Factors Contributing to the Cost and Time Overrun of a Construction Project at a South African Electricity Utility – An Eskom Case Study

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Declaration of Authenticity

I declare that the research project, Factors Contributing to the Cost and Time Overrun of a Construction Project at a South African Electricity Utility – An Eskom Case Study, is my work and that each information source has been acknowledged by a complete Harvard Referencing System. This dissertation has not been submitted before for any other research project, degree or examination at any university.

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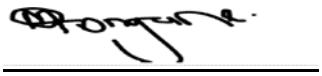

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Abstract

The construction industry is a principal driver of financial growth in any nation. However, the notoriety of cost and time overruns are a constant ongoing concern worldwide in the construction business, and hampering project success, despite the obvious improvement in the project management profession and using strategies and tools. A South African power utility Eskom, which forms part of the location of this investigation, has encountered several cost and time overruns on the development of the recently newly built power station. The opportune conveyance of projects within the utility is very important for the utility to ceaselessly convey on its mandate of providing electricity productively and economically. This study investigates elements that have contributed to the cost and time overrun of projects in construction at a South African electricity utility to give a practical and effective approach for the power utility to implement in overseeing and leading future construction projects.

This enquiry is inclined towards a subjective and interpretivist paradigm. Consequently, the data that were used to support the research findings were qualitative. A purposive sample of 15 Eskom employees from different functional areas that participated in the Medupi construction project was selected and interviewed. The results of the study identified 30 factors contributory to cost and time overruns at the electricity utility's construction project. The 30 factors were categorised into six themes, namely inadequate design, poor planning, scope creep, knowledge and skills shortage, internal factors and external factors. Among the measures to address these challenges, several recommendations were made, including investing adequate time and resources in selecting suitable design specialists and adapting various project management tools and techniques. The conclusion of this research study indicates a need to investigate and analyse the contractor's perception on time and cost overrun in construction projects towards reducing time and cost overruns at the electricity utility.

Keywords: Time overrun, cost overrun, construction projects

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List of Acronyms

Acronyms	Description
CIDB	Construction Industry Development Board
CM	Construction Management
CMT	Construction Management Theory
CPM	Critical Path Method
CTC	Cost to Completion
ECSA	Engineering Council of South Africa
EEF	Enterprise Environment Factors
EPLCM	Eskom Project Life Cycle Model
EVM	Earned Value Management
FAT	Factory Acceptance Test
FIFA	Federation Internationale de Football Association
FGD	Flu Gas Desulphurisation
GDP	Gross Domestic Product
IEC	International Electrotechnical Commission
ISO	International Organizational Standardization
KPI	Key performance Indicator
MW	Megawatts
OGC	Office of Government Commerce
PM	Project Management
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMO	Project Management Office
PRINCE	Project in Controlled Environment
P&SCM	Procure and Supply Chain Management
RAM	Responsibility Assignment Matrix
ROI	Return On Investment
TIPS®)	Technology, Innovation, People and Innovation
TQM	Total Quality Management
UK	United Kingdom
US	United States
VSE	Very Small Entities
4IR	Fourth Industrial Revolution

Chapter 1

INTRODUCTION

1.1 Introduction to the context of the study

The construction business is critical in a nation's growth, and it can upsurge or create the monetary advancement of a country. The construction industry is a key driver of monetary advancement in any nation (Baloyi & Bekker, 2011). According to Adugna (2015), the construction industry is enormous, complex, unpredictable, and risky and it involves huge investments outlay and limited budget. Yet, the notoriety of time and cost overruns are an insistent chronic concern worldwide in the construction industry, hampering project success, despite the obvious advancement in the project management career and utilizing modern methods and instruments (Ramabodu & Verster, 2013; Pinto, 2010; Olatunji, 2010; Sunjika & Jacob, 2013; Apolot, Alinaitwe & Tindiwensi, 2010).

Numerous projects experience extensive rescheduling, in this way surpassing the original time and cost estimates (Shete & Kothawade, 2016). The reason for delays has been examined for quite a while (Bosch-Rekveldt, Jongkind, Mooia, Bakker & Verbraeck, 2011) and delays in development projects for quite a long time (Doloi, Sawhney & Iyer, 2012). As indicated by Assaf and Al-Hejji (2006), seventy percent (70%) of building ventures encountered time rescheduling, and the normal time postponement goes from ten to thirty percent of the first term of the project (Memon, Rahman, Abdullah & Aziz, 2011), bringing about the development of ill-disposed connections, litigations, arbitration, income issues and an overall sensation of fear amongst project members (Memon, Rahman, Abdullah & Aziz, 2011).

The South African power utility Eskom, which forms part of the location of this investigation, has encountered a few cost and time overruns on the recently constructed power station. The electricity utility in bolstering of the South African regime, is building another power station to guarantee that South Africans have a continuous power source. The South Africa regime had to pronounce building the modern capacity, and Eskom was selected as the executing specialist of the contemporary construction plan, which was lined up with the public authority's objective of a six percent GDP development in the middle of 2010 and 2015. The original project for the baseload power station, Medupi power station, will increase by 4500 MW (6 × 750 MW) of baseload coal-fired capacity (Eskom, 2014). Upon finishing point, Medupi will be the third-biggest coal-fired power plant globally.

The Medupi power station's initial unit dispatching was planned for 2012, though the excess units were to be commercialized at eight-month interims, with the last unit sanctioned by 2015 (Eskom, 2014). Notwithstanding, the Medupi development project has been unsuccessful in meeting the due dates and it is overdue, as the period for synchronization was expanded on numerous occasions, where the principal unit was commercialized distinctly in March 2015 (Yelland, 2016).

The convenient conveyance of ventures within the utility is critical for the utility to constantly convey on its order of giving power productively and economically. Nonetheless, the power utility experienced difficulties in finishing the development project on schedule and under budget and remains monetarily depressed. Project deferments and cost overruns results in

construction projects not accomplishing their purposes and, eventually, the significance of this study in poor service delivery. This research investigates the contributory factors influencing the cost and time overruns in a construction project. The Eskom novel and recently constructed project at Medupi will be utilised as a case study.

1.2 Problem statement

Delays in projects have led to an expanded expenses and postponements in the generation of revenue from unfinished projects (Mulla & Waghmare, 2015), extra expenses because of lengthier working times, labour fee escalation, and higher manufacturing fee for the supplier (Haseeb, Rabbani, Xinhai-Lu, Maloof-ud-Dyian & Bibi, 2011). Cruywagen (2012) upholds this opinion and expresses that for the owner and supplier; postponements might also result in missing new opportunities because of the inaccessibility of investment and assets.

The building of the Medupi power station was projected to be finalized before the end 2014, and construction commenced in 2007. Nevertheless, the construction of the Medupi power station was unsuccessful in achieving any of its targets and it is long overdue. The initial unit was only synchronised in March 2015. Consequently, the construction of Medupi project is only projected to be completed by 2020, making it four years behind schedule, which is twice the original period. As Cruywagen (2012) indicated, time deferrals triggered by interruptions have a knock-on result, prompting to cost overruns because of inflated expenditures. The Medupi construction project was intended to be finalized within a financial plan of R105 billion; however, according to Chris Yelland (Mybroadband, 2019), an energy analyst in South Africa, the most recent estimation of the cost to completion (CTC) is R234 billion, which is 129% more than the original financial plan.

Although several research have been piloted to recognise the elements and reasons for project postponements and cost overruns in South Africa, the subject of project deferments and cost overruns has not yet been settled (Akinsiku & Akinsulire, 2012; Apolot *et al.,* 2010). Thus, the subsequent calamity of construction projects not being completed on time and within budget establishes this investigation that pursues to discover the major elements that contributed to the Medupi construction project cost and time overrun.

1.3 Research aim and objectives

This research explores elements that have contributed to the cost and time overrun of construction projects (specific to the Medupi Construction) to provide an appropriate and operational strategy for the power utility to adopt in overseeing and executing future construction projects. The objectives of this study are:

- to explore factors contributing to the cost and time overrun in construction project at a South African electricity generating utility.
- to identify and analyse factors contributing to the cost and time overrun in a construction project at a South African electricity generating utility, Medupi Construction Project.
- to recommend a suitable and effective strategy for a South African electricity generating utility to manage and execute future construction project effectively.

1.4 Research questions

Q1: What are the factors that have contributed to the cost and time overrun in a construction project at a South African electricity utility?

Q2: What are the effects of the cost and time overrun in a construction project at a South African electricity utility?

Q3: How can the cost and time overrun be mitigated in a construction project at a South African electricity utility?

1.5 Research philosophy

Saunders, Lewis, and Thornhill (2012) define research philosophy as the improvement of knowledge and the nature of that information. In social sciences, paradigm research philosophies are perceived and understood through their core ontological and epistemological assumptions emanating from distinct worldviews (Tang, 2011). The acknowledged philosophy of research includes assumptions about how the world is looked at by an observer.

This investigation is persuaded towards a subjective ontology in a view that reality is indirectly developed depending on individual understanding about the elements contributing to the time and cost overrun of construction project at a South African electricity utility. The epistemological assumption of this study is rooted within the interpretivism framework constructivism because an interpretivist study generates new, richer understandings and clarifications of social universes and settings.

1.6 Research methodology

From the research question presented in this study, the qualitative research design was appropriate, as the research relies on the researcher collecting non-numerical primary data, such as words and pictures, serving as an instrument herself and making qualitative research well-suited for providing factual and descriptive information (Johnson & Christensen, 2012). Berg and Howard (2012) describe qualitative research as meanings, concepts, definitions, images, symbols and descriptions of things. Numerous qualitative research strategies exist, including case study, phenomenology, narrative research and grounded theory. For this research, the researcher has selected the case study design because of its capability to analyse a single phenomenon within a broader setting and consequently enable the researcher to remain focused (Rule & John, 2011; Yin, 2012).

Qualitative study is aligned with interpretivism and semi-structured interviews as an information collection technique, as in this research. It may also be related with an inductive methodology where the emphasis is not on utilizing information to assess the theory but to develop and reproduce theory or theories where required. Moreover, this research is also exploratory. The exploratory research encompasses “discovering general information about a topic that is not understood clearly by the researcher” (Saunders, Lewis & Thornhill, 2009).

Consequently, the researcher collected information using a semi-structured interview. The crucial method of semi-structured interview involves posing relevant and exact questions.

Johannesson and Perjons (2014) define an interview as a correspondence gathering between the researchers and respondent in which the researcher controls the program by posing questions to the respondent. The interviewer commenced with introducing herself, brief description of the study, guaranteeing the respondents that all the data and evidence from the interview will be consciously utilised only for the study purpose. Furthermore, interviews were recorded only after obtaining consent from the respondents, and their anonymity was applied. The investigation of the case study outcomes was executed by employing a thematic analysis, producing descriptions, pattern coordinating and building clarification.

1.7 Significance of the study

Time and cost overrun influence the successful delivery of construction projects in many areas, causing time and cost overruns, claims and disputes. The contractor must achieve delivery and profit, whereas a project owner must ensure delivery with “good value for money”. Eskom has invested a significant amount of funds and time on the construction of the Medupi project. However, with the popularity of time and cost overruns in construction projects, these objectives are unachievable. Time and cost overruns are common problems that much of the time occurs in the construction project internationally (Sweis, Sweis, Rumman, Hussein & Dahiyat, 2013; Murray & Seif, 2013).

Upon recognising the factors contributory to cost and time overruns in construction projects at the power utility, this investigation aimed to provide an appropriate and viable technique for the power utility to adopt in overseeing and implementing upcoming construction projects. This research, therefore, is critical because it provides the construction industry fraternity with the findings to help suggest timely solutions to the challenges during construction in future. The study adds more insights to the existing literature and project management body of knowledge on factors contributing to time and cost overruns in construction projects. The study also enables individual researchers to identify gaps in this study and research those areas further.

1.8 Return on investment

Time and cost overruns have evident effects for the principal shareholders, the project owner, and the construction business in general and all parties involved. To Eskom, since the prediction that the project will be realised within an allocated time and cost border, time and cost overruns infer added expenses and more time than those originally contracted upon at the beginning, resultant in less returns on investment, poor quality workmanship, liquidations, discontentment by project owners and subsequently by end-users, undesirable media reports. The results are numerous. As with any sponsored work, the sponsor expects return on investment (ROI), additionally The Da Vinci Institute with its systems thinking approach, requires evidence of the potential application of the research findings in the workplace to illustrate ROI for the sponsor organisation. This study, a practical operational strategy generated from the theory and research findings will be presented to Eskom for possible application in the construction project management space and contribute to a growing body of knowledge on how to assist and to ensure continuous improvement within the construction projects environment.

It is anticipated that the new insight offered by the study findings will contribute valuable information to the research base for construction managers, project and contract managers, leadership and professionals working in the field of construction projects by increasing their awareness of the factors that contributed to the Cost and Time Overrun of Eskom Medupi Construction Project.

The other benefit is applying and using the strategies recommended in the research correctly and in alignment with the internal Eskom Business management systems policy and procedures to prevent cost and time overruns in construction projects. The recommendations can be applied on construction projects, refurbishment projects, outage management and by setting proper maintenance procedures to save costs and time. This will bring with it business improvement and many other benefits in short, medium and long term in different areas as listed below:

i. Improved plant performance.
ii. Good business governance acumen.
iii. Better integration of risk management.
iv. Corporate image enhancement.
v. Increase in employee satisfaction level.
vi. Cost and time savings.

1.9 Chapter overview

The dissertation is outlined in Table 1.1.

Table 1.1: Outline of the study

CHAPTER	DESCRIPTION
Chapter 1: Introduction	This section introduces the context of the research. The section presents the research problem, objectives, the research questions, research philosophy, followed by an introduction to the research methodology. The chapter concludes with an outline of the dissertation.
Chapter 2: Theoretical framework and literature review	Chapter 2 is a brief overview of the theoretical framework and literature related to the content of this dissertation. The principal topics covered in the chapter are types of construction delays, previous research concerning cost and time overruns, factors causing time and cost overruns, effects of cost and time overruns and project management standards available in construction projects.
Chapter 3: Research methodology	This section focuses on the enquiry approach that will be utilized during the research process. The chapter comprises a

CHAPTER	DESCRIPTION
	research design, research philosophy, population and sampling strategy, data collection instruments and analysis and ethical considerations.
Chapter 4: Findings	This chapter details the research findings obtained during data collection.
Chapter 5: Discussion of findings	This chapter discusses the research findings.
Chapter 6: Conclusion and recommendations	This chapter concludes the study and presents recommendations for future construction projects to enable and enhance successful project delivery.

1.10 Conclusion

Chapter 1 provided a synopsis of the study, including the context in which the study was set. The chapter presented the problem, objectives, and the research questions. This chapter further explained the research philosophy and introduced the research methodology used in the study and ended with an outline of the dissertation. Chapter 2 provides the theoretical framework and literature review, which offers insight into variables contributing to cost and time overruns in construction projects through the extant literature.

Chapter 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

This chapter presents the effects of cost and time overruns in construction, ending with project management standards available in the construction projects. Saunder, Lewis and Thornhill (2012) explained that “an essential preliminary task when undertaking a research study is to go through the existing literature in order to acquaint with the available body of knowledge in the area of interest”. This section classifies the factors causing cost and time overruns in construction projects as thoroughly as possible through a rigorous and wide-ranging analysis of studies by various researchers in different construction environments.

The following sections focus on the types of construction project delays, a review of previous studies relating to time and cost overruns, factors causing time and cost overruns in construction projects.

2.2 Types of construction delays

A construction project is an assignment undertaken to produce a unique facility, product or service within a specified scope, quality, time and cost (Ibrahim, 2013). Construction projects frequently experience delays. Construction delay is a major problem for any developing country. A deferment, as alluded to in construction, is a lengthy construction period and interruptions are proceedings disturbing the construction plan (Kikwasi, 2012). Any postponing event in construction could happen because of the employer’s shortcoming or the supplier or for a circumstance that is outside the ability to control of the two companies. Several authors have classified deferrals in construction projects but most of these groupings share a great deal and purpose concerning their fundamentals.

Construction deferments can be gathered or characterized into the following categories (Abdullah, Rahman & Azis, 2010; Gourlay, 2010; Kikwasi, 2012; Sivaprakasam, Dinesh & Jayashree, 2017; Sunjika & Jacob, 2013):

a) Critical or noncritical delays: Delays affecting the project completion date as agreed on contract are critical, although postponements that do not influence the project end date are noncritical.
b) Excusable or non-excusable delays: The delays that are not predicted under any activity that is beyond the control of the contractor are excusable. As indicated by general requirements in public agency stipulations, deferrals consequential from following events would be viewed as excusable. These are general workforce unrest, fires, floods, and actions of God, owner-directed modifications, oversights and mistakes in the plans and stipulations, varying location circumstances or covered conditions, strangely severe climate, interference by external agencies and absence of act by regime bodies, such as building evaluation.

According to Muhammed (2016), earlier the investigator concludes that a deferral is excusable dependent on the previous description; the person should allude to the construction agreement records. Verdicts regarding deferments should be prepared within the background of the particular agreement. The agreement ought to outline the variables that are viewed as valid deferrals to the project that substantiate time additions to the agreement end period; for instance, some agreements might not permit for any time expansion brought by climate, irrespective of how uncommon, unforeseen, or severe.

Non-excusable postponements are within the supplier's control or predictable and they are the responsibility of the contractor and the customer could be qualified to claim compensations. Muhammed (2016) list examples of non-excusable delays as the late performance of subcontractors, inconvenient performance by suppliers, defective workmanship by the supplier and subcontractors and a project-specific workforce unrest triggered by either the supplier's reluctance to meet labour agents or by unreasonable labour practises.

a) Compensable or Non-compensable delays: A compensable postponement is where the supplier is designated to prolong the time and add the reimbursement. Excusable delays can be compensated. In non-compensable delays, the contractor cannot claim for the compensation from excusable delays.
b) Concurrent or non-concurrent: A concurrent delay is a concept of presenting an analysis for common construction delays. The argument of concurrency is not to determine the critical delay viewpoint but an attitude responsible for damages connected with the delay to the critical path.

2.3 Previous studies relating to time and cost overruns of construction projects

A project is measured fruitful when it is finished on schedule, within financial plan, and according to stipulations (Aziz, 2013). These three measurements are unequivocally reliant and corresponded. The incapability to accomplish these targets manifests as deferral and overruns (Adam, Josephson & Lindahl, 2017) with risks, and therefore, the consequences of hazard events and overruns become common in the construction business. Time and cost overruns have been reported as major problems in construction projects globally (Enshassi, Najjar & Kumaraswamy, 2009; Ameh, Soyingbe & Odusami, 2010; Apolot *et al*., 2011) and South Africa is no different. Globally, investigations displayed that the time and cost overrun concern is a shared matter in construction projects and confirm that time and cost overruns are unacceptably high in construction projects (Ramabodu & Verster, 2013). According to Tshidavhu and Khatleli (2020), megaprojects also do have an excessive number of projects coming up short, because of budget surplus and schedule deferment, although comparatively small in number.

Megaprojects are costly and incorporate numerous hazardous factors that can cause deferments or disappointments through the project implementation (Ma, Zeng, Lin, Chen & Shi, 2017). Flyvbjerg (2014) defines megaproject as large scale, complex ventures that costs $1 billion or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people. Examples of megaprojects as illustrated by Flyvbjerg (2014) are high-speed rail lines, airports, seaports, motorways,

hospitals, national health or pension ICT systems, national broadband, the Olympics, large-scale signature architecture, dams, wind farms, offshore oil and gas extraction, aluminium smelters, the development of new aircrafts, the largest container and cruise ships, high-energy particle accelerators, and the logistics systems used to run large supply-chain-based companies like Amazon and Maersk.

As indicated by Assaf and Al-Hejji (2006), seventy percent of projects in construction encountered schedule overruns, and the normal time defer goes from ten to thirty percent of the initial period of the project (Memon *et al*., 2011). The Sydney Opera House is an illustration of a megaproject that went overbudget and finalized well outside of the projected plan, the project took ten years longer than projected and cost 1 400% more than anticipated (Flyvbjerg, 2014). In the transportation sector, Flyvbjerg, Skamris-Holm and Buhl (2013) conducted a measureable research of the expenditure performance of transportation projects and the research analysed a sample of 258 projects through 20 nations, with a collective expense of ~$90 billion. These projects were constructed between 1925 and 2000. The discoveries were concerning in that they uncovered that out of each ten transportation structure projects, nine encountered finance or budget overrun.

