indicated that unforeseen ground conditions, project team slow rate in making decision, material in market, weather, site condition and economic condition, procurement materials, lack of unavailability of working equipment were identified as causes of delay which could contribute to project implementation sluggishness. The research objective was achieved from both literature and questionnaire.

4.4.3 Objective 3 findings

The third research objective was to assess the planning and implementation practices of mega construction projects.

Findings from the questionnaire showed that 47% of the respondents were somewhat satisfied with the planning and 47% showed that respondents were somewhat dissatisfied with implementation of megaproject in Limpopo. Findings further indicated that lack of experience, shortage of managerial and supervisory staff, inadequate managerial skills and poor site management were factors affecting planning and implementation practices of megaproject.

Previous study by Othman (2013), revealed that lack of design knowledge and experience, lack of professional expertise, lack of financial resources, cost control, lack of experienced staff to accept critical roles which they are not prepared for, lack of available local labour, lack of properly trained on-site supervisors, huge numbers of people and organisations of different specialities involved in megaprojects development, lack of quality front-end were identified as some of the challenges of developing megaprojects. The research objective was achieved from both literature and questionnaire.

4.4.4 Objective 4 findings

Fourth research objective was to assess the local expertise and acumen during the front-end project preparation process.

Finding from the questionnaire showed that 35% believe we have local expertise in Limpopo, however this does not indicate a good sign as less than 50% of respondents thinks we do have local expertise. Further findings also indicate that changes in scope of work on site, contractual claims (extension of time with cost), variation orders, omission and errors in the bill of quantities, lack of cost planning and monitoring of funds, delay in costing variations and additional works, unexpected conditions on site, incomplete design at time of tender and ignoring items with abnormal rates were the top five factors indicating that the is lack of expertise and judgement in project preparation process. From the factors affecting management of megaproject findings revealed that poor site management, inadequate managerial skills and poor planning and control as the top three. This indicate that lack of skills is a challenge.

This findings were similar to the findings by Tahir et al. (2017), were delay in preparation of design document, changes in scope of work were identified to be the causes of delays which indicate lack of expertise. The findings were also in agreement with findings by Othman (2013), were lack of financial resources and lack of quality front-end planning were identified as challenges of developing megaprojects. Therefore, it can be concluded that research objective was met based on findings from literature and questionnaire survey.

4.5 Conclusion

Literature review showed that there are similar factors that causes schedule and cost overrun in megaprojects. Factors identified in the literature were similar to the ones identified in this study. Findings from the study supported the work reviewed by previous researchers. The results of this study indicate that proper planning and implementation of megaprojects is a challenge in South Africa. There is not enough local expertise in South Africa to ensure effective implementation of megaprojects. Poor site management, inadequate managerial skills, poor monitoring and control, lack of experience, unstable management structure, omission and errors in the Bill of Quantities and poor financial planning are other major challenges that impede the successful implementation of megaprojects in the country.

Using mean item score, it was found that the number one factors causing schedule overrun in megaprojects are client slow decision making and shortage of skilled labour, both with a MIS of 5.76. The number one factor causing cost overrun is inaccurate material estimate with a MIS of 3.76. The top five factors affecting the implementation of megaprojects in South Africa are poor site management (MIS 6.71), inadequate managerial skills (MIS 6.65), poor monitoring and control (MIS 6.53), unstable management structure (MIS 6.41) and lack of experience together with poor organisation structures (MIS 6.29).

Chapter 5: Conclusion and recommendations

5.1 Introduction

This chapter presents an overview of the study, noteworthy findings based on the research objectives. It also includes areas of further research and also gives a general research conclusion.

5.2 Overview of the study

Cost and schedule overruns are a challenge in megaprojects and construction projects as a whole. Successful projects are uncommon due to schedule and cost overrun. There are many causes of cost and schedule overrun in construction megaprojects with several studies having indicated many contributing factors. This study set out to identify the causes of cost and schedule overrun in South African megaprojects. The four objectives were to assess planning and implementation practices in mega construction projects, to assess the local expertise and acumen during the front-end project preparation process, to identify the local challenges militating against a megaproject's implementation success in South Africa, and to analyse the climatic local conditions that could contribute to project implementation sluggishness in SA.

A review of published literature was used to identify the variables causing cost and schedule overrun in construction megaprojects. The variables were used to design the questionnaire. The questionnaire was distributed to 51 built environment professionals and 17 were fully completed and analysed. A quantitative study using mean method was used for analysing data. The mean item score (MIS) method was used to rank the factors causing schedule and cost overrun. Using the ranking, the factors were ordered by importance, and the improvement thereof should be prioritised to improve megaprojects to attain improved cost and schedule performance and also to mitigate against further failures.