KPMG (2015) in their 2015 worldwide construction project owner's review detailed that merely 31% and 25% of the respondents' projects were conveyed within 10% of the initial financial plan and cut-off date, correspondingly, in the years past the investigation. Ramabodu and Verster (2013) reference some conspicuous projects with cost overruns globally, counting Denver Airport in the US, which was budgeted for US$5 billion yet finished above two hundred percent cost overrun, the Oresund Bridge between Denmark and Sweden, which encountered a sixty-eight percent cost overrun, and the Scottish Parliament building was finished three years after the scheduled end date with a 900% cost overrun.

Cantarelli, VanWee, Molin and Flyvbjerg (2012) noted that the Dutch construction projects had a regular cost overrun of 10.6% for railways, 18.6% for roads, and 21.7% for fixed links. In Portugal, construction projects experienced at least a minimum of 12% cost overrun (Abdul-Rahman, Memon, Abdul-Azis & Abdullah, 2013). These outcomes are not diverse in emerging nations. In Bosnia and Herzegovina, Abdul-Aziz, Memon, Abdul-Rahman and Karim (2013) revealed that in an investigation of 53 infrastructure projects, 29 new construction projects encountered a cost overrun of 6.84% all things considered, while the outstanding 24 reconstruction projects had a cost overrun of 9.23% on average. The World Bank report (2015) found that during the implementation phase of infrastructure projects, cost overruns occurred in 20% of cases, whereas time overruns were estimated at more than 110%.

A study by Endut, Shehu, Akintoye and Jaafar (2009) was on time and cost overruns in construction projects in Malaysia, including 308 public areas and 51 private regions. The outcomes display that the level of schedule overruns is higher than the ratio of cost overruns, but both are experiencing overruns above 50%. For the public area, only 20.5% of the projects were finished within the specified time and 46.8% of the projects were finalized within financial plan. For the private regions, only 33.35% and 37.2% of projects were finalized within time and cost approximation, correspondingly. MARA construction projects likewise experienced difficulties in time overrun, where it was tracked down that ninety percent of projects have encountered deferrals as from 1984 (Abdullar, Azis & Rahman, 2011).

South Africa has additionally encountered latest prominent cost overruns in numerous large-scale projects. By law, large-scale projects in South Africa must address both pro-growth and pro-poor socio-economic development goals (Sutherland, Sim & Scott, 2015). There are a limited number of megaprojects in development or finished in South Africa in different sectors including the energy, transport and infrastructure sectors. The 2010 FIFA World Cup Stadiums Project suffered delays and cost overruns. Samples are the Soccer City Arena in Johannesburg constructed for R3,3 billion and encountered a budget overrun of 58% (Davie, 2010: online). Greenpoint arena in Cape Town encountered a 50% expense overrun (Van Gass, 2007: online). Moses Mabhida stadium in Durban encountered a cost overrun of 38% (Venter, 2009: online; Piliso, 2009: online). Though these arenas were finished on schedule for the 2010 playoffs, Baloyi and Bekker (2011) stated that some were still unfinished as planned; therefore, they were not equipped to crowd the pre-FIFA World Cup African Confederation Cup competition in 2009 as prearranged.

Located in the Nkangala district of Mpumalanga, near the current Eskom Kendal Power Station, is the Eskom Kusile Power Station project which will comprise six units, each with an installed capacity of 800MW for a total capacity 4800MW. Once finalized, Kusile will rank as the fourth-largest coal-fired power station in the world (Eskom, 2014). The project commenced in 2008 and was anticipated to be accomplished by the end of 2014; however, the project is still not finished. According to Yelland (2019), the CTC was placed at R160 billion by July 2016 (originally estimated at R69.1 billion).

The Gautrain rapid rail link project is another project that suffered cost overrun. Initially, it was planned for R4 billion when it commenced. At the stage of finishing, its budget had increased to R30 462 billion (Fombad, 2013).

The novel multi-product pipeline is one of South Africa’s major pipeline projects. The intention of the project is to transport liquid petroleum between Durban and Johannesburg. The pipeline scheme will transport five grades of refined petroleum and will offer three pump stations and distribution yards along the road as well as coastal and inland petroleum depots. This new facility will offer the required volume to meet the forecast petroleum needs of the inland market for the year 2030 (ARUP, 2012). The original cost was R12.7 billion; this amount later increased to R15.4 billion and it further escalated to R23.4 billion in 2012. Nevertheless, the state-owned entity has stated that R30.4 billion was ultimately invested in the pipeline project. The new multi-pipeline project has been dogged by postponements and cost overruns, but it will significantly improve the security of supply threat for Gauteng’s petroleum supply (Groenewald, 2017).

2.4 Factors causing time and cost overruns

Many factors contribute to time and cost overruns in construction projects. These elements have been recognized in studies comprising of several dissimilar nations. However, elements triggering time and cost overruns differ from project to project, country to country and depend on political, economic and cultural factors (Ramabhadran, 2018). It is challenging to determine which factors are the most significant, as every researcher had their method of introducing their information. Ramanathan, Narayenan and Idrus (2012), subsequently to studying elements of overruns, discovered that it was challenging to take a broad view on the origin

source of overruns, as each investigation is an exceptional methodology and rankings of the causes.

Numerous investigations have highlighted different contributing factors dependent on the underlying condition of this study, such as project type, exact area and project size. Adam *et al.'s* (2017) recent in-depth survey uncovered 1 748 books exploring the reasons and effects of time postponement and cost overruns. The writing analysis of Adam *et al.* (2017) discovered eight underlying drivers of delay and overrun recorded below:

i. Communication: Lack of shareholder correspondence, unproductive communiqué
ii. Material: Shortage of tools, poor material arrangement
iii. Management: Poor site management, insufficient management abilities, poor observing and control, relaxed decision making, client alteration, poor workforce planning
iv. Organisational: Inappropriate managing structure, poor administrative structure, poor method techniques
v. Psychological: Optimism unfairness, dishonesty
vi. Project: Project difficulty, project period
vii. Financial: Deferred payments, poor financial forecasting, price instability
viii. Weather: Severe climate conditions, unpredicted ground settings

The principal factors triggering cost overrun throughout the construction phase of projects are unsuccessful planning, financial problems that suppliers face, cumulative labour wages, modifications in client prerequisites, fluctuation of material expenses, unfinished design drawings and stipulations at the tendering phase, planning and monitoring, variation of tools and machinery price and lack of harmonization among the managing crew (Jamaludin, Mohammad & Ahmad, 2014).

Farooqui, Hussain, Umer and Lodi (2012) established that the variables affecting costs in Pakistani construction projects are the most critical criteria for evaluating the success of a project. In their research, they concluded that poor project management (management factors) was the principal variable affecting construction costs. Therefore, the project manager and his/her teams were in a crucial necessity of improving the performance graph regarding the construction industry of Pakistan. Poor work performance (management factor) was another variable with a certain potential for affecting construction cost. The top three site factors were unforeseen ground conditions, political unrest in the area and remote location.

The top five classified reasons of time and cost overrun in the survey conducted by Olawale and Sun (2010) in the UK are configuration modifications, risk and ambiguity related to projects, incorrect assessment of projects time/duration, non-performance of subcontractors and selected suppliers and complication of works. Also, the top five categorized causes of time and cost overrun in research Memon *et al.* (2011) in Malaysia are unrealistic contract duration and requirements imposed, poor design and delays in design, late delivery of materials and equipment, lack of experience, and the relationship between management and labour. Lavura, Phoya, Tesha and Lyimo (2018) identified the top five critical factors in Tanzania as poor site management, delay of material delivery, design change during

construction, delay in decision making, design errors and omission in drawings and the bill of quantity, and incomplete design and estimate at the time of tender.

This correlates with the findings of Ameh, Soyingbe and Odusami (2010), who also indicate that lack of contractor's experience, frequent design changes, material cost and price fluctuation of materials attract delays and cost overruns. Furthermore, Ameh *et al.* (2010) show that some expansions of cost and time overruns are because of economic stability, mode of financing, high interest rates charged by banks on loans received by contractors, payments and bonds, including kickbacks and fraudulent practices. Doloi *et al*. (2012) advised that motives for construction project cost and time overruns in India incorporate land attainment, inappropriate planning and costing, and lack of proper coordination and observing of projects.

In India, the construction industry has endured ever since the previous era. Latest events in the area combined with the rebuilding of economies attracting foreign investment are expected to yield an extraordinary development in construction undertakings (Shanmugapriya & Subramanian, 2013). Table 2.1 displays surveys that identified the reasons or elements that led to cost overrun in India's construction industry.

Table 2.1: Causes of cost overrun in India

Author	Factors
Chitkara (2011)	• poor planning for execution • insufficient project preparation • lack of appropriate contract preparation and management • lack of project management throughout implementation
Saraf (2013)	• inadequate planning • inappropriate designing • site management decision making • construction approaches • shortage of workforce and technical employees • construction errors and faulty work • quality and shortage of materials and productivity
Subramani, Sruthi and Kavitha (2014)	• slow decision making • poor design/deferral in providing design
Tejale, Dhanashree and Khandekar (2015)	• material shortage • labour shortage • unavailability of competent staff • late delivery of materials and equipment • low productivity level of labour and quality of equipment and raw material

Author	Factors
NaveenKumar and Prabhu (2016)	• postponement in initial project handover • wrong/unsuitable choice of site • insufficient project planning • increase of material prices • resources limitation • volatile weather conditions • fluctuations in material costs • equipment distribution glitches • non-existence of cost reports • design modifications
Patil and Pankaj (2016)	• high transportation cost • modification in material stipulations • increase of material fee • recurrent failure of construction plant and tools, and rework

Naveenkumar and Prabhu (2016) found the following as variables influencing cost and time overrun in construction projects:

i. poor economic circumstances
ii. poor site administration
iii. slowness in issuing instructions
iv. postponement of material endorsement by advisors
v. interruption in bill payment
vi. unskilled workers
vii. low output of workforce
viii. deficiency of equipment upkeep
ix. poor site settings
x. deferment of material delivery
xi. inadequate number of staff
xii. impractical contract period enforced by the owner
xiii. owner interfering
xiv. high quality of work required
xv. lack of contractor skills
xvi. poor material management on-site
xvii. absence of advisors site staff
xviii. shortage of material in the market
xix. poor contract management by the consultant
xx. equipment and tool shortage on size
xxi. contract amendment
xxii. equipment accessibility and catastrophe
xxiii. difficulties with neighbours.

Kasimu (2012) found a qualitative research approach to obtain vital information on the principal variables causing cost and time overrun in construction projects. The factors were graded according to the degree of significance as evaluated by the respondents and show that the principal causes of time and cost overruns are materials price fluctuation, lack of experience of contract workers, insufficient time, and incomplete drawings. In a study by Abdullar, Rahman and Azis (2010), ten significant causes of cost overrun affecting cost performance of construction projects in Pakistan were identified as:

i. corruption and bribery
ii. political interests
iii. poor site management
iv. delay in site mobilisation
v. rigid attitude by consultants
vi. extra work without approvals
vii. frequent changes during execution
viii. gold plating
ix. safety and health
x. limited access to job sites

Memon *et al.* (2010) identified causative factors responsible for cost overrun in MARA large projects. The results showed the following as the most significant factors affecting construction costs:

i. cash flow
ii. contractor’s poor site management and supervision
iii. financial difficulties faced by contractors
iv. inadequate contractor experience
v. shortage of site workers
vi. incorrect planning and scheduling by contractors

In South Africa, the building industry is vital to the national economy of South Africa. It is a major factor in the country's economic growth (Windapo & Catell, 2013). While the viewpoint for the South African construction business is hopeful, numerous components could firmly influence predicated development (Milford, 2010; Boshoff, 2010). Baloyi and Bekker (2011) examined the reasons for cost and time overruns of the 2010 FIFA soccer world cup. Table 2.2 shows the components figured out to have triggered time and cost overrun for the period of the erection of arenas. A survey including 18 probable components triggering cost overruns and 34 probable elements causing deferments, positioned by respondents, was created (Baloyi & Bekker, 2011).

Table 2.2: Factors that caused time and cost overrun in 2010 South African stadiums

TIME OVERRUN FACTORS	RANK	COST OVERRUN FACTORS	RANK
Incomplete drawings	1	Increase in material cost	1
Design changes	2	Inaccurate material estimates	2
Client's slow decision making	2	Shortage of skilled labour	3
Late issue of instructions	2	Client's late contract award	4
Scarcity of skilled labour	2	Project complexity	5
Poor planning and scheduling	6	Increase in labour cost	6
Labours disputes and strikes	6	Inaccurate quantity take-off	7
Shortage of manpower	8	Difference between selected bid and the consultant's estimates	8
Changed orders by client during construction	9	Changed orders by client	9
Poor information dissemination	9	Shortage of manpower	9
Delay in work approval	9		

Source: Baloyi and Bekker (2011)

Doloi (2013) examined the critical factors in Australia that impact time and cost efficiency through design experts, suppliers and consumer viewpoints. This investigation included three categories of projects, which are construction industry, including residential, industrial and commercial buildings. The research discovered five noteworthy elements, which are:

i. scheduling and planning deficiencies
ii. techniques/strategies of construction
iii. effective observing and feedback process
iv. complication of design and construction
v. inappropriate control over site resource distributions

Among the factors contributing to cost overrun, Mahamid and Dmaidi (2013) found:

i. deceitful practices and bribes
ii. contract management
iii. extra work
iv. duration of the contract period
v. contractual procedure
vi. frequent changes in design
vii. non-existence of adequate manpower

additionally, Mahamid and Dmaidi (2013) found that elements related to project members were disagreements on-site, absence of harmonization amongst construction parties, poor monetary control on-site, poor preparation, preceding experience of contract work and relationship between managers and workers. In Nigeria, Amu and Adesanya (2011) explored elements that contributed to time and cost overrun in construction projects. The study presented subsidy and payment, supplier and customer elements are the principal

contributors to the postponement of projects. Table 2.3 displays several sources influencing cost overruns in construction projects in Nigeria.

Table 2.3: Causes affecting the cost overruns in construction projects in Nigeria

AUTHOR	FACTORS
Sunday, Busayo and Frank (2012)	• inflationary growth in material expenses • incorrect materials approximation • miscalculating of project overheads • expansion of project scope
Ameh *et al.* (2010)	• lack of experience of suppliers • price of material • instability in material costs • recurrent design modifications • economic stability • high interest rates charged by banks on loans • method of financing, bonds and disbursements • fraudulent practices and bribes
Kasimu (2012)	• materials expense fluctuation and inadequate time • lack works

Memon (2014) investigated the schedule overrun factor in Malaysia and revealed:

i. construction project business
ii. modification in the scope of the project
iii. deferment in progress payment by owner
iv. monetary complications of owner
v. deferrals in decisions making
vi. owner intrusion
vii. impractical contract period and requirements
viii. postponement in assessment and endorsement of completed work
ix. recurrent design modifications
x. errors and faults in design
xi. deferment preparation and endorsement of drawings
xii. unfinished design at the stage of tender
xiii. insufficient planning and forecast
xiv. lack of experience
xv. poor site management and administration
xvi. unskilled subcontractors
xvii. cash flow and financial problems
xviii. errors during construction
xix. variation of costs of materials
xx. scarcities of materials
xxi. late supply of materials and equipment

xxii. inadequate numbers of equipment
xxiii. labour force output
xxiv. scarcity of site workers
xxv. consequence of climate
xxvi. unexpected ground situation and accidents on-site

Principal factors affecting cost overruns in public construction projects (Kasimu, 2012; Tabish & Kumar, 2011; Memon *et al*., 2012; Le–Hoai, Lee & Lee, 2008; Doloi *et al*., 2012) were:

i. materials price fluctuations
ii. lack of experience of contractors
iii. incomplete drawings
iv. government delays
v. incompetence
vi. inaccurate estimates
vii. improper planning
viii. poor labour productivity

As diverse as the acknowledgement of motives for cost and time overruns in construction projects are, investigation studies have not delivered a conclusive resolution to this critical matter (Baloyi & Bekker, 2011). Love, Sing, Carey and Kim (2014) argued that the issue of cost and time overruns would persist except if research that vested in the fact of why and how projects brought about cost and time overruns were conducted. More recently, studies in different countries show similar results to the studies mentioned earlier.

Given the above literature review, the reasons for time and cost overruns in construction projects differ from project to project and country to country. Numerous factors have been quoted by researchers as the causes of cost and time overruns which comprise of underestimation of projects costs, change in material specification, high transportation costs, economic stability, frequent design changes, change in scope of work, project complexity, change in scope of work, poor site and supervision management. Therefore, projects failing to finish in the construction cycle as per the contract result in various negative effects.

2.5 Effect of time and cost overrun in construction projects

Time and cost overruns in construction enterprises are a worldwide phenomenon; be that as it may, the circumstance changes from country to country. Projects of any size battle with completing the project within a given time and allocated budget (Ocak, 2012). The consequence of time and cost overrun in construction projects has a rippling impact on the construction industry, contracting parties and residents in an economy. According to Ahady, Gupta and Malik (2017), cost overruns may result in project abandoning and a reduction in the business's construction activities. These may gain a bad repute and incapability to secure project funding or secure it at an advanced rate due to supplementary hazards.

According to Singh (2011), time and cost overruns lessen the effectiveness of accessible financial capitals, limit the growth possibilities and reduce the competitiveness of the economy. Li, Guo-hui and Eppler (2010) show the impacts as extra expenses, a decrease in quality and modify loss of profitability, late finish of the venture, expanded time-related expenses, outsider

cases, and end of agreements. Ansar, Flyvbjerg, Budzier and Lunn (2014) posits that, projects deferrals causes added danger of price increases and monetary charges to customers and suppliers, where a large portion of the business misfortune is linked to the party responsible for the delay.

Moreover, delays could yield uncertainties and make strain amongst the supplier, owner, and the owner's project management group (Aibinu, 2009). A contract delay has adverse effects on both the owner and contractor (either in the form of lost revenues or extra expenses) and it often raises the contentious issue of delay responsibility, which could result in conflicts that frequently reach the courts (Abbas, 2006).

According to Ali and Kamaruzzaman (2010), out of control construction costs add to investment pressure, increases in construction costs, affects investment decision making and wastes the national finance, resulting in corruption or offence. Aibinu and Jagboro (2002), as cited by Mahamid and Dmaidi (2013), examined and assessed the impacts of construction overruns on project conveyance in the Nigerian construction business. They found that the six impacts of construction overrun are time invaded, cost overwhelm, disagreement, mediation and lawsuit and absolute relinquishment.

The deferral of any construction project influences the project's direct costs. In a situation where the project is a public structure or hospital, since the client is a government organisation, the glitches increase. According to Al-Kharashi and Skitmore (2009), the impacts of overrun in such cases could include disarray with respect to public development plans, disruption of the government authority's budget execution plan and public inconvenience resulting from deferrals of projects. From the contractor's perspective, overrun is essentially an extra liability bringing about higher overheads costs and expenditures, and the whole operational capital of the supplier could get caught in one project.

Another effect of time and cost overruns, as indicated by Ahmed (2015), is the total abandonment of projects. According to Ahmed (2015), overruns in construction projects can cause the participants to abandon the project completely. If a construction project is deserted, it lessens employment chances, decelerates financial activities, government loses income and overseas financiers get discouraged from subsidizing construction projects in the economy. Aside from these, the parties in the construction contract suffer severe damage to their reputation.

As identified by Ameh and Itodo (2013), Mukuka, Agibavboa and Thwala (2014), Motaleb and Kishk (2010), Haseeb *et al.* (2011), Pourrostam and Ismail (2012), Mohammad and Isah (2012), Alinaitwe, Apolot and Tindiwensi (2013), and Owolabi, Amusan, Oloke, Olusanya and Tunji-Olayeni, Owolabi and Peter (2014), the main effects of construction project postponement are:

i. time overrun
ii. cost overrun, disputes
iii. distrust
iv. growth in adversarial relationships
v. claims
vi. total abandonment

vii. damage to parties' reputation
viii. arbitration and litigation

Given the above literature review, the reasons for time and cost overruns in construction projects differ from project to project and country to country. Numerous factors have been quoted by researchers as the effects of cost and time overruns which include project abandonment, reduction in business's construction activities, incapability to secure project funding, reduction of competitiveness of the economy, conflicts and disagreements that frequently reach the courts and severe damage to parties' reputation.

2.6 Project management standards in construction projects

Interest in project management is growing significantly and lately, the construction industry is evolving around project management (Thomas & Mengel, 2008). Shepherd and Atkinson (2011) note that project management is now accepted by many companies as vital to their business activities. However, Sanjuan and Froese (2013) state that despite all that is known about project management best practices, they are often absent from typical construction projects. Pinto (2010) said this expanded development could mostly be an explanation prompting project disappointments in light of the fact that numerous companies enter projects without completely understanding how they ought to be overseen and the strategies needed to guarantee that a project delivers according to expectations.

As indicated by Truman (2015), there is consistently a need to consolidate the exertion of a specific number of various organisations teaming up towards a shared objective to finish a particular task in any construction project. These organizations incorporate the customer, end-users, engineers, draftsmen, suppliers, project managers and other shareholders (Akinsiku & Akinsulire, 2012). However, the project manager's role is becoming increasingly demanding given the dynamic, complex and uncertain environment of construction projects (Cheng, Malik & Sorooshian, 2017). Despite the uncertainty in the environment, Aziz (2013) maintains that a project is successful when it is completed on time, within budget and in accordance with specifications.

The PMI introduced a guide that project administrators can apply to assist in lessening time and cost overruns, known as the Project Management Body of Knowledge (*PMBOK® Guide*) (PMI, 2013). According to Sanjuan and Forese (2013), many standards and methods for PM practices exist, and Selissen (2014) states that currently, two international known standards of project management exist. The *PMBOK® Guide* was published by PMI in 1987 and the sixth version was edited in 2017 (PMI, 2017). This PM standard consists of ten knowledge areas and five process groups. The ten knowledge areas are scope, integration, cost, time, quality, risk, human resources, stakeholder management, communication and procurement (PMI, 2013). It defines the five process groups based on the five stages of the project implementation as follows:

a) the initiating
b) planning,
c) executing,
d) monitoring and controlling

e) closing process groups

PRINCE2 (Project in Controlled Environment) was established by the UK regime agency Office of Government Commerce (OGC). Seven values, seven topics, and seven methods make up PRINCE2 (Figure 2.1). The PRINCE2 philosophies are elements of the project that tend to be implemented, and if any of them is not functional, the project is not being driven utilizing PRINCE2 (OGC, 2009).

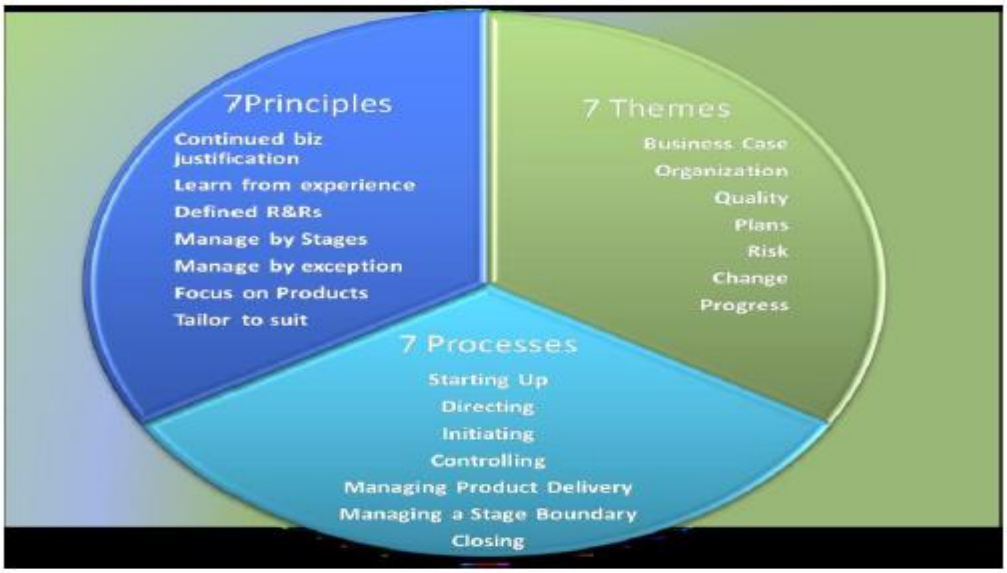

Figure 2.1: Basic structure of PRINCE2 (Source: Matari, 2014)

Other standards developed by different project management specialists and standardisation organizations for use in the project management setting include the ISO 21500 Standard for Project Management developed by the International Organization for Standardization (ISO) from 2007, later released in September 2012. The standard guides on PM and can be applied for any custom of organization, together with public and private organisations, and for any kind of project, regardless of complication, extent and length (Zandhuis & Stellingwerf, 2013). This PM standard consists of ten project management themes, called subject groups and five process groups. The ten subject groups are integration, stakeholders, scope, human resources, time, cost, risk, quality, procurement and communication. The five practice groups are initiating, planning, implementing, controlling and closing (Zandhuis & Stellingwerf, 2013).

Another standard is the new Software Engineering Standards for project management focusing on very small entities (VSEs) known as the ISO/IEC 29110 and was approved by ISO in 2011(ISO/IEC 29110). The ISO/IEC 29110 defines the project management process and software implementation process and there are five parts of this guide, namely overview, framework and taxonomy, assessment guide, profile specification and management and engineering guide.

Construction time and cost are fundamental considerations in project management and critical parameters for measuring the success of any project (Memon, Rahman & Azis, 2012). Using certain project management elements enables the possibility of success to influence the process regarding cost and time overruns (Selissen, 2014). According to Papke-Shields,

Beise and Quan (2010), the project management practices that make a difference might not be the most frequently used and the better the project management practices are, the better are the project results.

2.7 Theoretical framework

The theoretical context is the outline for the whole study enquiry, as indicated by Grant and Osanloo (2014). Theoretical structures help the researcher in arranging and contextualising official speculations into their investigations as a guide (Ravitch & Carl, 2016). Agreeing with Akintoye (2015), the appropriate selection and existence of a theoretic outline persuades readers that the research did not depend on the researcher's individual senses yet solidly established in a set up theory chosen through credible studies. The theory of construction management (CMT) will guide this study.

Radosavljevic and Bennett's (2012) opinion on CMT is to give an in-depth concept founded on a "tool kit of concepts and relationships" that will advance the proficiency and quality of "construction products". The distinction between the ordinary methodology of CMT, where suppliers convey projects, and organisations creating an item is crucial in the rationale behind the theory suggested here. Following that aim, Radosavljevic and Bennett (2012) recognised and characterised the ideas expected to comprehend CMT. Radosavljevic and Bennett (2012) reluctantly built up their concept without drawing on broad administration speculations yet put together their thoughts with respect to construction business undertakings and practice, which makes these definitions crucial to their CMT and the comprehension of that philosophy.

In construction projects management, the CMT is important since it centres round the ideas, construction materials, practices, institutions, experiences, relationships and learning and results that establish effective philosophies of project management. The concept subsequently offers a model for project directors to incorporate crucial achievement factors, such as communication, response loops, and how deep-rooted relations are (inner relationships) or not (boundary relations) to assist construction projects to be efficient.

2.8 Conclusion

This chapter discussed the types of construction delays, and they were classified as critical or non-critical delays and excusable or non-excusable delays. As time and cost overruns have been reported as major problems in construction projects globally, previous studies relating to time and cost overrun in construction projects was also presented in this chapter and quite number of studies were undertaken by different scholars. What is noticeable is that there is a general consensus that time and cost overrun in construction projects is truly a major problem globally and organisations are experiencing difficulties in completing projects on time and within the budgets.

This section also presented the theoretical framework on construction management theory and literature review on factors causing time and cost overruns on various construction projects. The review shows that there has been much interest in the examination of variables that have contributed to cost and time overrun in construction project. Numerous factors have been quoted by researchers as the causes of cost and time overruns which comprise of

underestimation of projects costs, change in material specification, high transportation costs, economic stability, frequent design changes, change in scope of work, project complexity, change in scope of work, poor site and supervision management.

The chapter also highlighted the project management standards in construction projects. The advantages and shortcomings of several research approaches are also deliberated and presented. All of the above-mentioned standards and others not stated here are accessible to the project team to improve the obligatory processes and control project works and activities with a view to finalizing a construction project successfully. To be fruitful a construction project must achieve its objectives, including attainment of its technical performance, sustaining its schedule, and maintaining the budget as planned (Frimpong, Oluwoye & Crawford, 2003).

Based on these identified factors, a list of questions was developed and presented during the interview to the Eskom employees that directly participated in the Medupi construction project so as to identify the most important factors that cause delay and cost overrun in construction project at a South African electricity utility, Medupi and to come up with possible solutions/recommendations to the problem.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction

The research methodology focuses on the rationality of inquiry, of how new information is created and the justification of new knowledge. It covers different parts of the research process. The technique is about which strategy can be utilised to get information (Johannesson & Perjons, 2014), as such, the research approach is concerned about why, what, where, when and how information is gathered and analysed. Saunders *et al*. (2012) recommend that a specific approach choice is driven by the study questions, objectives and aims. This technique should empower the researcher to accomplish a realistic degree of rationality that will empower the researcher to respond to the inquiries, aims and meet the exploration objective.

This section presents the research methodology adopted in this research and the objective of the research described in Chapter 1 and presents the research questions of the study. The key topics in this chapter include research philosophy, research design, and it further explains the population and sampling strategy and data collection instruments, data analyses and how the enquiry process was accomplished.

3.2 Research questions

Saunders and Lewis (2012) defined the research question as a single inclusive question or many strategic questions that the research enquiry addresses. To explore factors contributing to cost and time overrun of construction projects, research objectives were combined with the literature reviewed and the following questions were proposed as relevant to the research.

Research question one: What are the factors contributing to cost and time overruns in a construction project at a South African electricity utility?

The objective is to explore factors contributing to cost and time overruns in construction project a South African electricity utility.

Research question two: What are the effects of cost and time overruns in a construction project at a South African electricity utility?

The objective is to identify and analyse factors contributing to cost and time overruns in construction project at a South African electricity utility.

Research question three: How can cost and time overruns be mitigated in a construction project at a South African electricity utility?

The objective is to recommend a suitable and effective strategy for a South African electricity utility to manage and execute future construction project effectively.

3.3 Research design

Saunders, Lewis and Thornhill (2011) describe research design as the overall arrangement of how the researcher will approach addressing the research question the individual has set, and it guides the researcher in arranging, executing and observing the study (Johannesson & Perjons, 2014). Sahu (2013) characterizes research design as a chart of the various strides to be taken, beginning with the hypothesis being formulated to drawing inferences during the research process. Furthermore, a research design is a technical document consisting of a series of actions necessary to effectively conduct a research study, which is developed to conduct a research project with control over features that could affect the validity of the findings (Burns & Grove, 2003; Blaikie, 2010). It alludes to the various advances taken to apply data collection and interpretation to the study questions (O'Gorman & MacIntosh, 2015).

As indicated by Sahu (2013), a decent research design helps to achieve the purpose of a research programme in the most ideal manner. Akhtar (2016) additionally recommends that a successful research design includes the accompanying components:

a) Good research is impartial
b) It gives the littlest trial mistake
c) It yields most extreme data in various parts of a research problem

As per Sahu (2013), research designs change subject to the style of the study and are outlined in exploratory, descriptive and explanatory research forms. Exploratory approach gives new insight and assesses themes from an alternate point of view and is used on topics briefly explored previously or not explored in any manner (Dudovskiy, 2016). Descriptive research is intended to precisely portray people, occasions or circumstances, and explanatory studies, circumstances or issues are concentrated to give clarifications and connections between factors (Saunders & Lewis, 2012).

For this enquiry, the researcher adopted an exploratory research design. Exploratory research design encompasses “discovering general information about a topic that is not understood clearly by the researcher” (Saunders *et al*., 2009). According to Saunders and Lewis (2012) and Akhtar (2016), this approach provides insight into new phenomena. Furthermore, the objective of exploration is to develop a hypothesis and not essentially it’s testing (Ghauri & Gronhaung, 2010). The researcher applied the exploratory research design to explore the factors that had contributed to cost and time overrun of construction projects at a South African Electricity Utility as exploratory studies are a valuable means of understanding what is happening, to explore new perspectives, ask questions and, in a new light, analyse the research issue. Furthermore, one of the reasons is that the researcher had a lot of flexibility and can adapt to changes as the research progress and it enabled the researcher to understand at an early stage if the research topic is worth investing the time and resources and if it is worth pursuing.

Because of the epistemological and ontological direction that lines up with qualitative research strategy (Brymann & Bell, 2011), the researcher adopted a qualitative research design to address the research question. Berg and Howard (2012) describe qualitative research as meanings, an idea, a definition, metaphors, images and a portrayal of things. Consequently, qualitative research improves the researcher’s capacity to consider representative

measurements and social implications. The reason for adopting the qualitative approach is because it emphasises processes and meanings that are not measured in terms of quantity, amount, intensity or frequency and it is sufficiently adaptable to follow unforeseen thoughts during research and investigate the series successfully. Additionally, the researcher adopted qualitative approach as its intents to discover and to explore matters about the problem statement, which is the time and cost overrun and because very little is known about the problem.

3.3.1 Qualitative research

Wiid and Diggines (2009) define qualitative research as the collection, analysis, and interpretation of data that cannot be meaningfully quantified or summarised in the form of numbers. Creswell (2013) defines qualitative research as an approach in which the researcher makes knowledge claims based on constructivist or advocacy/participatory perspectives or both. According to Johnson and Christensen (2012), qualitative research relies on the researcher collecting non-numerical primary data such as words and pictures and serving as an instrument him/herself, making qualitative research well-suited for providing factual and descriptive information. Due to the ontological and epistemological positioning that aligns with qualitative study approaches (Brymann & Bell, 2011), the researcher implemented a qualitative research design to respond to the research question. The qualitative approach emphasises processes and meanings that are not measured in terms of quantity, amount, intensity or frequency. This research design is adaptable enough to follow unforeseen ideas during research and explore the process successfully. Berg and Howard (2012) portray qualitative research as meanings, an idea, a definition, metaphors, symbols and a description of things. Therefore, qualitative research improves the researcher's capacity to study symbols. Qualitative research stresses words as opposed to numbers and measurements and observes the world in its natural setting, interpreting situations to understand the meanings that people make daily (Walia, 2015).

Leedy and Ormrod (2010) contend that; qualitative analysis is beneficial for defining, interpreting, checking and evaluating circumstances. It utilizes interpretative procedures for illustrating and learning the significance of phenomena in the social world (Cooper & Schindler, 2014). Furthermore, qualitative study recommends a method of induction; the researcher explores meanings and insights in a situation (Strauss & Corbin, 2008; Levitt, Motulsky, Wertz, Morrow & Ponterotto, 2017). Denzin and Lincoln (2003) affirm that "qualitative researchers deploy a wide range of interconnected interpretive practices hoping always to get a better understanding of the subject matter at hand".

Qualitative research also refers to a range of data collection and analysis techniques that use purposive sampling and semi-structured, open-ended interviews (Dudwick, Kuehnast, Jones & Woolcock, 2006; Gopaldas, 2016). Qualitative research often involves the reconstruction of events by asking interviewees to recall how specific sequence of actions unfolded regarding a current circumstance (Bryman & Bell, 2011). Qualitative research is often associated with interpretivist paradigms (Punch, 2013), and qualitative researchers are subjectivists in their research approach (Creswell, 2009).

Lastly, Qualitative research methods typically include interviews and observations, but may also include case studies, surveys, and historical and document analyses (Cibangu, 2012). The choice of methodology is directed by the questions being raised (Viswambharan & Priya, 2016). Yin (2014) clarifies that there are three settings that influence the choice of research method in a specific research. These are (1) the kind of research questions presented, (2) the level of control a researcher poses over genuine behavioural elements, and (3) the focus on contemporary rather than entirely historical events. On the kind of research questions displayed, he clarifies that, research normally answers questions of, “what?” “who?” “where?” “why?” “how?” “how many?” and “how much?” History, experiment and case study research approaches or methods address research enquiries of “how?” and “why?” Reviews or surveys and archival examination, address enquiries of “who?” “what?” “where?” “how many?” and “how much?” On behavioural events, only the experimental technique necessitates control of behavioural events. Survey, experiment and case study centre around contemporary events. History concentrates on historic and archival examination on both historical and contemporary events. For the resolutions of this research the researcher has chosen to adopt a case study research design given its capability to analyse a single phenomenon within a broader setting and thus help the researcher to be focused (Rule & John, 2011; Yin, 2012). Additional motive is that the case study research technique permits one to carry out an in-depth examination of the phenomena which makes it appropriate for exploring the variables that lead to cost and time overruns.

3.3.2 Case study

In conceptualizing the study, the researcher chose to investigate a specific construction project as a case study. Yin (2003) offers a more detailed and technical definition of case studies as a pragmatic analysis that examines a contemporary phenomenon within its real-life setting, particularly when the margins between phenomenon and context are not clearly evident. There are several purposes for which a case study method can be implemented. Amongst other purposes, a case study can be utilised to create a comprehension of and understanding into a specific phenomenon, investigate an issue within a focused setting, and shed some light on other comparable phenomenon prompting some kind of transferability or generalisation (Rule & John, 2011).

Multiple or single case study research could be completed (Darke, Shanks & Broadbent, 1998, Yin, 2014). Because of practical contemplations, such as cost and time, the researcher considered a single case study achievable. In a single case study, one case is acknowledged and investigated in-depth. The circumstances in which a single case study is utilised incorporate where the case study signifies a basic examination of concept or best characterizes the research of the theory or where the condition offers a unique occurrence for research and may not be repetitive (Yin, 2014). The research study for the investigation of factors contributing to the cost and time overrun of a construction project at a South African electricity utility is a single case study concentrating on the Medupi project case. The conclusion regarding the study was completed and grounded on the information gathered from Medupi project participants.

3.4 Research philosophy

The implemented research philosophy contains suppositions about how the observer views the world. Saunders *et al*. (2012) define research philosophy as the expansion of information and the nature of that knowledge. In the arena of social sciences, research philosophies are perceived and understood through their core ontological and epistemological assumptions emanating from distinct worldviews (Tang, 2011). Saunders *et al.* (2012) opine that the choice of the greatest research philosophy ought to rely upon the research question(s) that the study pursues to respond to.

3.4.1 Ontological consideration

Easterby-Smith, Thorpe and Jackson (2012) define ontology as the philosophical presumption about the real world (or inventiveness of information) and its reality that the researcher explores. Smiraglia (2014) adds that ontology is the philosophical investigation of what is? Moreover, ontology determines whether the biosphere is viewed through a subjective or an objective lens (O'Gorman & MacIntosh, 2015). Two ontological contemplations exist, namely objectivism and constructionism (Bryman & Bell, 2011). Subjectivism and constructionism are two terms for something very similar. This investigation was inclined towards subjective ontology in view that the truth is by implication developed dependent on individual translation of variables adding to time and cost overruns of construction projects at the power utility. The reason for subjective ontology was that the researcher was keen on various opinions and narratives that can help represent diverse social real factors of various social actors. The study reality or phenomenon is established inside the association and awareness of person and doing.

3.4.2 Epistemological consideration

Epistemology is the division of philosophy which investigates the nature and the beginning of information (Smiraglia, 2014). Viljoen (2012) depicts epistemology as how the researcher moves towards understanding the exploration problem. As indicated by Scotland (2012), epistemological suppositions are concerned about how information can be generated, obtained and conveyed; in other words, what it means to know. The focal epistemological inquiry is whether the theoretical social reality can be considered utilizing similar standards as in common sciences (Bryman & Bell, 2011). Easterby-Smith *et al*. (2012) describe three regularly acknowledged epistemological methods of reasoning, to be specific, positivism, constructivism and critical realism. The epistemological presumption of this investigation is established in the interpretivism structure. The researcher applied the interpretivist paradigm because in the interpretive approach the researcher does not stand above or outside but is a participant who engages in the activities and discerns the meanings of actions as they are expressed within specific social contexts as advised by (Easterby-Smith *et al*., 2012).

Interpretivism advocates that the researcher should comprehend the contrasts between people in their roles as social actors (Saunders *et al*., 2012). The interpretative epistemological methodology sights human conduct as something that ought to be perceived rather than clarified (Saunders, 2009). The interpretative methodology distinguishes the contrasts amongst the normal and social sciences (O'Gorman & MacIntosh, 2015). The interpretivist

research creates new, richer understandings and translations of social universes and settings and can prompt amazing discoveries or support past discoveries (Bryman & Bell, 2011).

According to Bryman and Bell (2015), interpretivism is the cognising of individual exercises. Saunders (2009) affirms that an interactive process exists amongst the researcher and subject to discover data with respect to the subject and understanding the climate in which they work. Interpretative way of thinking frequently works better with qualitative research, which is generally appropriate for this exploration since it will give a superior comprehension of key elements adding to cost and time overruns on construction projects at the power utility. Basic to the interpretivism reasoning, according to Saunders *et al*. (2013), is that the researcher should take a sympathetic position and understanding the world from the perspective of the study subject.