The majority of the respondents had more than ten years' experience in their field. Causes of schedule and cost overruns were ranked per discipline of the participants. All of the factors that ranked number one were considered to have a high impact on their

contribution to the implementation of megaprojects in South Africa. Factors causing schedule overrun were ranked per discipline as follows: engineers ranked client slow decision making number one (MIS = 6.20), architects ranked shortage of skilled labour number 1 (MIS = 6.40), project managers ranked poor planning and scheduling number 1 (MIS = 6.25) and quantity surveyors ranked poor planning and scheduling number one (MIS = 6.00). Factors causing cost overrun were ranked per discipline as follows: architects ranked inaccurate material estimate number one (MIS = 4.60), engineers ranked inaccurate material estimate number one (MIS = 4.40), project managers ranked shortage of skilled labour number one (MIS = 4.00) and finally quantity surveyors ranked client's late contract award number one (MIS = 3.67).

5.3 Noteworthy findings

In relation to research objective 1, some of the challenges that were identified as militating against project's implementation success are lack of communication between contractor and client, inefficient communication, poor site management, inadequate managerial skills, poor monitoring and control, lack of experience, shortage of managerial and supervisory staff, shortage of skilled labour and unstable management structure.

Some of the other causes that can affect the implementation of megaprojects in Limpopo, South Africa in relation to research objective 2 were identified as poor material planning, shortage of equipment, slow decision making, knowledge of specifications, material ordering and poor financial planning.

In relation to research objective 3, it was identified that proper planning and implementation of megaprojects is a challenge in South Africa. This factors affects planning and implementation practices of megaprojects, lack of experience, shortage of managerial and supervisory staff, inadequate managerial skills and poor site management.

In relation to research objective 4, it was clear that construction cost and schedule overrun is a problem in South Africa megaprojects just as in other countries. Changes

in scope of work on site and variation orders were identified as important in their contribution to the implementation of a megaproject. Other factors that rank high in importance are omission and errors in the Bill of Quantities and contractual claims with cost. Futhermore it is believed by the respondents that Limpopo, South Africa does not have enough local expertise.

Poor planning, labour unrest and unskilled staff were the most mentioned by the respondents as causes of late completion. Poor planning, poor costing at the start of project due to insufficient information and labour unrest were the most mentioned as contributors for overrun.

5.4 Recommendations

The problem of cost and schedule overrun in megaprojects are badly affecting the construction industry. All stakeholders should work together to achieve the successful outcome of all megaprojects. A competent project team should pay close attention to planning and preventive action to be able to manage the megaproject to success. Since there are no specific solutions to mitigate the factors in existing literature, it is therefore recommended that specific solutions to mitigate causes and schedule overrun be included in future studies.

5.5 Areas for further research

The following recommendations are proposed for further studies

- The study should investigate the effectiveness of procurement systems in South Africa.
- The study should also investigate the level of expertise of South African construction professionals with regards megaprojects design and management.

5.6 Conclusion

The overall result indicates that most important causes of cost and schedule overruns in South African megaprojects originate from financial and poor resource management.

In order to minimise these causes, proper estimating should be done in the planning stage and human resources should be provided with proper training in managerial and technical aspects of the megaprojects. Since a project is implemented by different stakeholders, it is important that all stakeholders support each other in order to minimise the challenges of cost and schedule overruns in South African megaprojects.

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Appendix A: More Questions with responses

1. What causes late completion in Megaprojects?

The following are what some of the respondents indicated

- Incomplete design, poor time management
- Communication, indecisiveness
- Poor managerial skills
- Method of appointing contractors
- Poor planning, budget constraints, scarcity of skills, scope creep
- Lack of proper planning, unexpected results, lack of co-operation by team members
- Poor planning and monitoring of site
- Reluctance in implementing punitive measures (e.g. how often are consultants punished for failing in their professional responsibilities)
- Labour unrest, community involvement and political interference
- Complexity of the project
- Delays in payments to contractor, delays in delivery of material, poor planning, lack of financial control by the contractor, strikes, weather conditions
- Poor planning, poor supply chain management especially with regards to procuring the right professional team and contractor
- Contractors not competent
- Inadequate scope definition at the beginning, design changes, unskilled staff, poor scheduling at beginning of project

2. Why generally there is cost overrun on megaprojects?

The following is what the respondents indicated

- Due to poor planning and management
- Inadequate adjudication
- Under-pricing of tender document
- Poor planning, budget creep
- Inaccurate project estimates, sever errors on project designs, variation orders, administration errors, poor site management