3.5 Research population and sampling

A research population is the portion of the research and comprises of each person, group, association, product and event or the circumstances to which they are uncovered (Saunders *et al*., 2012). Subsequently, the population for this inquiry comprised of 5 379 Eskom workers who took part in the chosen case study which is Medupi construction project. According to Burns and Burns (2008), when piloting an investigation, it is a mission for the researcher to consider the whole population of interest. Subsequently, he proposes that the researcher should utilize a sample to assemble information. Alvi (2016) characterizes a sample as a gathering of fewer individuals chosen from a population for analysis. Leedy and Ormrod (2013) perceive sampling as the demonstration, practice or strategy of choosing an appropriate example or a representative part of a population for deciding boundaries or qualities of the entire population. Sampling decreases the amount of gathered information, disapproving of requirements like time, cash and availability. Alvi (2016) has detailed a bunch of few sample standards for members to limit the sampling size. Setting up sampling measures limits the quantity of sources where information can be gathered and guarantees that the nominated samples have more shared characteristics, prompting more legitimate and trustworthy data.

Moreover, the sampling cycle comprises of two sorts of sampling procedures, in particular probability and non-probability sampling (Saunders *et al*., 2012). Probability sampling transpires when the researcher has a whole list of the entire population and can utilize a probability sampling strategy that suits their planned research approach. Probability sampling implies that every individual from the population has an equivalent chance for taking part in the study (Dudovskiy, 2016). As illustrated in Saunders *et al.* (2009) and Denscombe (2014), Table 3.1 summarises the five probability sampling techniques.

Table 3.1: Probability sampling techniques

Technique	Characteristics
Random sampling	• Each element or individual has an equivalent opportunity for being nominated • No influence from the researcher to the sample • Unbiased data can be obtained • Conducted within a selected sample frame a known population for which the research outcome can be generalised
Systematic sampling	• Similar to random sampling but every case is included • To be ensured that the nomination does not cause any unfairness to the sample
Cluster sampling	• Clusters within a population are selected • Saves time and money • Small form of the total population, counting everybody within a cluster
Multi-stage sampling	• Samples drawn from samples in a classification of stages • Principle of random selection is applied • Samples can be drawn from the clusters to save money
Stratified sampling	• Slightly deviated from pure random sampling • Research population is subdivided into different groups (strata) • Subgroups must be homogeneous • Required numbers of elements are randomly selected from each stratum

Source: Denscombe (2014)

Non-probability sampling is a non-irregular sampling strategy and a typical word utilized to depict all types of sampling that is not directed by the ordinances of random sampling (Bryman, 2012). According to Saunders and Lewis (2012), the five classifications for conducting non-probability sampling are quota, purposive, snowball, self-selection and convenience sampling. Table 3.2, illustrated in Denscombe (2014), describes the five non-probability sampling techniques.

Table 3.2: Non-probability sampling technique

Techniques	Characteristics
Quota sampling	• The same principle of stratified sampling but random selection is not applied • Selected in proportion to the population
Purposive sampling	• Hand-picked sampling based on the relevance to the topic and knowledge of the people about the research question • Ideal for qualitative data collection
Theoretical sampling	• The selection of incidences follows a way of inventions based on emerging theory that is grounded in evidence • Sample evolves and continues to grow until sufficient information is achieved to develop the theory
Snowball sampling	• Sample arises through a procedure of references from one person to the next • Originally, limited number of people participate, and they suggest the others and the sample quickly grows • Perfect for small-scale projects seeking rationality of qualitative data
Convenience sampling	• Samples are selected conveniently for the researcher • Can be unfair, hence less consistent

Source: Denscombe (2014)

This study required a smaller size sample than probability sampling would require because sample in qualitative research tend to be small in order to support the depth of the case-oriented analysis that is fundamental to this study. Therefore, for this study, a non-probability sampling technique was adopted, and only specific members could participate in the research project (The Da Vinci Institute for Technology Management (Pty) Ltd. 2016). Furthermore, a non-probability purposive sampling method was adopted for this study because participants were selected purposively by virtue of their capacity to provide richly textured information relevant to the case study under investigation. Yin (2011) defines purposive sampling as “the selection of participants or sources of data to be used in a study based on their anticipated richness and relevance of information in relation to the study’s research questions”. The reason for adopting a purposive sampling approach was because it adds to getting helpful data on the subject from the members that will be chosen (Robinson, 2014). The researcher employed purposive sampling to ensure that those with experience regarding cost and time overruns at the Medupi construction project were eligible participants. Obviously, the nominated sample ought to have a significant input to make to the resolution of the research. With this thoughtful, the researcher has been able to decide the most suitable population sample. Purposive sampling was utilised for gathering subjective information and researchers

utilize their verdict to select who was the best to respond to the research questions (O'Gorman & MacIntosh, 2014; Saunders & Lewis, 2012).

The sample size in qualitative research directly influences accomplishing data saturation and the study discoveries (Cleary, Horsfall & Hayter, 2014). Data saturation is achieved when there is no additional data or themes to add to the research discoveries (Yin, 2014). As the researcher contemplates about purposive selection, as indicated by Marshall, Cardon, Poddar and Fontenot (2013), the researcher should consider the issue and its experience, the research technique, the investigation and the theoretical framework while settling on the number of participants.

The researcher should similarly choose a fitting number of participants without wasting time and energy while yet accomplishing data saturation (Griffith, 2013). As indicated by O'Reilly and Parker (2013) and Yin (2014), the rules for choosing the necessary total of partakers in qualitative study are the capability to accomplish data saturation and respond to the research question utilizing the chosen sample. As stated by Cooper and Schindler (2014), the sample size in qualitative research differs according to the sampling method utilized but, in any event, is usually lesser. Guest, Bunce and Johnson (2006) arguments that there are no published strategies or trials of competence for assessing the sample size expected to reach saturation. Marshall, Cardon, Poddar and Fontenot (2013), advised that somewhere in the range of 07 and 12 interviews plentiful of the themes from the case study would have developed repeatedly.

A sample size of 27 participants were purposively chosen from a list of Medupi employees obtained from Eskom Medupi Human Resource database and invited to participate in the study through email. The participants were chosen by virtue of their capacity to provide richly textured information relevant to the case study under investigation. The chosen participants included 1 group executive, 1 senior executive manager, 5 middle managers, 8 lower managers, 2 supervisors, 3 senior advisors, 2 contracts administrators, 2 engineers, 1 specialist, 1 senior quantity surveyor and 1 construction planning manager. After several reminders, only 15 participants agreed to participate in the research interviews from the 27 invitations that were send out (Appendix 6). Table 3.3 denotes a brief profile of the participants of this study.

Table 3.3: Research participants' profile

DEPARTMENT	LEVEL	NUMBER
Executives	Senior Executive	1
Project Management Office	Middle Manager Lower Manager	1 1
Procurement	Senior Advisor	2
Contract Management Office	Middle Manager Lower Manager Contract Administrator	1 4 1
Engineering	Engineer	1
Construction Management	Senior Quantity Surveyor Constriction Planning Manager Senior Supervisor	1 1 1
	TOTAL	**15**

The researcher selected specialists or experts on the subject who directly participated in the Medupi construction project. Subject matters include staff with different years in employment, insight and experience and capabilities. The participants possessed a full range of project management information, generally took part in project execution and had insight of construction projects. They directly took an interest in project implementation and represented the whole range of the construction community. They equally had practical information and decision-making power in the project. The study included participants irrespective of whether their role/position changed (for example, if they received a promotion or were transferred to other projects).

3.6 Data collection instruments

In any research, either qualitative or quantitative data should be gathered or ordered in most scientifically generated manner to satisfy the objectives of a research (Sahu, 2013). A fundamental stage in data gathering is to decide if the assembled information is primary or secondary. According to Kothari (2011), primary data are collected afresh and for the first time and thus, are original.

Secondary data are existing information acquired by others and normally for future resolutions and at any rate one level of translation amongst the observed occasion and resulting footage (Cooper & Schindler, 2014). To guarantee closeness to reality and evade blunders (Cooper & Schindler, 2014), primary data are the sole foundation of information gathering for this investigation. In qualitative investigations, the researcher is the primary instrument of information collection and analysis. According to Kothari (2011), the upside of primary information is that the researcher affects what is gathered and flexibility of time.

The case study method involves a range of empirical material collection tools in order to answer the research questions with maximum breadth. (Rashid, Rashid, Warraich, Sabir and Waseem, 2019). The Da Vinci Institute for Technology Management (2016) describes typical information collection strategies as questionnaires, interviews, literature reviews, observations, focus groups and case studies. In qualitative study, information can be gathered from partakers in their normal locations by interview (sound or video), observation, open-ended questions and field notes (Daniels, 2016). Therefore, this study adopted interviews as a primary data collection instrument because:

a) qualitative researchers are interested in what people say and how they say it (Bryman & Bell, 2011).

b) interviews are more dominant for collecting unpredictable and complex data.

c) interviews are also frequently utilized for evoking feelings, approaches, sentiments and knowledge from the respondents.

d) interviews are appropriate for reaching people who have access to exceptional data, individuals having profound and remarkable data and information about variables adding to cost and time overruns in the construction of the Medupi power station.

3.6.1 Interview design

The most generally utilized qualitative study method for primary data assortment is the interview (Bryman & Bell, 2011). Johannesson and Perjons (2014) characterise an interview as a correspondence gathering concerning a researcher and respondent in which the researcher controls the program by posing questions to the respondent. An interview places value in personal interaction and language as authentic data and one-on-one interviews take into account more profundity of importance and encourage further knowledge and comprehension (Ritchie & Lewis, 2003). As noted by Tracy (2013), "*interviews provide opportunities for mutual discovery, understanding, reflection, and explanation and elucidate subjectively lived experiences and viewpoints*". Interviews, therefore, permit the researcher to access information in context and learn about phenomena otherwise challenging or impossible to observe. Kumar (2011) advocates the advantages and disadvantages of interviews (Table 3.4).

Table 3.4: Advantages and disadvantages of interviews (Source: Kumar, 2011)

Advantages of interviews	Disadvantages of interview
The interview is the most fitting methodology for probing complicated and sensitive areas, as the interviewer can set up a respondent prior to posing delicate questions and disclose complex ones to respondents face to face.	Interviewing takes time and is costly, particularly when potential respondents are dispersed over a wide geographic region.
It is valuable for gathering in-depth data. In an interview circumstance, an investigator can acquire in-depth data by probing. Thus, in conditions where in-depth data is prerequisite, interviewing is the ideal technique for information collection.	The quality of information relies upon the quality of the communication amongst the inquirer and the interviewee.
Data can be enhanced. A questioner can enhance data acquired from reactions with those acquired from noticing non-verbal responses.	The quality of information relies upon the questioner's expertise and experience and commitment of the interviewee.
Questions can be clarified. The interviewer can recap a question or put it in a form that the respondent understands.	The quality of information may differ when several interviewers are utilized. Using different interviewers could amplify the issues recognized in the two past points.
An interview can be utilized with practically any sort of population; children, the handicapped, unskilled, or elderly.	The researcher may present their bias by the outlining of questions and the understanding of reactions.

A few sorts of interviews are steady with the implemented research technique, such as, structured, unstructured and semi-structured interviews (Bryman & Bell, 2011). As indicated by Johannesson and Perjons (2014), the structured interview follows a predefined convention and resembles a survey, as it expands on a constant rundown of questions that can be replied by browsing from a prearranged set of permitted responses. Value is set on replies that can be measured rapidly, with an accentuation on augmenting consistency and legitimacy (Bryman & Bell, 2011). A semi-structured interview is additionally founded on a cluster of questions, yet these can be debated flexibly, and they are open, so respondents can formulate the appropriate responses in their words (Johannesson & Perjons, 2014). In a semi-structured interview, the researcher is unpretentious as could be expected and permits the respondent to speak openly about a subject without being confined to the exact questions.

The researcher for this study chose to utilise a one-on-one semi-structured interview as the primary information collection for this study. Since the study is qualitative, the structured interview method is not applicable. A semi-structured interview is marked as a directed verbal conversation (Ritchie & Lewis, 2014), which depends on the correspondence and relational abilities of the researcher guiding the interview (Clough & Nutbrown, 2002). As indicated by

Nieuwenhuis (2010), semi-structured interviews make confirmation conceivable as they necessitate the participants to respond to a set of prearranged questions.

Bryman and Bell (2011) suggest developing an interview guide containing a list of questions however they do not need to be explicit and could, for instance, comprise of a short list of items of subjects instead (Bryman & Bell, 2011). A template was developed to guide the interviewees to give portions of knowledge that helped with addressing the research question (Appendix 5).

Even though this method of interview allows for divergences from the subject, the researcher succeeded in retaining the interviews focused and reverted to the question at hand when required. Before the introductions, the researcher requested consent to record the interview on an audio device, and the participants endorsed their consent. A quiet interview room that ensured privacy and confidentiality for participants was provided, and the interview lasted approximately 30 minutes. The researcher explained the purpose of the interview and study, the motivation for the study and why they were chosen for the study.

All through the interview, the researcher chose to reiterate to the interviewee noteworthy opinions and themes to reality check and guarantee a completely demonstrative understanding of what the interviewee was saying. Towards the finish of each interview, the researcher reiterated an outline of all key themes spoken about during the interview and inquired as to whether they needed to make any amendments. In other words, member checking or casual criticism was tended to during the interview. This inherent flexibility permitted for important developing insights to be discovered in-depth. After all, “qualitative research aims to achieve an in-depth understanding of a situation …” (Cooper & Schindler, 2014; p. 144).

All the interviews were transcribed word for word. The recorded interviews were introduced to the respondents to authenticate and endorse the content to ensure the trustworthiness and legitimacy of data. Furthermore, notes were taken throughout the interview as a back-up to note down non-transcribed content to acquire as much of the whole picture as possible. Utilizing this technique permitted the researcher to manuscript the insights and observations during the interview.

3.7 Data analysis

As indicated by Johannesson and Perjons (2014), data analysis develops valuable info from data to portray or clarify the phenomenon being scrutinized. Furthermore, data analysis is the systematic organisation and synthesis of the research data and evaluation of the research question using that data (Lindof & Taylor, 2010). In qualitative research, meanings are principally derived from words, not numbers. Qualitative researchers originate their data through direct interaction with the phenomenon being studied.

The qualitative researcher assumes that the human instrument is equipped for continuous adjusting to produce the most fruitful array of information. Morgan and Krueger (1998) provide critical perspectives when they repeat that the examination of qualitative approaches must be systematic, consecutive, provable and perpetual. In this study, data will be examined applying

the qualitative technique, therefore the suitable method of data analysis within the qualitative research should be selected.

3.7.1 Analysis and interpretation of qualitative data

Bogdan and Biklen (2003) define qualitative data analysis as “working with the data, organising them, breaking them into manageable units, coding them, synthesising them, and searching for patterns”. According to Johannesson and Perjons (2014), qualitative data investigation deals with qualitative information, including text, sound, photographs, pictures and video clips. The process of qualitative data analysis is “labour intensive and time-consuming” (Lofland, Snow, Anderson & Lofland, 2006) because of “large amounts of contextually laden, subjective, and richly detailed data” (Byrne, 2001), and it is described as chaotic and vague but also as a creative and fascinating process. Saunders *et al*. (2012) also indicate that qualitative data are more ambiguous, elastic and complex. Denscombe (2014) describes the general characteristics of qualitative data analysis as

a) Iterative: Data gathering and analysis normally take place at the same time or parallel and iteratively, where the outcomes from data analysis influence how data assortment continues.
b) Inductive: The examination moves from specific to general; therefore, based on the analysis of exact cases and circumstances, more broad statements are recommended.
c) Researcher centred: The circumstantial, principles, and encounters of the researcher are imperative elements influencing the data analysis.

Saunders *et al.* (2012) distinguish that qualitative research is associated with an interpretive philosophy because the researcher must make sense of the subjective and socially constructed meanings expressed by the research participants. Creswell (2013) refers to meaning as the aim of the original writer. Qualitative researchers thus, utilize a more personal, literary style, and they incorporate the participant’s language. According to Leedy and Ormrod (2013), no single correct way exists to analyse the data in a qualitative study. The researcher begins with a large body of information and through inductive reasoning, sorts and categorises it and gradually boils it down to a small set of abstract, underlying themes.

Furthermore, Ngulube (2015) indicates that various approaches used to analyse qualitative data are at the disposal of the researcher. Harding (2013) suggests four strategies. (1) Thematic analysis which includes discovery of themes emerging from the data. This might be completed by investigating commonality for example, common opinion and common experience. (2) Comparative analysis which includes comparison or contrasting information from diverse respondents until no more matters or themes emerging arise any longer. (3) Content scrutiny where the researchers work through each transcript logically to understand how certain variables emerge which are recorded by codes. (4) Discourse analysis which concentrates on patterns of speech and the manner in which the language is utilised to convey meaning. Furthermore, whichever approach the researcher adopts, the data analysis procedure should be aligned to the gathered data and the assumptions of the research approaches (Ngulube, 2015). Lastly, according to Harding (2013), the researcher should also note that “all forms of qualitative data analysis involve interpretation and the researcher must always acknowledge the possibility that alternative interpretations are possible”. Utilising a

thematic analysis, producing descriptions, pattern matching and description building, the investigation of the case study outcomes was done.

Saunders *et al*. (2012) outlined a generic approach to analyse qualitative data as identifying categories or codes that allow the researcher to comprehend data, attaching data from disparate sources to appropriate categories or codes to integrate data, developing analytical categories further to identify relationships and patterns, developing testable propositions, drawing and verifying conclusions.

Ngulube (2015) states that qualitative data analysis is concerned with converting raw information by probing, assessing, identifying, coding, mapping, exploring and defining patterns, styles, themes and categories in the raw data to understand them and provide their fundamental meanings. For this study, the researcher adopted and followed the steps on data analysis of qualitative research as suggested and recommended by Creswell (2009) (Figure 3.1).

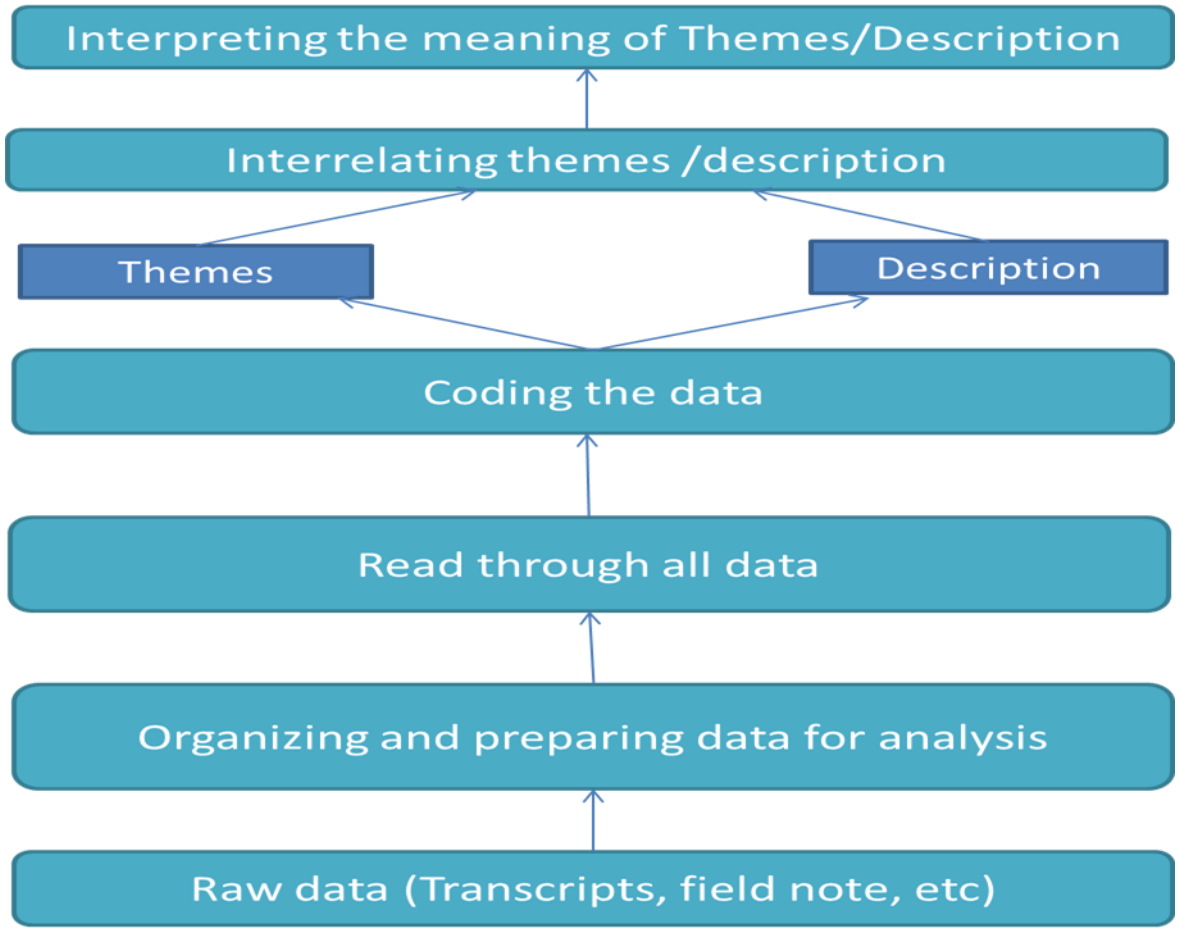

Figure 3.1: Steps on qualitative data analysis (Source: Creswell, 2009)

a) Step 1. The researcher organised and prepared the data for analysis by transcribing interviews, typing up notes taken, and arranged the data from interviews in the sequential order in which they were collected.
b) Step 2. The researcher read all the data. This step presented an opportunity to reflect on the overall meaning of the data.

c) Step 3. Coding all the data. Coding is the process of organising the data by bracketing chunks and writing a word representing a category in the margins (Rossman & Rallis, 2012). Coding is useful to organise and categorise the gathered information to classify themes (Marshall & Rossman, 2016; Yin, 2014). The analysis identified 30 codes from the data of the 15 transcribed interviews.
d) Step 4. The researcher used the coding process to generate themes for analysis. The researcher generated eight themes from the codes that appeared with more than 50% of the participants for the study. These themes appeared as major findings in the study.
e) Step 5. The researcher advanced how the description and themes will be presented. This will be a detailed discussion of several themes and interconnecting themes and was done in table form.
f) Step 6. A final step in data analysis involved interpreting the findings to draw conclusions and recommendations.

Evaluating the accurateness of qualitative research findings is challenging. However, numerous approaches and criteria can be adopted to improve the trustworthiness of qualitative study discoveries. According to Billups (2014), trustworthiness, which is concept adapted and promoted by Lincoln and Guba (1985), is the quintessential framework for evaluating qualitative study. Trustworthiness is the degree to which the information and data examination are trustworthy and believable. The researcher adopted the four elements of the trustworthiness framework, namely credibility (truth), dependability (consistency), transferability (applicability) and confirmability (neutrality) (Billups, 2014) to enhance the trustworthiness of the findings in the study.

Credibility: According to Liamputtong (2009) and Hannes (2011), credibility addresses how well the findings reflect the perspectives of the research participants, how the research findings match the reality. According to Billups (2014), credibility is analogous to the notion of validity in quantitative research. Qualitative researchers tend to concentrate on instituting the research's trustworthiness to confirm research legitimacy (Khorsan & Crawford, 2014). According to Harvey (2015) and Koelsch (2013), participant scrutiny is the best technique to attain trustworthiness of the gathered information in qualitative study. Therefore, the engagement with the data (recordings, notes and transcripts) was done intensively to demonstrate clear links between the data and interpretations. By including member scrutiny into the findings, that is, acquisition of feedback on the information, interpretations and conclusions from the members themselves increased the credibility of this study.

Dependability: According to Tong, Palmer, Craig and Strippoli (2016), dependability refers to the transparency and auditability of the research process and ensures that the researcher's decisions are transparent to show signs of steadiness and consistency in the course of the survey. Care was used to guarantee that the study process was logical, noticeable and clearly documented reflexively by giving a detailed account of the research process.

Transferability: According to Liamputtong (2009), transferability refers to the potential relevance and applicability of the findings (concepts, theories, themes, explanations and descriptions) to other individuals, populations, contexts and settings. The data collection included participants from the case study which is Medupi project only, which is a restricted region that might generate a constraint to the generalisability and transferability. Judgement

of the study transferability is outside the ability to control of the researcher (Tsang, 2014). Marshall and Rossman (2016) advise leaving the assessment of study transferability to upcoming researchers.

Confirmability: Confirmability seeks to demonstrate that the findings are derived from the data and not misconstrued or imagined by the researcher (Padgett, 2008). An audit process will be implemented by working forward and backwards through the research cycle to guarantee that the information and readings of the discoveries are sound and confirmed. The aim during the clarification procedure was not to generalise the discoveries to a population, acknowledged philosophies and patterns linked to it, but to identify the research topic.

3.8 Pilot study

According to Creswell (2013), a pilot study reveals any unfairness that the interviewer may have and gives data on whether the questions are rich and unambiguous and if they must be tuned. Before starting with the interviews, the researcher piloted the interview questions with people who comprehend the idea of the research and had some information on the phenomenon. Those individuals were asked to audit the design and arrangement of the questions to guarantee that they would stimulate the information from the participant. This pilot study exercise also allowed the researcher to adjust the interview questions, practise and improve her interview skills.

3.9 Limitations

Time and monetary constrictions were the principal limitations to the study. Given the time limitations, the study was limited to a qualitative study. The reliance on the single method might have affected the possibility of gathering additional information from the participants using another method. Limitations existed because of sampling.

While the discoveries of this research might be valuable in different settings through the progression of transferability, it ought to be noticed that the assessment was restricted to a single case study that happened under conditions. The sample size was restricted to the South African setting and the Eskom Medupi project setting. Consequently, the applicability of research discoveries to other contexts could be debatable. The limited time and resources available for the study affected the number of participants; therefore, it might not be possible to generalise the study to all Eskom construction projects. Furthermore, other participants might have found it difficult to divulge some information required for this study.

3.10 Ethical considerations

Because this is a qualitative research, the researcher had to interrelate intensely with the participants, consequently entering their private spheres to collect data. The researcher was entering their private spaces, such as their homes, to necessitate the protection of confidentiality. According to Gravetter and Forzano (2012), research ethics concern the responsibility of researchers to be honest and respectful to all individuals affected by their research studies or reports of the studies' results. Saunders *et al*. (2012) refer to ethics as the guidelines of conduct guiding the researcher's behaviour regarding the privileges of the

individuals who become the subject of the research or are influenced by it. The ethical principles are a set of standards to assist researchers in conducting the studies (Johnson & Christensen, 2012). This research study was guided and followed the ethical principles suggested and recommended by Saunders *et al*. (2012), Bertram and Christiansen (2014), and Rule and John (2011).

- Autonomy: participants voluntarily participate and have the freedom to pull out from the research at any time
- Non-maleficence: researchers are advised to take steps in shielding the identities of people when they distribute the outcomes of their research

Beneficence: Maximise benefits while minimising risk (Krysik & Finn, 2010)

Furthermore, the following ethical issues were considered, as suggested by Welman, Kruger and Mitchell (2012):

a) Informed consent: Participants were notified about the nature of the research study
b) Anonymity: The research study was conducted to ensure the privacy of the participants
c) No pose of any harm to the research participants
d) Participants have a right to privacy

Three further basic ethic principles suggested by Gravetter and Forzano (2012) and Saunders *et al*. (2012) also guided the ethics applied in this study, namely

a) welfare and dignity of the participants
b) respect for others
c) accuracy and honesty

Saunders *et al*. (2012) recommend that the participants and organisation involved in the research have to stay unidentified and the information they disclose should be administered to make it non-attributable except if there is consent to attribute comments. All sensible efforts were made to secure the collected data that was used only for this research. All responses obtained from participants were made anonymous and kept in confidence.

Finally, permission to conduct the study was obtained from Eskom management, and the Eskom Ethical Clearance is attached (Appendix 2). In accordance with the prerequisite of the institution, Ethical declaration endorsement was authorised by the Research Ethics Committee of The Da Vinci Institute (Appendix 1). All participants were informed of the objectives of the study before the interview started and were provided with a letter of invitation to participate (Appendix 3).

3.11 Conclusion

This chapter presented the research methodology adopted in this research. Regarding the research question posed in this study, the qualitative research design was an appropriate method. This chapter further covered the research philosophy, population and sampling strategy, data collection instrument whereby the interview technique was used to collect the primary data to gain insight into the factors contributing to time and cost overruns from the research participants. The chapter ended by explaining the limitations and ethical procedures

implemented for collecting data from the research participants. The next chapter presents the primary research findings. Table 3.5 summarises the research methodology.

Table 3.5: Summary of research methodology

Research design	Exploratory (Provide new insight) Qualitative (Discover and explore) Case study (Investigate within a focused setting)
Research philosophy	
Ontology	Subjective (Various opinion and narratives)
Epistemology	Interpretivism (Create new, richer understanding and translations)
Research approach	Inductive (to develop and reproduce theory)
Research population and sampling	Non-probability purposive sampling (Getting helpful data on the subject matter)
Data collection	Semi-structured interview (open and debatable)
Data analysis	Thematic analysis

Chapter 4

FINDINGS

4.1 Introduction

Chapter 3 described and delineated the research approach implemented in this research and outlined the research design and philosophy, population and sampling strategy, data collection instruments and methods used to analyse the data collected. This section reveals an overall outlook about the elements of time and cost overruns that transpired in the construction project at the electricity utility. In this chapter, the primary research findings captured through qualitative data from semi-structured interviews that were guided by the questionnaire are presented.

4.2 Primary research findings

Given the popularity of time and cost overruns within construction projects, this study was set to answer to the three questions framed in the opening chapter.

RQ1: What are the factors contributing to cost and time overruns in a construction project at a South African electricity utility?

RQ2: What are the effects of cost and time overruns in a construction project at a South African electricity utility?

RQ3: How can cost and time overruns be mitigated in a construction project at a South African electricity utility?

An invitation letter to research participants was sent to 27 Medupi project employees. From them, only 15 employees accepted the invitation to participate, 2 employees declined the invitation and 10 did not respond to the invite, as reflected in the interview schedule (Appendix 6). Interviews were conducted between November and December 2019. During the interview, the interview questions (Appendix 5) were structured to allow participants to indicate factors that they believed are the leading cost and time overruns at the Medupi construction project. The participants were also requested to provide their general background and information to provide general information about the participants regarding their departments, designations and experience in years and their professional affiliations, as discussed below.

4.2.1 Participants grouped by departments and designation

Table 4.1 displays the number of members who participated in the interview per section and their designations. The representation of the number of participants per department gives a decent equilibrium of participants to give significant and intelligent data on the factors contributing to cost and time overruns at the Medupi construction project. Furthermore, Table 4.1 displays the number of participants and their particular designations to specify their level of superiority within the grading of the Medupi organisational structure to ration the level of experience to decision making regarding the construction project.

Several decisions regarding construction projects are taken at different levels of the organisation and decision making could influence or be influenced by certain organisational elements that could contribute to construction project time and cost overruns. Data from different organisational levels were considered critical for the research study; therefore, participants at several levels were nominated to identify elements contributing to time and cost overruns in construction projects. Most participants were lower managers from the contracts management office.

Table 4.1: Number of participants per department and designation

Department	Designation	Number
Executives	Senior Executive	1
Project Management Office	Middle Manager Lower Manager	1 1
Procurement	Senior Advisor	2
Contract Management Office	Middle Manager Lower Manager Contract Administrator	1 4 1
Engineering	Engineer	1
Construction Management	Senior Quantity Surveyor Constriction Planning Manager Senior Supervisor	1 1 1
	TOTAL	**15**

4.2.2 Participants grouped by experience in years

Participants were required to specify the number of years' experience in their particular sections. Figure 4.1 displays the percentage composition of the 15 participants depending on their years of experience in construction projects to measure their level of experience to construction projects. The results show that most participants (~93%) had over three years' experience in construction projects at the time of the research. The supposition was that a substantial number of years' experience indicates exposure to construction projects and that would permit the participant to provide a significant understanding on elements contributing to cost and time overruns in construction projects. Therefore, this assured the realistic and correctness aspect of answers on factors that are assumed to have contributed to cost and time overruns in construction projects, as acknowledged by the participants.

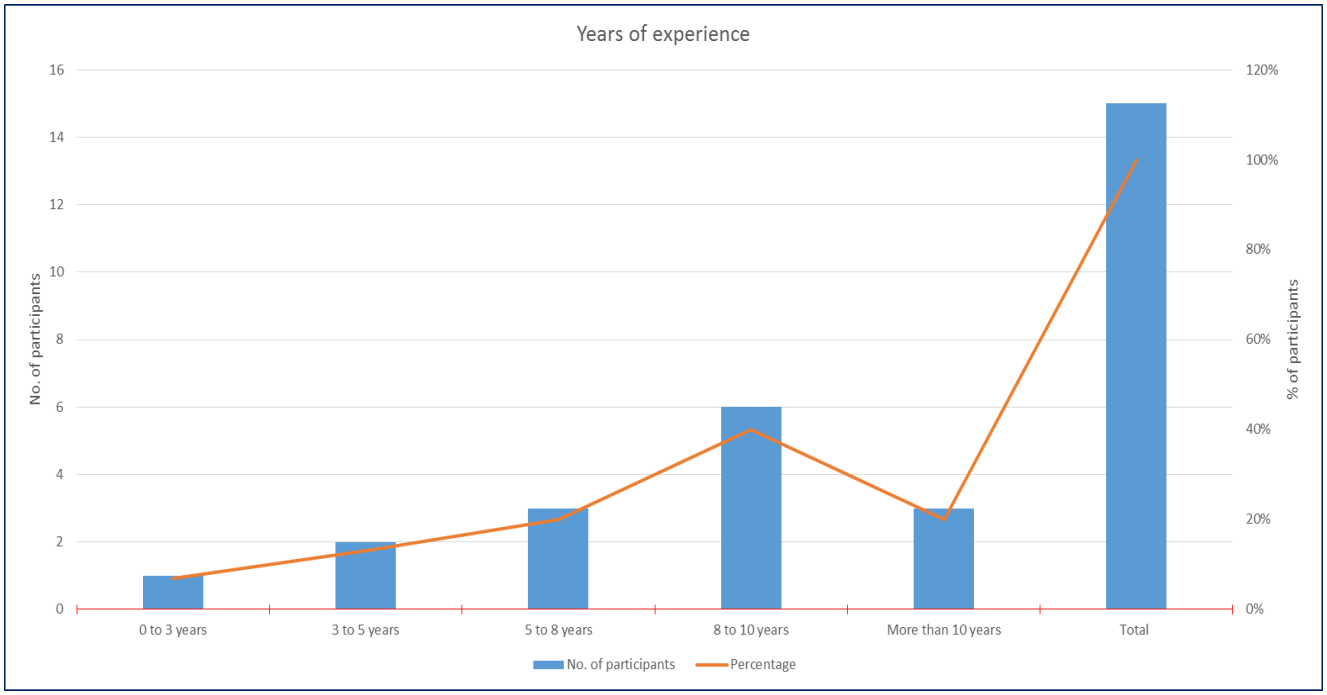

Figure 4.1: Participants' years of experience

4.2.3 Participants grouped by professional registration

Figure 4.2 shows the ratio structure of the 15 participants as per their professional affiliations. Note that few participants have dual affiliations and 13% are not yet completed registration but candidates, hence, categorized as not registered to any. This result submits that most respondents are registered with the ECSA**.**

Figure 4.2: Participants' professional affiliations

4.3 Factors contributing to time and cost overruns in the Medupi construction project

The data collected and analysed from the interview delivered rich data and contributed to responding to the research question: What are the factors contributing to cost and time overruns in construction projects? The transcribed information from interviews was gathered in the chronological order in which they have been gathered. Yin (2011) calls this 'ordered compilation of a database'. From this information base, paragraph by paragraph the information is separated in an intense quest for codes, patterns and themes. This procedure of investigation is called 'coding' (Maree, 2007). The insightful data obtained from the 15 participants were sufficient to accomplish data saturation when the codes started to repeat, and no new data developed from the interviews. Table 4.2 shows the detailed report on codes from participants' responses on principal factors that they believed that contributed to cost and time overruns at the Medupi construction project. The researcher had to frequently go back to the record as part of a trial-and-error procedure of testing and confirming the hesitant themes. Bowen (2008) guides that the continuous assessment of information from diverse interviews assists with testing the ideas and themes with the purpose of developing a theory that is grounded in the information.

In total, 151 codes were generated from the participants (Table 4.2). The dot (.) display on the table or matrix indicates the appearance of the elements contributing to time and cost overruns. Commonalities among produced codes were evaluated, and the Occurrence column indicates the occurrences of a specific code, as stated by the participants. The Percentage column of the table presents the percentages of participants who identified a specific code. The Ranking column shows which code has the highest percentage.

Once the information had been coded, it was then conceivable to arrange the codes into specific patterns and eventually themes. Through a method of inductive examination, a complete set of themes was laid out (Creswell, 2014). The pattern and themes arise from the empirical information (Bertram & Christiansen, 2014). While for certain codes it was not difficult to assign specific groups, for others it was not so clear. This procedure too was reiterative, moving codes from one group to the other until all the codes had been grouped correctly. From these groups the researcher then created themes.

Table 4.2: Generated codes of time and cost overrun factors' matrix

	Research Participants																	
Time and cost overrun factors	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**	**OCCURRENCE**	**%**	**RANKING**
Participant 1																		
Inadequate design	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Insufficient geotechnical information	•			•		•		•			•				•	**6**	**40**	10
Project too big to be implemented at once	•			•	•					•		•				**5**	**33**	11
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Too many contract packages	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Inadequately trained workforce	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Labour unrest	•		•	•	•			•	•	•	•	•	•	•	•	**12**	**80**	4
Over ambitious non-realistic schedule	•						•			•					•	**4**	**27**	12
Poor leadership	•														•	**2**	**13**	19
Participant 2																		
Poor decision making		•	•		•			•	•		•		•	•		**8**	**53**	8
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Quality issues		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Delayed approvals		•	•				•			•	•		•	•		**7**	**47**	9
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Design changes	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Contractor's incompetent		•						•								**2**	**13**	20
Participant 3																		
Design of the project was late	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Additional scope / scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Too many contract packages	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Delayed decision making		•	•		•			•	•		•		•	•		**8**	**53**	8
Delayed approvals		•	•				•			•	•		•	•		**7**	**47**	9
Labour strike	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Lack of resources	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Safety incidents			•					•		•						**3**	**20**	13
Participant 4																		
Poor designs	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Project too big to be implemented at once	•			•	•					•		•				**5**	**33**	11
Overseas proffessional not adding value to the project				•												**1**	**7**	26
Skills shortage	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Poor quality		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Too many contract packages resulting in claims	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Insufficient geotechnical information	•			•		•		•			•				•	**6**	**40**	10
Labour strike	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Localisation of labour forces with very limited to no experience				•												**1**	**7**	27
Lack of supervision				•				•						•		**3**	**20**	14
Poor performance of the contractor				•				•	•							**3**	**20**	15
Participant 5																		
Slow decision making		•	•		•			•	•		•		•	•		**8**	**53**	8
Labour unrest	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	
Split of the project into packages led to massive claims	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Design issues	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Quality issues		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Project too big	•			•	•					•		•				**5**	**33**	11
Political influence					•							•		•		**3**	**20**	16
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Incomplete scoping	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3

Table 4.2: Generated codes of time and cost overrun factors' matrix

	Research Participants																	
Time and cost overrun factors	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**	**OCCURRENCE**	**%**	**RANKING**
Participant 6																		
Pressure from the top to execute the project						•							•			**2**	**13**	21
Labour strike	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Additional work	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Additional design work	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Project not properly planned		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Changes in environmental standards and requirements						•					•					**2**	**13**	22
Geotechnical and environmental conditions	•			•		•		•			•				•	**6**	**40**	10
Participant 7																		
Lack of updated and current engineering standards							•									**1**	**7**	28
Poor quality		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Unrealistic schedule	•						•			•					•	**4**	**27**	12
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Poor engineering designs	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Delayed approvals		•	•				•			•	•		•	•		**7**	**47**	9
Inadequate skill	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Subsequent claims due to split of project into packages	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Funding availability							•				•					**2**	**13**	23
Participant 8																		
Knowledge and skills shortage	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Safety incidents			•					•		•						**3**		13
Poor design - Using Majuba Power station design as a proxy was not optimal	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Poor supervision				•				•						•		**3**	**20**	14
Linkage between packages were not properly understood	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Labour strikes	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Geotechnical and environmental conditions	•			•		•		•			•				•	**6**	**40**	10
Poor decision making		•	•		•			•	•		•		•	•		**8**	**53**	8
Poor quality		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Lower than anitcipated productivity				•			•	•								**3**	**20**	15
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Contractor's incompetent		•						•								**2**	**13**	20
Contracts limitations								•						•		**2**	**13**	25
Participant 9																		
Insufficient competent engineering practitioners									•							**1**	**7**	29
Skills shortage	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Poor quality which led to re-work		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Roles and responsibilities not defined									•							**1**	**7**	30
Slow decision making		•	•		•			•	•		•		•	•		**8**	**53**	8
Design flaws	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Contractors not coping with Eskom requirements and processes				•				•	•							**3**	**20**	15
Additional scope / scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Labour dispute	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Particpant 10																		
Instability experienced on site due to stikes	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Safety incidents			•					•		•						**3**	**20**	13
Time for environmental authorisation and land acquisition		•	•				•			•	•		•	•		**7**	**53**	9
Poor quality		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Over ambitious non-realistic schedule	•						•			•					•	**4**	**27**	12
Too many project packages	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Project too big	•			•	•					•		•				**5**	**33**	11
Lack of front end planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Inadequate skill	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Design flaws - Adoption of virtual design based on Majuba power station	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1