- Not knowing what is below the ground in the planning stage which will cause some changes in construction stage
- Poor skilled service providers
- Awarding contract to the lowest and inexperienced bidder
- Poor planning
- Poor costing at start of project due to insufficient information, client changes

3. What in your opinion contributes to schedule overrun?

The following is what the respondents indicated

- Poor planning
- Slow progress
- Poor planning from contractor and human resource from contractor
- Poor planning, delayed scheme approval by clients, delayed municipal approval
- Poor quality work leading to rework inadequate cash flow to contractor stakeholder conflict on the project, harsh climatic condition on site, frequent additional work
- Lack of skill and lack of enforcement on the contractor to deploy skill full personnel on site
- Strikes, unavailability of material
- Strikes, payments on time to workers
- Poor planning
- Contractors incompetence
- Client changes, poor definition at start of project, Bad construction management

4. What are the common causes of delays in commencing with megaprojects?

The following is what the respondents indicated

- Finance
- The client
- Unforeseen circumstances
- Poor planning, delayed scheme approval by clients, delayed municipal approval
- Unavailability of budget from client
- Lack of adequate communication between the parties

- Poor planning and delay in approving to award the tender
- Site clearance and approvals by the local municipality
- Poor planning, poor communication, poor workmanship
- Client changes, inadequate funding, design delays due to unforeseen changes

5. Are you aware of any interventions to mitigate cost overruns in megaprojects and what are they?

The following is what the respondents indicated

- Good planning and scope creep control
- Paying a lot of attention to project planning, checking of contractor's capabilities before appointment, attempting to stay within the scope that was originally planned, usage of good scheduling tools and charts, making sure that the stakeholders in the project are on the same page, constantly tracking and measuring of progress on site
- Proper costing at the planning stage
- Specialist sub-contracting, well experience foreman and Project Manager supported by skilled labours
- Experienced professional team and contractor
- Effective management planning, enough budget for project
- Proper planning and communication

Appendix B: Research ethics clearance

School of Construction Economics & Management

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SCHOOL OF CONSTRUCTION ECONOMICS AND MANAGEMENT RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER CEM/18/02/TJF**
PROJECT TITLE	Assessing the cause of schedule and cost overrun in South African Megaproject
INVESTIGATOR	**Tshidavhu Judith Fhumulani 1558751**
SCHOOL/DEPARTMENT	**SCHOOL OF CONSTRUCTION ECONOMICS AND MANAGEMENT**
DATE CONSIDERED	1 March 2018
DECISION OF THE COMMITTEE	Approved conditionally with respect to the declaration
EXPIRY DATE	2 March 2019
DATE	1 March 2018
CHAIRPERSON	Dr Kola Ijasen

cc: Supervisor : Dr Nthatisi Khatleli

DECLARATION OF INVESTIGATOR (S)

To be completed in duplicate and **ONE COPY** returned to the Secretary Mrs. M. Sithole at the CEM reception desk.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature **Date** 01 / 03 / 2018

Appendix C: Questionnaire

Welcome to the research study!

My name is Fhumulani Tshidavhu and I am a student at Witwatersrand University studying towards my Master's degree in Construction Project Management and I am being supervised by Dr Nthatisi Khatleli. I am inviting you to participate in my research on Assessing the Causes of Cost and Schedule Overrun in South Africa Megaproject. The aim of the study is to identify major causes of cost and schedule overrun in South African Megaproject. The potential benefit is that this study will add value and enable Built Environment Professionals to better plan the projects once causes of this failures are identified. You will be presented with information relevant to assessing the causes of cost and schedule overrun in South African Mega projects and asked to answer some questions about it. Please be assured that your responses will be kept completely confidential.

You have been selected as you have the experience in Megaproject and projects in general and your professional opinion is of value to my study. The study should take you around 10-15 minutes to complete. Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Fhumulani Tshidavhu at 1558751@students.wits.ac.za.

By clicking the button below, you acknowledge that your participation in the study is voluntary, and thank you for taking time to consider this invitation. Your participation will be greatly appreciated.

Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

Researcher contact details:
Fhumulani Tshidavhu -Mobile: 071 679 8604 Email: 1558751@students.wits.ac.za

Dr Nthatisi Khatleli (Supervisor)-Tel: 011 717 7651 Email: nthatisi.khatleli@wits.ac.za

- I consent, begin the study
- I do not consent, I do not wish to participate

1. What is your discipline?

- Architect
- Mechanical Engineer
- Electrical Engineer
- Civil Engineer
- Structural Engineer
- Quantity Surveyor
- Project Manager
- Client
- Contractor
- Other

2. Years of experience in line of your work

- 1 - 5 years
- 6 - 10 years
- 11 - 15 years
- 16 - 20 years
- 21 years and above