Table 4.2: Generated codes of time and cost overrun factors' matrix

	Research Participants																	
Time and cost overrun factors	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**	**OCCURRENCE**	**%**	**RANKING**
Particpant 10																		
Instability experienced on site due to stikes	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Safety incidents			•					•		•						**3**	**20**	13
Time for environmental authorisation and land acquisition		•	•				•			•	•		•	•		**7**	**53**	9
Poor quality		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Over ambitious non-realistic schedule	•						•			•					•	**4**	**27**	12
Too many project packages	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Project too big	•			•	•					•		•				**5**	**33**	11
Lack of front end planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Inadequate skill	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Design flaws - Adoption of virtual design based on Majuba power station	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Participant 11																		
Labour dispute	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Foreign exchange fluctuations											•	•		•		**3**	**20**	17
Availability of funding							•				•					**2**	**13**	23
Design flaws	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Too many packages	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Poor quality which led to re-work		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Delayed decision making		•	•		•			•	•		•		•	•		**8**	**53**	8
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Geotechnical and environmental conditions	•			•		•		•			•				•	**6**	**40**	10
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Changes in environmental standards and requirements						•					•					**2**	**13**	22
Delayed approval which led to standing time		•	•				•			•	•		•	•		**7**	**47**	9
Participant 12																		
Political interference					•							•		•		**3**	**20**	16
Availability of skilled resources	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Inadequate design	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Poor project management - due Internal incapacity to plan, manage and execute the project												•	•			**2**	**13**	24
Project too big to be executed at once	•			•	•					•		•				**5**	**33**	11
Procurement process												•	•	•		**3**	**20**	18
Fluctuation in material and costs											•	•		•		**3**	**20**	17
Master planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Scope variations / scope creeps	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Participant 13																		
Poor project management - insuffucient project preparations												•	•			**2**	**13**	24
Internal procurement issues												•	•	•		**3**	**20**	18
Incomplete designs	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Split of the project into packages led to massive claims	•		•	•	•		•	•		•	•		•			**9**	**60**	7
Poor work quality		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Labour unrest	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Delayed approval which led to standing time		•	•				•			•	•		•	•		**7**	**47**	9
Instability experienced on site due to stikes	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Poor decision making by management		•	•		•			•	•		•		•	•		**8**	**53**	8
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Rushing to construction due to pressure from the top						•							•			**2**	**13**	21
Inadequate skills	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Participant 14																		
Delays in government approvals		•	•		•		•			•	•		•	•		**7**	**47**	9
Labour strike	•		•	•	•	•		•	•	•	•		•	•	•	**12**	**80**	4
Poor planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Client decision making		•	•		•			•	•		•		•	•		**8**	**53**	8
Foreign exchange fluctuations											•	•		•		**3**	**20**	17
Knowledge and skills shortage	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Political interference					•							•		•		**3**	**20**	16
Poor engineering designs	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3
Lack of supervision				•				•						•		**3**	**20**	14
Poor procument practices												•	•	•		**3**	**20**	18
Poor contract management								•						•		**2**	**13**	25
Participant 15																		
Re-design	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	**15**	**100**	1
Poor quality which led to re-work		•		•	•		•	•	•	•	•		•		•	**10**	**67**	6
Labour dispute	•		•	•	•			•	•	•	•		•	•	•	**12**	**80**	4
Skills shortage	•		•	•			•	•	•	•		•	•	•	•	**11**	**73**	5
Poor project planning		•	•	•	•	•	•	•	•	•	•	•	•	•	•	**14**	**93**	2
Non-realistic schedule	•						•			•					•	**4**	**27**	12
Insufficient geotechnical information	•			•		•		•			•				•	**6**	**40**	10
Poor leadership	•														•	**2**	**13**	19
Scope creep	•	•	•		•	•		•	•	•	•	•	•	•	•	**13**	**87**	3

Figure 4.3 shows a summary of factors generated from the data, and 151 codes were summarised to 30 factors and ultimately, 6 themes were defined through inductive process. From Figure 4.3, note that all 15 participants identified one similar factor that significantly contributed to cost and time overruns, namely design, which was derived from:

i. design changes
ii. design of the project was late
iii. poor designs
iv. design issues
v. additional design work
vi. poor engineering designs
vii. poor design (using Majuba power station design as a proxy was not optimal)
viii. design flaws
ix. incomplete designs
x. poor engineering designs
xi. re-design

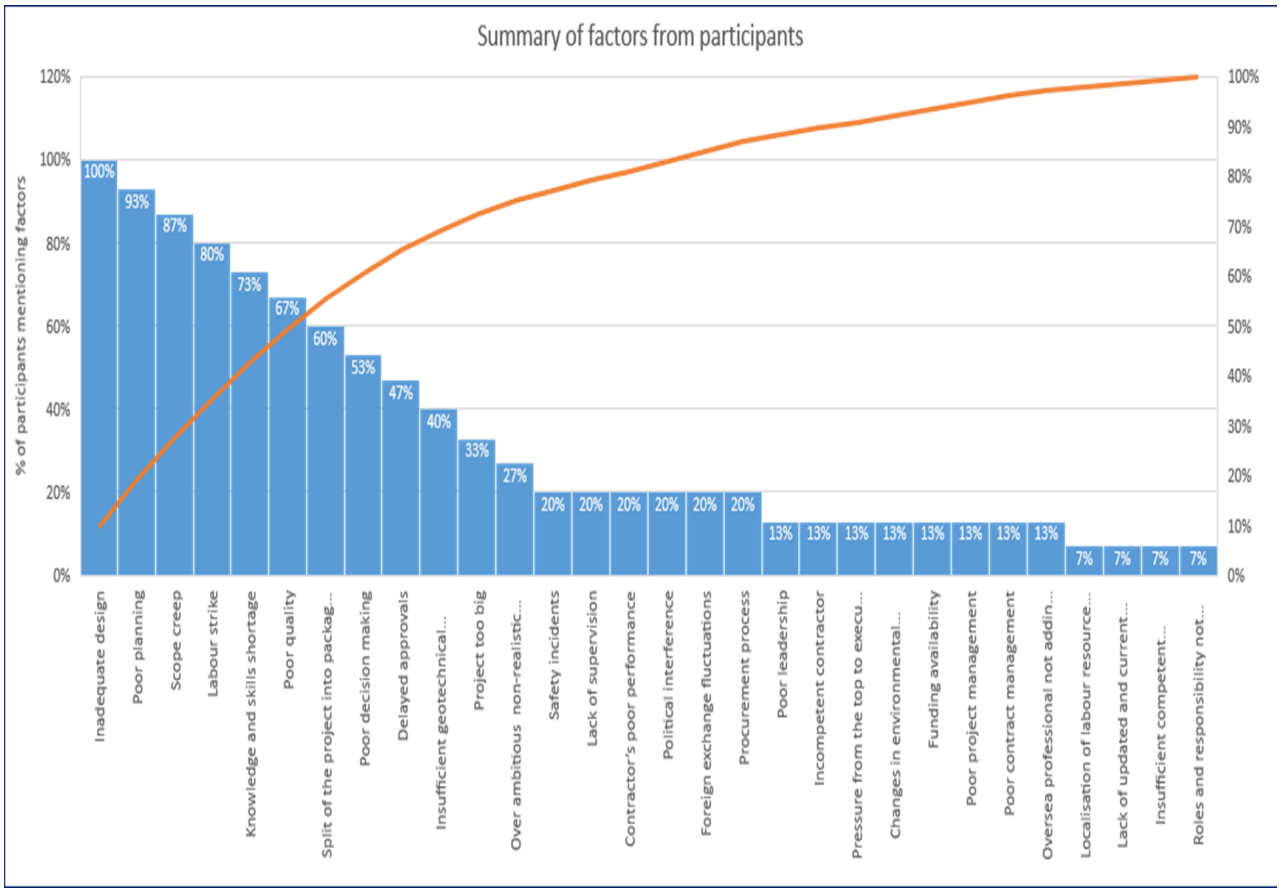

Figure 4.3: Summary of factors from the participants

4.4 Conclusion

This chapter presented the primary research findings from the qualitative data collected from the interviews that were guided by the question sheet. From this chapter, only 14 factors from the primary research findings were common to the factors contributing to time and cost overruns from the literature, namely inadequate design, poor planning, scope creep, labour strikes, knowledge and skill shortages, poor quality, poor decision making, delayed approvals, safety incidents, contractor's poor performance, foreign exchange fluctuations, incompetent contractor, poor project management and poor contract management.

Other factors identified through this study which are different from the literature were found to be unique to the case study Medupi project. It is imperative to note that also some of the preceding academics on the topic of project delay and cost overrun factors found certain variables to be exclusive in areas where they conducted their research studies. These factors include, split of project into packages, which led to massive claims, poor leadership, pressure from the top to execute the project, foreign country professionals not adding value to the project, roles and responsibilities not clearly defined. Considering that the discoveries of this research are not envisioned to be generalised, even though the researcher can possibly do as such, as contended by Flyvbjerg (2006) and Yin (2011, 2014) that generalisation is conceivable even from a single case study. The next chapter presents an in-depth discussion of the findings.

Chapter 5

DISCUSSION OF FINDINGS

5.1 Introduction

While the preceding chapter introduced the discoveries of the research, this section comprises the in-depth discussion of the findings. The data in Chapter 4 were analysed in line with the research objectives and the results obtained from the analysis are presented in this chapter. From the results, 30 codes were categorised and themes were derived. Themes derived from the codes are presented and further discussed below.

5.2 Discussion of themes

After thorough review and analysis of 30 codes from 15 participants, 6 themes emerged. The themes were defined through the process of abstraction and based on the analysis of the collected data. Below, the researcher deliberates on the six themes that contributed to cost and time overruns in construction projects at the electricity utility. The six themes were inadequate design, poor planning, scope creep, knowledge and skills shortage, internal factors and external factors.

5.2.1 Inadequate design

All research participants mentioned inadequate design or design errors as the most significant factor contributing to cost and time overruns at the Medupi construction project. Webster (2017) defines error as “a deviation from accuracy or correctness; a mistake, as in action or procedure; an inaccuracy, as in speaking or writing”. Design errors refer to design mistakes, design omissions, and design conflicts (Peansupap & Rothmony, 2015). Elaborating on this theme, P1 mentioned that;

“*the contract award prior to sufficient design resulted in higher package cost and delays*”.

This finding concurs with the findings from the literature of Kasimu (2012), Baloyi and Bekker (2011), Memon (2014), Luvara *et al*. (2018), and Jamaludin *et al*. (2014), who documented that incomplete or insufficient design drawings and specifications at the tendering phase contribute to the factors of cost and time overrun in construction projects.

Furthermore, P2 revealed that engineering design of the project was late, resulting in delays in the civil works and steel erection. P2 further said;

“*Anytime delay will have a cost impact in the project*”. P4 added that “*The lack of designs that was supposed to go out to contractors during the tender phase was a killer of time and money*”.

P5 further mentioned that;

“*Execution of the project started without a firm design to meet a fast-tracked schedule, which led to more delays and additional costs*”.

This discovery concurs with the findings of Rajakumar (2016) and Mohamid and Dmaidi (2013) who documented that delays in issuing engineering design have significantly influenced project cost and sometimes unacceptable design performance can lead to time and cost overruns. This study's finding of delay in providing engineering design with regards to time and cost overruns concurs with discoveries from past studies (Memon, Rahman & Aziz, 2011; Memon, 2014; Subramani *et al*., 2014).

It was also discovered from P6 that Eskom based the design on a combined basic design of the existing Matimba and Majuba power stations, which led to design errors causing time and cost overruns. P10 highlighted that;

"*Eskom was aware from the beginning that not having a firm design, but rather using Majuba design as a proxy for the project was not optimal but a necessary requirement to fast track the project which resulted in cost and time escalations*".

According to Han, Love and Peňa-More (2013), design errors can significantly degrade the project performance by producing reworks, necessitating added time and resource expenses. This was confirmed during an interview, as P8 mentioned that;

"*the design and technical problems include flaws in boiler design, resulting in high temperatures that the spray water-cooling system cannot cope with under certain conditions, which causes units to trip*".

P12 further added that;

"*Flaws in the design of the fabric filter plant result in excessive wear of bags, requiring frequent bag replacement and causing ash blockages and increased load losses and trips*".

Lastly, P14 mentioned that;

"*The coal mills do not meet operational technical requirements, meaning they need to be serviced twice as often as they should be*".

Absence of incorporating the design of project systems are causative elements to cost overruns and schedule deferrals (Abdul-Rahman, Aziz, Memon & Karim, 2013; Jallow, Demian, Baldwin & Anumba, 2014). Upgrading of standard drawing at the construction phase stalls project implementation because of the time it takes for such a design to be revised, edited and accepted for construction work (Luvara, Phoya, Tesha & Lyimo, 2018). Incessant modifications in design influence budgeted cost, delivery time and quality (Akinyede & Fapohunda, 2014). Design details disparities found between drawings and specifications during the construction phase impact on planned cost, and during the building establishment process causes modifications in design, and most projects are delivered exceeding budgeted cost indicated (Akinyede & Fapohunda, 2014). Design errors are critical contributors to reworks, cost overruns, schedule delays and unsafe environments, affecting project performance (Love *et al*., 2013). Numerous difficulties occur in the interface between the design and contraction phases, affecting the constructability of design components and subsequent quality, time and cost (Akinyede & Fapohunda, 2014).

Engineering design influence on cost might also be associated to repeated modifications in the design because errors and omissions found in engineering design affect budgeted costs and cause construction costs to be delivered exceeding the budgeted cost (Alsuliman, Bowles & Chen 2012). Oberlender, David and Anwar (2012) report that some designers tend to make changes during the design to please clients without considering the effect of these changes on the project's initial cost and schedule. Alsuliman *et al*. (2012) confirm that clients initiate most modifications during the design stage. However, according to Sheferaw (2013), changes are critical to keeping the significance of the project through time. Oberlender *et al*. (2012) also reported that these changes, though inevitable, usually add initial cost and time to the original design.

Design errors are unavoidable in any construction project and can negatively affect cost, schedule and safety performance (Peansupap & Rothmony, 2015). Design errors are inevitable and critical, negatively affecting project management efficiency and effectiveness (Love *et al*., 2013). Changes to technology because of invention by the engineer impact budgeted cost through design modifications (Akinyede & Fapohunda, 2014). Alsuliman *et al*. (2012) further state that design errors are the most critical reasons of variation orders in the construction industry.

Variation is a change or any modification to the contractual guidance provided to the contractor by the owner or consultants (Ismail, Pourrostam, Soleymanzadeh & Ghouyounchizad, 2012). Variation orders consequent from design errors upsurge the project time and cost (Al-Hazim, Abu Salem & Ahmed, 2017). Design errors and modifications are significant reasons for reworks (Sambasivan, Deepak, Salim & Ponniah, 2017). Choosing the correct expert minimises design modifications, improves design credentials, and decreases cost overruns and schedule deferrals (Hemal, Waidyasekara & Ekanayake, 2017).

5.2.2 Poor planning

Poor planning is the second theme as indicated by 93% of the research participants and is inductively derived from the codes non-realistic schedule, lack of front-end planning, split of projects into packages, pressure from the top to execute the project without proper planning, poor planning and scheduling and project too big. Project planning is an operational success element for any project (Turner & Zolin, 2012). According to PMI (2017), schedule management includes the processes required to manage the timely completion of the project. Poorly planned projects have an opposite result on the similar success principles of operational project management, which means cost and time overruns, deficient quality, damage of repute and displeased patrons (PMI, 2017; Meredith & Mantel, 2011). During the interview, P3 highlighted that;

"*the lack of upfront integrated schedule covering all project developments, engineering, procurement and construction management activities and timelines meant that all activities were out of phase and this resulted in rework, delays and subsequent claims*".

P5 mentioned that;

"*project integration was also a major contributor to cost overrun as the linkage between project packages was not properly understood*".

P7 added that;

"*cost escalation was due to inadequate front-end planning at the inception of the project*".

Furthermore, P8 indicated that;

"*over-ambitious non-realistic schedule was imposed on the contractor and expectation to meet unrealistic duration, and this was merely influenced by the pressure from the top to execute the project".*

Discoveries for the poor planning theme affirm prior researches featured in the literature review. Of the authors, 35% confirm that planning and scheduling deficiency is a contributing factor to time and cost overruns in construction projects (Doloi *et al*., 2012; Memon *et al*., 2010; Baloyi & Bekker, 2011; Doloi, 2013; Mahamid & Dmaidi, 2013; Memon, 2014; Jamaludin *et al*., 2014; Chitkara (2011); Saraf, 2013). Given this, poor planning and management were mentioned in their works as a general term of delay and time overrun, including resource planning, time planning, financial planning, poor material and equipment planning, insufficient time and site management.

AlSehaimi, Koskela and Tzortzopoulos (2013) chose studies concerning cost overruns and schedule deferrals and established that 87% recognized poor planning. Kyando (2013) affirms that the degree of poor planning contributes to the postponement in construction works, resulting in depletion of time and money, resulting in price escalation. Poor planning affects the progress of the project and results in delayed delivery or increased costs, and sometimes, poor construction quality (Gajewska & Ropel, 2011). Larson and Gray (2014) further augment that an unsuccessful schedule prompts project deferments and cost overruns, which is demonstrated to manifest itself halfway through a project steadily, in that way creating hasty modifications and improvements challenging.

5.2.3 Scope creep

Scope creep is the third theme, according to 87% of the study participants. Scope management of a project is a combination of the processes required to ensure that the project includes all the work and only the work that is required to successfully complete the project (PMI, 2017). The term scope creep refers to jeopardising the scope of work by uncontrolled changes that creep towards and into the project scope causing continuous but distorted, growth of the project's scope (PMI, 2013). Greiman (2013) adds that uncontrolled growth is because of changing requirements, emphasising that these changes are conducted without considering the likely effects on the organisation's assets or project plan. Hussain (2012) discovered that 97% of construction projects encountered scope creep here and there. The Medupi construction project was also not immune to scope creep, as P5 highlighted that;

"*insufficient upfront work was done on the projects leading to incomplete scoping before contracts award resulting in scope creep which contributed to time and cost overrun*".

P12 further added that;

"*the additional scope of work that was not part of the initial plan led to delays and costs movement*".

This study's finding of scope creep or changes in the scope of the project regarding cost and time overruns in construction projects agrees with the discoveries of Memon (2014), Adam *et al*. (2017), Baloyi and Bekker (2011), Abdullar, Rahman and Azis (2010) and Jamaludin *et al*. 2014). The finding of this study was also supported by Husain (2012), who published that scope creep is a negative process that results from slow and unofficial changes made to the scope of the project without considering concomitant changes to other factors such as the budget or the deadline, resulting in cost overruns and project failures. Meredith and Mantel (2011) and Amoatey and Anson (2017) formulated a finer explanation of scope creep as a regular interruption to projects, contending that scope creep is the propensity of management or stakeholders to change project objectives without earlier warning or discussion with different stakeholders associated with the project.

Furthermore, researchers have found that scope creep/change is a critical root cause of cost overruns and schedule deferments in large-scale construction projects (Hussain, 2012; Amoatey & Anson, 2017; Habibi, Kermanshachi & Safapour., 2018a, 2018b, Safapour, Kermanshachi & Ramaji, 2018). Scope changes can significantly affect project costs and schedule performance (Thakore, 2010; Turk, 2010; Du, El-Gafy & Zhao, 2016; Kermanshachi & Safapour, 2019). Project management writings broadly accept that scope creep, much of the time, results in additional cost and project deferrals (Greiman, 2013; Larson & Gray, 2014; Moneke & Echeme, 2016; Sliger, 2010).

P14 mentioned that additional scope that was not engineered caused delays in the civil portion of the work because of a lack of clarity during the scope definition. Amoatey and Anson (2017) and Turk (2010) give details that the principal root causes of scope creep are a lack of clarity in the scope definition and lack of formal review and approval procedures. Mirza, Pourzolfa and Shahnazari (2013) propose that the absence of appropriate information, knowledge or outlining a project scope towards the start of a project prompts scope creep and significantly contributes to project failures. Other than cost overruns and deferments, scope creep makes the project quality poor (Moustafaev, 2014).

5.2.4 Skills shortage

Skills shortage is the fourth theme with more than 73% of participants. According to Utting (2010), skills shortage happens where companies cannot fill jobs or have challenges in filling jobs for a specific profession, or specialised expertise needs within that profession under existing levels of compensation and conditions of occupation and place. During the interview, P1 underlined that;

"*Eskom recognised from the beginning of the project that there were insufficient competent engineering practitioners to execute the project*".

ECSA (2007) stated that they experience difficulties in recruiting engineers and technical employees for construction companies annually. According to Utting (2010), the industry has responded by recruiting from overseas. However, according to P8;

"*Complementing the Eskom knowledge and experience with that of execution partners from overseas was only partially successful*".

In support of the findings by Utting (2010), where bring in foreign workforces fails to address the spreading skills gap that is driving construction price increases, restricting capacity and unpleasantly affecting project time measures and funds, P12 adds that;

"*Eskom insisted on foreign countries professionals to come to South Africa to ensure skills transfers, these people came from all over the world at a huge cost with excellent CVs, but 90% of them did not contribute much to the project. They admitted that it was more like a paid holiday*".

Discoveries for the skills shortage subject endorse previous studies underlined in the literature review. Adam *et al*. (2017), Memon *et al*. (2010), Baloyi and Bekker (2011), Mahamid and Dmaidi (2013), Naveenkumar and Prabhur (2016), Memon (2014), Saraf (2013), and Tejale *et al*. (2015) support these findings by documenting that shortage of labour, skilled and site workers hinders the constricted delivery plan enforced by customers, projects' performance, capacity restraints and finance-related matters.

It was further noted that there was a lack of resources from the main contractor with regards to welders, which resulted in time overrun, as mentioned by P4. In support of this finding, Oke, Aigbavboa and Khangale (2018) posit that the key skills clusters that are critical need pressing consideration incorporate high-level top notch executive, planning and engineering skills, town, city and provincial planning skills, and artisan and technician skills. P3 added that;

"*the initial assumption was that the contractors have the necessary knowledge and skills to execute mega projects in the South African environment to supplement Eskom did not prove to be valid*".

P13 further mentioned that;

"*inadequate contractor capacity, which is a contrary to the popular belief that contractors will always be far ahead in terms of knowledge and skills, this contributed significantly to the project cost and time overrun*".

As a labour-intensive industry, construction heavily relies on the skills of its workforce. Essential skills in terms of expert, commercial and managerial are required to improve the efficiency of the employees and for the general performance of construction projects.

The research results indicate that Eskom focused on the localisation of labour forces and many people with limited to no experience joined the project at the expense of the project (P2). P2 further highlighted that;

"*localisation was forced on the contractors and caused delays*".

It was additionally noted from the literature that after the finishing point of such projects, the end results are below quality, and the efficiency of work deteriorates when utilizing unskilled labour force.

Oke *et al*. (2018) support the statement by indicating that skills shortage in the construction business prompts problems such as project cost escalation, project deferment, decrease in

quality, expansion in number of mishaps on-site, rework and low productivity of the labour force. P4 further added that;

"*lack of skilled supervisors resulted to poor performance which resulted in rework and contributed to cost and time overrun*".

Given that, the rework because of poor quality and performance was further mentioned by P15 as quoted below:

"*Specialised welding on the boiler was of poor quality, the control and instrumentation factory acceptance test (FAT) and substantially lower than anticipated productivity resulted in both cost and schedule delays*".

During the interview, it was also noted that when the project started, the contractor's experience was fairly good with a high number of experts and senior staff. However, P5 indicated that as time went by, these managers left the project without passing their skills. P5 further mentioned that;

"*over a long-lasting project, it is very difficult to retain services of highly skilled individuals who make up the contractor's workforce as the highly skilled workforce move around international companies looking for the best remunerations*".

P9 was of the view that the professionals joined the project, stayed for a while and left because of poor Eskom leadership and political interference. Lastly, P14 highlighted that;

"*the simultaneous construction of Medupi and other Eskom construction projects (Kusile and Ingula) has put additional strain on the already limited capacity of contractors*."

Studies have revealed a high deficiency of skills in the construction business. Utting (2010) indicated that skills scarcity presents the highest risk to the future of construction and will proceed as the demand for construction work rises. According to Utting (2010), more projects were not finalized on time or within financial plan; some organisations try to take faster routes and safety slips because of skills shortage. The skills shortage in the construction business has become a significant constraint to the progress and improvement of business (CIDB 2015). Tshele and Agumba (2014) noticed that the absence of skilled workers is an enormous business limitation for ~40% of South African private manufacture companies. The skills shortage in the construction business prompts issues such as project budget escalation, project deferment, decrease in quality, and expansion in the number of mishaps on-site, rework and low productivity of the labour force.

5.2.5 Internal factors

Another theme derived from the codes that were captured from the interview is internal factors which PMI (2017) refers to as Enterprise Environment Factors (EEF). According to Ng, Tang and Palaneeswaran (2009), internal factors are within the control of an organisation's administration, and such aspects mirror the organisation's current status and performance competency on a project. Gudienė, Banaitis, Banaitienė and Lopes (2013), documented internal factors as:

a) Project-related factors include project cost, magnitude, nature, intricacy, objectives and risks.
b) Project management/team members-related factors include skill, knowledge, decision-making efficiency, inspiration, technical competence, and workforce disputes.
c) Project leader-related elements consist of leadership, organisational, leading skills of project managers, their experience, authority and trust.
d) Contractor-related factors include business attributes, technical and specialized skill, experience, profitable and monetary circumstances, quality issues, wellbeing and safety conditions, and work conditions.
e) Client-related variables. The accomplishment of construction projects relies upon the customer's experience, category (private or public), size, impact, capacity to make appropriate decisions, rich and accurate objectives, risk approach, and capacity to partake in different stages of the project.
f) Shareholders.

Some of these factors captured by the PMBOK guide include leadership styles, infrastructure, company culture, company infrastructure and capability. The internal factors identified by the participants are delayed approvals and poor decision making, poor leadership, roles and responsibilities not clearly defined, and procurement processes. Regarding delayed approvals and poor decision making, management in a construction business entails making a series of decisions and approvals on time to avoid any further delays. This study reveals that delayed approval and decision making are factors causing delay and cost overruns in construction projects. P2 indicated that;

"*decision making on some of the scopes was very poor, the station was not ready for supply of coal from the mine and Eskom ended up spending money for the coal that was not used*".

The finding compliments what was written by Memon (2014), Kyando (2013) and Adugna (2015), documenting that when the client delays in deciding at the commencement of a project can result in time delays and extra cost because if the client wants to add some design at the time of construction, the contractor will acquire extra cost and time.

Furthermore, P11 highlighted that;

"*the delayed decision making on the approvals of the granular fill under the turbine, which took months to get past this approval*".

P9 mentioned that;

"*roles and responsibilities were not ideally defined; as a result, the decision-making process took long contributing to time overrun*".

According to Luvura *et al*. (2018), slow decision making could be caused by an organisation's internal bureaucracy or wrong channel of communication in construction projects. P14 further highlighted that;

"*the slow decision making of the engineering department contributed to serious delays*".

This can be because most of the decisions are based on the approval process at different levels in the organisation.

Another factor identified by participants under internal factors is the procurement process. The procurement process involves a series of activities such as purchasing, transporting, stocking and supply (Nikhil, Arokiaprakash & Manivel, 2016). The role of procurement is to further advise on an appropriate contracting strategy, offering and preparing tender documents, the choice of experts and contractors (Patil & Nadaf, 2017). As explained by Esterhuyzen (2011), the Eskom procurement process followed within Project Sourcing is governed by the Constitution of South Africa and the Public Finance Management Act 1 of 1999 (PFMA, 1999) and, more recently, the Preferential Procurement Policy Framework Act 2000 (PPPFA, 2000), which states that an organisation such as Eskom should have in place "an appropriate procurement and provisioning system which is fair, equitable, transparent, competitive and cost-effective". However, from the data collected from the participants, P12 mentioned that;

"*the context in which Eskom operated in proved to be something that the contractors were unable to cope with; these included some of the commercial/procurement processes and requirements, the public finance management act requirements of a state-owned company. Eskom had to insist that these be followed*".

P13 highlighted that;

"*contracts entered into with boiler and turbine suppliers were standard best practice contracts and management applied the best judgement at that time however, current contracts are heavily loaded upfront in terms of payments and liabilities are capped allowing for little recourse during construction*".

According to Eriksson and Westerberg (2011), the construction industry frequently receives criticism regarding poor quality and customer satisfaction, frequent conflicts and disputes among different actors, and cost and schedule. These criticisms in construction projects are linked to inadequate procurement processes, where the focus is on short-term individual sub-optimisation rather than long-term project team performance (Eriksson & Westerberg, 2011).

5.2.6 External factors

Another theme that was derived from the codes captured during the interview is external factors, referring to circumstances that are outside the control of the parties to the construction agreement. Gudienė *et al*. (2013) define external environmental factors as those affecting the success of construction projects, which are beyond the control of the management team. According to PMI (2017), variables in the external environment include the political climates, trademarks, financial constraints, economic and social environments. Several challenging external factors contributed to cost and time overruns at the electricity utility construction project, as identified by the participants.

a) insufficient geotechnical information
b) changes in environmental standards and requirements
c) political interference
d) labour strikes

Regarding insufficient geotechnical information and changes in environmental standards, P1 mentioned that;

"*insufficient geotechnical information delayed the civils construction and contributed to time overrun on the project*".

P4 stated that;

"*environmental authorisation and land acquisition contributed to time overrun*".

P13, P6 and P4 further highlighted that;

"*changes in environmental standards and requirements, the geotechnical and environmental conditions at the location of the projects and the lack of updated and current engineering standards during the early days of the projects further resulted in cost escalations and time delays later in the project's life (through variation and claims)*".

The research results of Adam *et al*. (2017), Farooqui *et al*. (2012), Naveenkumar and Prabhur (2016) and Memon (2014) support this result, in that unsatisfactory geotechnical information and unforeseen ground conditions are factors contributing to time and cost overruns.

Regarding political interference, P5 and P14 highlighted that;

"*the instability often experienced at the construction sites, the emergence of social formations demanding job and business opportunities. In many cases, these developments are politically motivated, and unfortunately, it delayed the project*".

P12 mentioned that;

"*the political influences did contribute to the time and cost overrun of the project*".

Since these projects are usually funded or subsidised with public funds, an unstable political environment can affect the project implementation, which could lead to delays in completion and cost overruns.

Lastly, the participants identified labour strikes as a factor contributing to cost and time overruns at the Medupi construction. P1 said that;

"*The industrial actions which had a detrimental impact to the project costs and time and also creating mistrust and placing the entire country's economy on a negative path of which we have never recovered from*".

P2 mentioned that;

"*the project had serious industrial relation shortfalls which led to strikes and damage of property which resulted in time and budget overrun*". P9 highlighted that "*the labour strikes contributed to the essence of time due to the contractors not managing their IR portion which resulted in strikes*".

Lastly, P15 added that;

"*force majeure (strikes) led to more than 18 months delay with associated cost movements*".

This finding confirms earlier studies in the literature review as documented by Farooqui *et al*. (2012), Baloyi and Bekker (2011), Mahamid and Dmaidi (2013) and Abdullar *et al*. (2010) that political unrest or labour disputes and strikes affect the construction project negatively through time and cost overruns. In most instances, labour unrest is caused by employers increasing profits at the expense of their employees with insufficient resources. According to Grogan (2014), labour unrests also occur because of the failure of collective bargaining, the lack of effective communication and insufficient employee benefits. The political agendas that arise in employment relationships also influence labour unrest in construction projects. These three factors should be given adequate attention in formulating and implementing construction projects in the electricity utility.

5.3 Effects of time and cost overruns on the Medupi construction project

The outcomes display that most participants expressed the challenges of the effects of time and cost overruns on construction projects. Time and cost overruns have evident effects for the principal shareholders, the project owner, and the construction business in general and all parties involved. To the project owner, since the prediction that the project will be realised within an allocated time and cost border, time and cost overruns infer added expenses and more time than those originally contracted upon at the beginning, resultant in less returns on investment. Project owners will lose confidence in consultants and professionals.

To the contractor, it deduces a loss of revenue for non-completion and an offence that could jeopardise his/her opportunities of winning more jobs if at fault. Cost overruns affect both those parties directly involved in the construction of a project and the construction industry as a whole and subsequently, to the national economy of the country. All these effects destabilise the feasibility and sustainability of the construction industry.

The following are the principal effects of time and cost overruns that were obtained from the participants during interviews and from the literature:

i. time overruns
ii. additional cost, budget shortfall
iii. the supplier will suffer from budget deficit of the customer
iv. contractor's costs increase beyond project budgets, which creates a claim culture
v. construction delays, as materials do not reach the project because of insufficient cash flow on the part of the contractors
vi. poor quality workmanship
vii. liquidations
viii. discontentment by project owners and subsequently by end-users
ix. undesirable media reports
x. negative perception concerning the construction business by the upper public authority and society
xi. the influence of the construction business to the development of the state economy of the nation will be less

xii. deteriorates the development of the construction industry by eroding common trust and admiration
xiii. discourage investment and investors pull out from new projects, hence the number of projects will decline in the future
xiv. generates a cynical outlook on evaluation of new construction projects
xv. some project owners (clients) become unwilling to effect additional payments to servicers and they view the cost overrun as a made-up thing, which will push to postponement the project and become a basis of disagreement among participants of the project
xvi. creates frustration on stakeholders
xvii. the client is then faced with higher interest cost during construction
xviii. delays to the supply of electricity, which further prevents economic growth
xix. debt because of cost overruns
xx. budget depletion and variation orders

5.4 Integration of TIPS framework

TIPS® is an integrated framework for the management of *Technology, Innovation, People and Systems.* The framework fosters hyper-competitiveness and synovation as well as emphasising organisational behaviours such as agility, strategic alignment and human engagement wherein the whole is greater than its parts (The Da Vinci Institute, 2015b).

In order to deal effectively with the work-based challenges faced by construction project teams, a different approach from traditional means is required. As a Master's student with the Da Vinci Institute of Technology Management, my research ethos is embedded within the philosophy of the Da Vinci's learning of systems thinking which shares a principle of the synthesis of subsystem and interconnectivity, management of change, leadership in technology, innovation, people and systems (TIPS®). The researcher took the opportunity to combine Da Vinci's learning of management leadership in technology, innovation, people and systems (TIPS®) with her skill in the Eskom contract and project management space. As a contract manager at Eskom, this journey created curiosity about what motivates an individual to want to acquire competency and strive for better performance at a higher level. The researcher submits that this approach is foundational to heightened levels of strategy making and the managerial leader's capabilities to beneficially and systemically *co-create the future* (The Da Vinci Institute, 2015b).

The researcher's ontological and epistemological approaches are firmly enshrined within the social science research methodologies, At Da Vinci, she could blend her ontological paradigm of being and her assumptions about reality with her views in the world of construction projects (Mouton, 2014). Da Vinci Institute promotes systems thinking as an approach to resolving 'real-world' problems in the work environment. Learning at this institution is based on trans-disciplinary, engaged application to a real world and work-based challenge approach, and while embracing heterogeneity of learning, it is reflective and accountable to society. The researcher submits that this component is useful for reframing people in the organisational context as actors within a dynamic system.

5.5 Conclusion

Through a systematic examination of the information, codes were created that resulted in organising the information in terms of groups and ultimately themes. In essence, these themes established the discoveries of this study in relation to its mission to explore the factors contributing to the cost and time overrun in construction project at a South African electricity utility. This chapter presented an in-depth discussion of the findings of the study where six applicable themes were reviewed and discussed.

This chapter also presented the results from the data collected on the effects of time and cost overruns, and participants expressed the challenges of the effects of time and cost overruns on construction projects. What follows is Chapter 6 that presents the conclusion and recommendations of the study.

Chapter 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

While the previous chapter presented an in-depth discussion of the findings of the study, this chapter concludes this study by providing a summary of the findings. This part will also offer conclusions to the study by deliberating and assessing whether the objectives of the study have been accomplished. Recommendations for a reasonable and effective approach for the power utility to adopt in overseeing and executing upcoming construction projects form part of this chapter. The researcher closes this chapter with a proposal of the continuation of this study through further future research.

6.2 Summary of findings

The analysis of the collected data revealed significant factors contributing to time and cost overruns in construction projects at the electricity utility in Chapter 4. The discoveries of the study presented that there are several critical factors causing delays and cost overruns in construction projects at the electricity utility, and 30 factors were identified from the interviews. Out of 30 factors emerged 6 themes, including:

a) inadequate design/design errors
b) poor planning and scheduling
c) scope creep,
d) skills shortage
e) internal factors
f) external factors

These discoveries are comparable to those recognized in the literature review. Based on the literature study, 217 factors were identified from various authors and summarised to 79 factors. The literature review acknowledged the fluctuation of material prices, planning and scheduling deficiencies, shortage of labour, frequent design changes, delays in decision making, poor site management, lack of experience, and material shortage as some of the delay factors.

6.3 Conclusions

Construction projects are complex with uncertainty from various sources. Completing a construction project on time and within the budget is a criterion of the success of a project. However, many construction projects encounter time and cost overruns and it has become a mutual issue in the construction industry and affects project performance. Construction project time and cost overruns are caused by various factors, which can be avoided or minimised when their sources are recognized.

This study explored factors contributing to cost and time overruns of construction projects to offer an appropriate and effective approach for the power utility to adopt in leading and executing future construction projects. Identifying and assessing the factors contributing to

cost and time overruns empower construction managers to resolve and control the issues to uphold business sustainability in the short and long-term. Reducing time and cost overruns can enhance the performance of construction project businesses and upgrade the existences of people.

In conclusion, the researcher will conclude the report by deliberating and evaluating whether the objectives and aim of the study were accomplished. As indicated in the opening chapter of this study, the three research objectives identified were to:

I. *Explore factors contributing to time and cost overruns in construction project at a South African electricity utility.*

This objective was successfully addressed in the research and the study explored the factors contributing to time and cost overruns in construction projects for different projects countrywide through the literature review. Numerous factors have been quoted by researchers as the causes of cost and time overruns which comprise underestimation of projects costs, change in material specification, high transportation costs, economic stability, frequent design changes, change in scope of work, project complexity, poor site and supervision management.

This objective also explored the effects of cost and time overruns. Numerous factors have been quoted by researchers as the effects of cost and time overruns which include project abandonment, reduction in business's construction activities, incapability to secure project funding, time and cost overruns, reduction of competitiveness of the economy, conflicts and disagreements that frequently reach the courts and severe damage to parties' reputations.

The project management standards in construction projects were also highlighted and are accessible to the project team to improve the obligatory processes and control project works and activities with a view to finalising a construction project successfully

II. *Identify and analyse factors contributing to time and cost overruns in construction project at a South African electricity utility.*

This objective was successfully addressed in the research by conducting a semi-structured interview, based on the identified factors from the literature review, a list of questions was developed and presented during the interview to the Eskom employees that directly participated in the Medupi construction project to identify the most important factors that cause delay and cost overrun in construction projects at a South African electricity utility. By utilising thematic analysis, the research study identified 30 factors contributing to time and cost overruns in construction projects at the electricity utility through interviews and formed six themes through an inductive process.

Other factors identified through this study which are different from the literature were found to be unique to the case study of the Medupi project. These factors include, split of project into packages, which led to enormous claims, poor leadership, pressure from the top to execute the project, foreign country professionals not adding value to the project, roles and responsibilities not clearly defined. The six themes were inadequate design, poor planning, scope creep, knowledge and skills shortage, internal factors and external factors.

III. *Recommend an appropriate and effective approach for a South African electricity utility to manage and execute future construction project effectively*

This objective was successfully addressed in the research as recommendations have been established according to the results of studied projects from the literature review and based on the participants' submission and lastly, the researcher's recommendations on how to avoid and prevent factors contributing to cost and time overruns. Further areas of study were recommended.

The aim of the research was to explore elements that have contributed to the cost and time overrun of construction projects (specific to the Medupi construction) to provide an appropriate and operational strategy for the power utility to adopt in overseeing and executing future construction projects. This aim was achieved by conducting a comprehensive literature review to explore the factors contributing to time and cost overruns in construction projects. Afterwards, interviews were conducted with Eskom workforces associated with the construction of the Medupi project. Results of the interviews concluded that "*inadequate design/design errors, poor planning and scheduling, scope creep, skills shortage, internal and external factors*" were the most critical factors contributing to cost and time overruns in the construction project at the electricity utility. This was successfully addressed in the research and further areas of study were recommended

6.4 Recommendations

The third research question of this study was how can cost and time overruns be mitigated in a construction project at a South African electricity utility and the third objective was to recommend an appropriate and effective approach for a South African electricity utility to manage and execute future construction projects effectively. This section attempts to address the third research question and to recommend the following courses of action to avoid the causes of time and cost overruns in electricity utility construction projects. These recommendations have been established according to the results of studied projects from the literature review and based on the key findings from the investigation and lastly, the researcher's recommendations. The recommendations proposed in this study are therefore outlined as follows:

Invest adequate time and capitals in choosing suitable design specialists

The research discovered that inadequate design or design errors were the most noteworthy elements contributing to cost and time overruns. Design is the most critical aspects of a successful project. This research, therefore, suggests that customers invest adequate time and capitals in choosing suitable design specialists. Once the design specialist has been involved, customers ought to guarantee that the design specialist understands their design intentions. The Eskom intellectual property rights in the design, drawings and information supplied should also form part of the agreements or contracts signed for protection in terms of exploitation by third parties. The third party's limitation of liability to Eskom for defects of the third party's design should be clearly stipulated on the contractual agreements.