3. What are the factors causing Schedule overrun

	Strongly Agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Incomplete drawings							
Design changes							
Client slow decision making							
Late issue of instructions							
Shortage of skilled labor							
Poor planning and Scheduling							

	Strongly Agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Labor unrest							
Shortage of manpower							
Delay in work approval							

4. What are the factors causing Cost overrun

	Strongly agree	Agree	Moderate	Disagree	Strongly Disagree
Increase in Material cost					
Inaccurate material estimate					
Shortage of skilled labor					
Client's late contract award					

5. Do you consider construction Cost and Schedule overrun as a problem in South Africa Megaprojects?

Definitely yes	Probably yes	Might or might not	Probably not	Definitely not

6. How important do you think the following contribute to the outcome of the megaproject

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
Changes in scope of work on site	○	○	○	○	○
Incomplete design at time of tender	○	○	○	○	○
Contractual claims (extension of time with cost)	○	○	○	○	○
Lack of cost planning & monitoring of funds	○	○	○	○	○
Delay in costing variations & additional works	○	○	○	○	○
Variation orders	○	○	○	○	○
Provisional Bill of quantities	○	○	○	○	○
Unexpected conditions on site	○	○	○	○	○
Importing materials	○	○	○	○	○
Delays in issuing info to contractor	○	○	○	○	○
Communication barrier	○	○	○	○	○
Ignoring items with abnormal rates	○	○	○	○	○
Omission & errors in the BoQ	○	○	○	○	○

7. Do you think the following affects the outcome of the Megaproject?
Communication

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Lack of communication between contractor and client	○	○	○	○	○	○	○
Inefficient communication	○	○	○	○	○	○	○

8. Do you think the following affects the outcome of the Megaproject?
Management

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Poor site management	○	○	○	○	○	○	○
Inadequate managerial skills	○	○	○	○	○	○	○
Poor monitoring and control	○	○	○	○	○	○	○
Slow decision making	○	○	○	○	○	○	○

9. Do you think the following affects the outcome of Megaproject? **Personnel**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Shortage of managerial & supervisory staff	○	○	○	○	○	○	○
Shortage of skilled labour	○	○	○	○	○	○	○
Lack of experience	○	○	○	○	○	○	○
Low motivation	○	○	○	○	○	○	○
Too many responsibilities	○	○	○	○	○	○	○

10. Do you think the following affects the outcome of the Megaproject? **Organizational**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Unstable management structure	○	○	○	○	○	○	○
Poor organization structure	○	○	○	○	○	○	○

11. Do you think the following affects the outcome of the Megaproject? **Planning**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Client initiated change order	○	○	○	○	○	○	○
Inadequate design specification	○	○	○	○	○	○	○
Rework	○	○	○	○	○	○	○
Poor labour planning	○	○	○	○	○	○	○

12. Do you think the following affects the outcome of Megaproject? **Site conditions**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Unforeseen ground conditions	○	○	○	○	○	○	○

13. Do you think the following affects the outcome of Megaproject? **Weather**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Harsh weather conditions	○	○	○	○	○	○	○

14. Do you think the following affects the outcome of the Megaproject? **Project related**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Project complexity	○	○	○	○	○	○	○
Project duration	○	○	○	○	○	○	○

15. Do you think the following affects the outcome of the Megaproject? **Material related**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Shortage of equipment	○	○	○	○	○	○	○
Poor material planning	○	○	○	○	○	○	○
other	○	○	○	○	○	○	○

16. Do you think the following affects the outcome of the Megaproject? **Process related**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Poor procedures	○	○	○	○	○	○	○

17. Do you think the following affects the outcome of the Megaproject? **Financial**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Delayed payment to contractors/consultants							
Poor financial planning							

18. Do you think the following affects the outcome of the Megaproject? **Price related**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Price increases							

19. Do you think we have enough local expertise in South Africa?

- Definitely yes
- Probably yes
- Might or might not
- Probably not
- Definitely not

20. How satisfied are you with the planning of megaprojects in South Africa?

- Extremely satisfied
- Somewhat satisfied
- Neither satisfied nor dissatisfied
- Somewhat dissatisfied
- Extremely dissatisfied

21. How satisfied are you with the implementation of megaprojects in South Africa?

- Extremely satisfied
- Somewhat satisfied
- Neither satisfied nor dissatisfied
- Somewhat dissatisfied
- Extremely dissatisfied

22. What causes late completion in megaprojects?

23. Why generally there is cost overrun on megaprojects?

24. What in your opinion contributes to schedule overrun?

25. What are the common causes of delays in commencing with megaprojects?

26. Are you aware of any interventions to mitigate cost overruns in megaprojects and what are they?