More time should be spent during the design concept phase to get it right the first time before the tender is issued to the market. Feasibility studies should be conducted to a critical degree of detail that traces the potential results of a project. At the design stage, it is easier and more cost-effective to make changes than at the construction stage. The study recommends that the design specialist build up a framework for scrutinizing the design before starting construction.

Additionally, the design specialist should focus on executing a suitable coordination framework between various engineering divisions. One of the critical reasons of design faults in the electricity utility construction projects is poor amalgamation amongst various engineering departments or delayed approvals. Monitoring and controlling the design changes to avoid time and cost overrun is essential. The formation of a mechanism to monitor and control design change is imperative and any changes should be made and approved before implementation.

Establish Proper critical path method (CPM)

This study findings suggest that poor planning and scheduling of projects were among the main sources of time and cost overruns. Planning is an absolute must for any project. Proper project planning is essential upfront and must be detailed. Therefore, the research suggests that more consideration should be aimed at the beginning phases of construction projects. A proper critical path method (CPM) should be established and used during the schedule generation because it is generally accepted by the engineering/construction industry. Furthermore, this should be tracked by close observation to guarantee that the duration and cost of the definite project does not diverge from the scheduled project.

Moreover, regular meetings should be conducted to guarantee accurate correspondence between stakeholders. Reporting using daily diaries and pictorial progress is critical to any project. The following flow diagram can be adopted to monitor the construction project, which must be in the following order:

a) Project plan

b) Monitor progress

c) Report variances

d) Take corrective actions

e) Rollback into the project plan

Invest more time on feasibility study

This finding suggests that clients must be aware that scope creep or any modification of the scope, once the execution of these kinds of projects has begun, can be very troublesome to the smooth development of the project. Given the beliefs regarding the negative effects of scope creep, this study recommends that serious attention should be placed on the feasibility study. There must be a clear definition of scope and review for completeness and accuracy of the scope should be done.

The project manager should take the data from the partners, define the scope of work, split it into components, and manage the scope variations to evade cost overrun and time deferrals (PMI, 2017). Thus, the idea of scope change management becomes critical because changes might be desirable; however, if not managed properly, it can result in harmful consequences to the project.

Empowerment of skilful personnel

The quality and experience of the labour force can significantly influence projects. Using unqualified workers could lead to inefficient work and cause accidents during construction. Skilled people and people with sound construction experience must be employed sooner rather than later for any project. However, for the electricity utility to entice skilled artisans and experts there is a need to improve their wellbeing, increase their earnings and compensations and improve their entire remuneration.

Furthermore, to cope with the circumstances of skills scarcity, there is a requirement for absorbing and training more skilful personnel in the construction industry, such as artisans and specialists, to improve the performance of construction projects. Therefore, the electricity utility should invest in teaching, studying and developing their workers across different divisions of the organisation. There is also a necessity for construction organizations to invest in technical schools to introduce young people to construction-related controls at beginning phases of their schooling. Lastly, the electricity utility should establish educational and training centres to qualify and equip emerging contractors with basic construction management skills to grow sustainable businesses and support the locals to enter the construction industry workforce.

Develop a Contracts Manager Development Programme

Inadequate contracts and project management expertise by contract could be a recipe for unsuccessful projects. The contract and project management should include a skilled contract and project management team consisting of planners, cost engineers, quantity surveyors and data analysts. They should be equipped with capable planning tools and database programmes, 3D modelling and risk management. However, the information gap recognized during the interview phase of the research reveals that some projects fail, regardless of having the necessary information and contractual measures. There is a need to guarantee that personnel or experts leading the construction projects have the essential training in construction management, contract management and project management.

Contract managers are entrusted with a daunting array of duties and tasks that must be accomplished competently within prescribed boundaries of time, cost and quality set by numerous laws and regulations. Therefore, the Eskom Learning Centre should develop a Contracts Manager Development Programme to ensure effective solicitation and management of services, goods and works.

Adopt Total Quality Management (TQM) techniques

The consultant and quality professionals must monitor the quality of activities ceaselessly to set the required quality system in the different activities of the project to minimise and avoid any mistakes that might lead to rework of activities resulting in time and cost overruns. TQM techniques should be adopted, which are defined as “an approach or methodology that is used to achieve high quality and sustainable quality products and services that focus on improvement of maintenance and continuous process that detects prevention or blocks each of organisation level and provide qualitative and effective products and services to business world” (Qasim & Zafar, 2016).

Many construction organisations have used TQM as an initiative to solve their quality problems. TQM philosophy aims at continuous, customer-centred, employee-driven improvement, and throughout all projects it can help an organisation to improve its productivity, performance, and both customer and employee satisfaction by eliminating and reducing poor quality. The following are critical principles of TQM (Steyn & Schmikl, 2019):

a) Do the right things right the first time to eliminate costly rework
b) Listen to and learn from customers and employees
c) Make continuous improvement and make everyday matter
d) Build teamwork, trust and mutual respect

Adaptation of different project management methods and procedures

Technological improvements in the growth of practical strategies or frameworks for operative cost, schedule or quality assurance and control were noted as similarly imperative. Experts should attempt utilizing existing data in the public area and create methods of addressing the difficulties the industry faces. No single framework would work for all construction projects. The adaptation of different project management methods and procedures to suit a given project setting is fundamental.

The construction industry’s current time and cost overruns would be resolved if effective project management standards, tools, techniques and processes were implemented. The use of standards, knowledge, tools and techniques guarantee the excellence of projects and their success (Grau, 2012), but these standards, knowledge, tools and techniques must be used appropriately (Zwikael, 2009). By examining the benefits of PMBOK® Guide (2017) as it contains all processes and knowledge areas, the construction project team need to ensure that the standards set by the PMBOK® Guide are adhered to and followed. However, Zwikael (2009) points out that most project managers choose to perform only those processes that they are most familiar with or that are easier to perform. In doing so, they may give lower priority to knowledge areas or processes that have a higher impact on project success. The PMI does not support the perception that if a particular process is not required it should not be addressed (PMI, 2017). This means that, to ensure conformity and enhance the chance of project success, the construction project team using the PMI standards should structurally deal with all the knowledge areas and processes.

Apply earned value management (EVM)

Different processes through appropriate coordination and control of scheduling, design, approximating, contracting and construction in the whole cycle should be implemented. However, where the above remedies are available however operative coordination does not exist, project achievement can be implausible. Special attention should be placed on earned value management (EVM). EVM is a decent easing approach that the electricity utility should adopt to minimise time and cost overruns. Since EVM helps monitor work movement, project managers will utilize it, knowing how their work would go from the beginning.

The precise budget estimates are fundamental; consequently, excellent cost management is vital for overseeing cost escalation. This is concerned with an improvement of an accurate expense model with proper acknowledgment of risk, obligation to addressing concerns as they emerge and consistent budget checking during the project (Alias *et al*., 2014). The contract strategy should enable the contractor to design, plan, execute, monitor and control, and close-out the project while allowing contract incentives for productive working and cost savings. Future projects should have adequate contingency plans to cater for unforeseen circumstances to avoid unrealistic project time planning.

Develop an effective Responsibility Assignment Matrix (RAM)

Though there are not yet drastic consequences for the construction project cross-functional team in Eskom when they underperform, this apparent freedom from accountability has now come under scrutiny. According to the PMBOK guide, to operate effectively and efficiently, the project manager needs to understand where responsibility, accountability, and authority reside within the organisation. Therefore, Eskom management should develop an effective Responsibility Assignment Matrix (RAM) to clarify and define roles and responsibilities for the cross-functional team or departments involved in the construction project to avoid lack of accountability. Another method which may help addressing lack of accountability in construction projects is the proper structuring of key performance indicators (KPI) for cross-functional teams. These KPIs need to be aligned with the expected roles and responsibilities of the cross-functional team as described in the RAM to help in ensuring accountability.

Implement strict consequence management practice

A consequence management policy should be enforced to ensure accountability from the cross-functional team involved in the construction project. The organisation should implement a consistent, transparent and fair disciplinary and consequence management process against employees who deviate from and transgress the duties and responsibilities bestowed upon them by their appointments in the construction project. This process should always be applied consistently across all levels of employees in the organisation and at all times

Enhance knowledge management

To enhance knowledge management using a project learning approach, the lessons learnt during the construction of the project, whether these are positive or negative must be recorded and how those difficulties were attempted would be of significant help and guidance to similar future projects. Developing and maintaining a lessons-learned database contributes towards

an organisation's knowledge management system. The lessons learned must be incorporated into the relevant policies and procedures, either the Eskom Project Life Cycle Model (EPLCM) and/or the Procurement and Supply Chain Management (P&SCM) Procedure (32-1034). Hyperwave, sharepoint and open text are some of the tools that Eskom management can utilise to document and record lessons learnt. This will assist to ensure continuous improvement within the organisation.

Use of internal Eskom Business Management Systems policy and procedures

Lastly, according to PMI (2017), projects operate within the constraints imposed by the organisation through their structure and governance framework. In practice the use of internal Eskom Business Management Systems policy and procedures can prevent or decrease cost and time overruns. Eskom leadership should enforce compliance to internal policy and procedures to ensure improvement on plant performance, better integration of risk management and continuous improvement of processes.

6.5 Future research

In light of the discoveries of this study and commendations, the following areas are proposed for upcoming research:

Since the subject of construction time and cost overruns is broad, further research can be conducted to analyse the contractor's perception on construction time and cost overrun. Interesting research can be focused on analysing the contractor's perception of the causes of construction time and cost overruns. The researcher found this interesting since construction parties blame one another on the factors that contributed to time and cost overruns of construction project at the South African electricity utility. Moreover, construction time and cost overruns involve all construction parties; hence the perception of the contractor will be interesting and be of value to Project Managers.

Currently, the world has recently entered the fourth industrial revolution (4IR), which, according to Schwarb (2017), "is characterised by a fusion of technologies that blurs the lines between the physical, digital and biological domains". The construction industry has not fully harnessed the benefit of 4IR concepts (Li & Yang, 2016). This study recommends further research on the fusion of construction 4.0 principles with construction projects towards reducing time and cost overrun at the electricity utility.

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APPENDIX 1: Ethical Declaration

The Da Vinci Institute for Technology Management (Pty) Ltd
PO Box 185, Modderfontein, 1645, South Africa
Tel + 27 11 608 1331 Fax +27 11 608 1332
www.davinci.ac.za

Ethical Declaration

I, the undersigned, hereby declare that the Masters Research of the student named below has received ethical clearance from The Da Vinci Institute Ethics Committee. The student and supervisor will be expected to continue to uphold the Da Vinci Institute's Research Ethics Policy as indicated during the application.

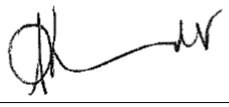
Proposed Title: Factors Contributing to the Cost and Time Overrun of Construction Projects at the Electricity Utility

Student Name: Matshidiso Tonyane
Student number: 4262
Supervisor: Dr Attilio Dalvit
Co-Supervisor: N/A

Period: Ethics approval is granted from 2019/10/24 to 2021/10/10

Chairperson: Ethics Committee

Krishna Govender
Dean: Research

Signature: 

Date: 24/10/2019

Directors: EC Kieswetter (President), B Anderson (Vice-President and Chief Executive Officer)
Registration No. 2001/009271/07
Registered with the Department of Higher Education and Training as a private higher education institution under the Higher Education Act, 1997.
Accreditation No. 2004/HE07/003

APPENDIX 2: Eskom Ethical Clearance

Eskom

The Registrar
The Da Vinci Institute
16 Park Avenue
Modderfontein
1609

Date: 01 October 2019

Enquiries: 011 800 8284

To whom it may concern

ETHICAL CLEARANCE: PERMISSION AND SECURITY CLEARANCE TO CONDUCT THE STUDY FOR MS MATSHIDISO TONYANE

Research topic. **AN INVESTIGATION OF FACTORS CONTRIBUTING TO THE COST AND TIME OVERRUN OF CONSTRUCTION PROJECTS AT THE ELECTRICITY UTILITY**

Ms Matshidiso Tonyane has followed due internal processes in terms of gaining permission for this research This letter serves as permission and security clearance for the **Masters** level research and write-up by **Ms Matshidiso Tonyane**. The following conditions will apply to the permission rendered

1. Intellectual Property Rights

All rights, title and interest in and to the Intellectual property of the experimental based research, research results and questionnaires developed by **Ms Matshidiso Tonyane** shall remain vested with Eskom.

2. Publication Protocol

Eskom recognises that under the academic policies of **The Da Vinci Institute**, the results of research work must be publishable and agrees that the Researchers engaged in the research shall be permitted to present a symposia, at national or regional professional meetings and to publish in journals, theses or dissertations, or other methods of reporting of their own choice, results of the Research.

The **Da Vinci Institute** may publish or allow the publication of the proprietary data of Eskom, on whatever medium, concerning the research provided that this does not affect the protection of

Intellectual Property Rights. Eskom shall be given 30 (thirty) days prior written notice of any planned publication of the research to take steps necessary to protect its rights

If, before the end of this period, Eskom so request, a copy of the planned publication shall be provided to Eskom within 30 (thirty) days after receipt of such request Eskom may require the removal of any or all of its Confidential Information or Intellectual Property from a planned publication in order to protect its proprietary rights and interests and the Researchers will be required to comply with any such requirement prior to publication.

Eskom may object to the planned publication within 30 (thirty) days after receipt thereof. The planned publication shall be suspended until the end of this consultation period, not exceeding twelve (12) months. In the absence of any objection within the above-mentioned period, it is deemed that the Eskom agrees to the publication.

3. Copyright

Copyright in proprietary data, including the content of the questionnaire, remains vested with Eskom The questionnaire should be marked with the copyright notice which is as follows: " © Eskom Holdings SOC Ltd 2018."

Copyright in Academic Works (the thesis, as submitted to **The Da Vinci Institute** library) shall solely vest in **The Da Vinci Institute**. **The Da Vinci Institute** shall acknowledgement Eskom as the copyright owner of the Intellectual property of the experimental based research, research results, and questionnaires, and if applicable, in other publications.

It must be noted that this general clearance is for a limited period only, which will be for the period **October 2019** to **March 2020.**

Yours sincerely

Elsie Pule

GROUP EXECUTIVE:HUMAN RESOURCES

Date:

APPENDIX 3: Letter of Invitation to Research Participants

Letter of invitation to research participants

Date: 18/11/2019

Title: An investigation of factors contributing to the cost and time overrun of construction projects at the electricity utility

Dear Prospective Participant,

My name is Matshidiso Tonyane and I am doing research under the supervision of Dalvit Attilio, towards Masters at the Da Vinci Institute. We are inviting you to participate in a study entitled an investigation of factors contributing to the cost and time overrun of construction projects at the electricity utility. This study is expected to collect important information that could assist in providing suitable and effective strategy for the power utility to adopt in managing and executing future construction projects

You are invited because of your ability to provide valid/unbiased responses and because of your vested interest in the success of Medupi construction project and you poses a high degree of exposure and involvement in the project I obtained your information from the Project Human Resource Management Office and only 24 participants are invited to take part in the research project

The study involves audio recording during interviews which should take approximately 30 minutes for the initial interview. It might require having follow-up interview if there is a need Participating in this study is voluntary and you are under no obligation to consent to participation If you decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time with no negative consequences There will be no monetary gain from participating in this study Confidentiality and anonymity of records identifying you as a participant will be maintained by the researcher and Da Vinci Institute

Hard copies of your answers will be stored by the researcher for a period of 5 years in a locked filling cabinet at Megawatt Park for future academic purposes and it will be shredded, electronic information will be stored on a password protected computer and it will be deleted from the hard drive of the computer through use of relevant software programmes after five years Future use of the stored data will be subject to further Research Ethics Review and approval if applicable

This study has received written approval from the Research Ethics Review Committee of the Da Vinci Institute. A copy of the approval letter can be obtained from the researcher if you so wish

If you would like to be informed of the final research findings, please contact Matshidiso Tonyane on 011 516 7182 or email tonyanmn@eskom co.za The findings are accessible for 4 months Should you have concerns about the way in which the research has been conducted, you may contact Attillio Dalvit on 082 345 9625

Thank you for taking time to read this information sheet and for participating in this study

Sincerely,

Matshidiso Tonyane

APPENDIX 4: Consent Returns Slip

Consent return slip

Da Vinci Institute

Masters research

Researcher: Matshidiso Tonyane – 079 526 0776

Supervisor: Attilio Dalvit – 082 345 9625

I,....., confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and I am prepared to participate in the study. I understand that my participation is voluntary and that I am free to withdraw at any time without penalty.

I am aware that the results of the study will be processed into a research report, journal publications or conference proceedings, but that my participation will be kept confidential unless otherwise specified. I agree to the recording of the interviews.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (Please print)

.....

....

Participant Signature Date

Researcher's Name & Surname (Please print)

.....

....

Researcher's signature Date

APPENDIX 5: Interview Questions/Guide

INTERVIEW QUESTIONS

Section A: General background and information

- What is the name of your department?
- What is your position in the project?
- What are your responsibilities in the project?
- How long have you been involved in construction projects?
- In which category of the construction professions do you belong?

Section B: Investigation on the factors that contribute to time and cost overrun on construction projects

- What are the high lights and low lights of Medupi construction project?
- In terms of your experience, which significant factors would you consider to be the major contributors to time and cost overrun in Medupi construction project and provide a description of each identified factor?
- How would you describe the competency of Contractors on the Medupi construction project?
- What is the level of experience of contractors compared to the construction project assigned to them?
- What is the level of project management principles awareness in construction industry?
- What would you consider to be some of the effects of time and cost overruns on Medupi construction project?
- Please write your suggestions to reduce the effects of the above mentioned factors which have the highest level in your opinion.
- Please indicate the most significant methods that could be used to minimize time and cost overrun drawbacks in the construction projects.
- If you have to execute the construction project similar to Medupi, how will you do it differently?
- How would you describe a successful construction project?
- What other relevant project management strategies and information would you like to share or recommend to reduce time and cost overruns?

APPENDIX 6: Interview Schedule

NO	DATE	VENUE	DEPARTMENT	LEVEL	STATUS
1			Executive	Group Executive	No response
2	04-Dec-19	Medupi Power Station	Executive	Senior Manager Construction	Completed
3	26-Nov-19	Megawatt Park	PMO	Middle Manager	Completed
4			PMO	Lower Manager	Declined
5	04-Dec-19	Medupi Power Station	PMO	Lower Manager	Completed
6			PMO	Supervisor	No response
7			Procurement	Middle Manager	No response
8	05-Dec-19	Medupi Power Station	Procurement	Senior Advisor	Completed
9			Procurement	Senior Advisor	No response
10	04-Dec-19	Medupi Power Station	Procurement	Senior Advisor	Completed
11			CMO	Middle Manager	No response
12	04-Dec-19	Medupi Power Station	CMO	Middle Manager	Completed
13			CMO	Lower Manager	Declined
14	05-Dec-19	Medupi Power Station	CMO	Lower Manager	Completed
15	05-Dec-19	Medupi Power Station	CMO	Lower Manager	Completed
16	05-Dec-19	Medupi Power Station	CMO	Lower Manager	Completed
17	05-Dec-19	Medupi Power Station	CMO	Lower Manager	Completed
18			CMO	Lower Manager	No response
19	03-Dec-19	Medupi Power Station	CMO	Contract Administrator	Completed
20			CMO	Contract Administrator	No response
21			Finance	Middle Manager	No response
22			Engineering	Engineer	No response
23	03-Dec-19	Medupi Power Station	Engineering	Engineer	Completed
24			Engineering	Specialist	No response
25	25-Nov-19	Megawatt Park	Construction Management	Senior Quantity Surveyor	Completed
26	29-Nov-19	Megawatt Park	Construction Management	Senior Superviosor	Completed
27	04-Dec-19	Medupi Power Station	Construction Management	Construction Planning Manager	Completed