IMPROVING SUCCESS IN SHUTDOWN PROJECTS IN SOUTH AFRICA

by

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ABSTRACT

Shutdown projects are known as strategic components used for maximizing production throughput and increasing the reliability of the plant. Research has shown that project managers are faced with a number of challenges when implementing shutdown projects. This research examined how shutdown project success is perceived based on the views of those engaged in these projects in South Africa, studied the factors that can contribute towards improving the project outcome, and developed a conceptual model for examining the significance of these factors on project success.

An extensive evaluation of existing literature was conducted, from which this study extracted a set of success criteria used to assess the outcome of shutdown projects and success variables in shutdown projects. A conceptual model was developed, which examines the association between the critical success factors and project success. The research design of this study was guided by the positivist research philosophy. A cross-sectional survey was undertaken to collect data from participants involved in shutdown projects in South Africa. The sample was selected using purposive sampling. The investigation resulted in a sample of 246 valid responses being received. The hypothesised association between project success and the critical success factors was analysed using structural equation modelling.

In this research study, success is regarded as a multi-dimensional construct characterised by project efficiency and organisational success. The study established that success in shutdown projects is accomplished when the project is concluded according to the project costs, time, commissioning incidences, health safety and environmental (SHE) specifications; according to the needs of stakeholders and the profitability of the business. Further, the following categories of success factors critical for shutdown project success were established: project management actions, competence of the project manager, organisational success, competence of the project team and project characteristics. Of these critical success factors, the overall success of shutdown projects was significantly affected by organisational factors. Although project characteristics were found to be significant for the project efficiency dimension of project success, project management actions and competence of the project team were found to be significant for the organisational success dimension of project success.

The findings of this research therefore provide a holistic view of the measures used to evaluate the outcome of shutdown projects and guide project managers to the critical success factors that can be considered when improving the success of their shutdown projects.

DECLARATION

Name: Flavia Thembelihle Masubelele

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Degree: Doctor of Philosophy

I declare that the dissertation titled: **Improving Success in Shutdown Projects in South Africa** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references. I further declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other higher education institution.

20 November 2019

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SIGNATURE DATE

DEDICATION

I dedicate this work to my precious jewel, Thaki.

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My greatest appreciation is to God, without whom this work would not have been completed.

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PUBLICATIONS

The following articles have been submitted for publication as a result of the research contained in this thesis:

1. Masubelele, F. & Mnkandla, E., 2020, The Identification of Critical Success Factors for Turnaround Projects, *IEEE International Conference on Mechanical and Intelligent Manufacturing Technologies* (ICMIMT 2020), 20-22 January 2020 (accepted).

2. Masubelele, F. & Mnkandla, E., 2020, Exploring the Success Criteria for Turnaround Maintenance Projects, *Journal of Quality and Reliability Management* (paper submitted).

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LIST OF ACRONYMS

KMO	Kaiser-Meyer-Olkin
MRQ	Main research question
PCA	Principal component analysis
PMBOK	Project Management Body of Knowledge
RSQ	Research sub-question
SEM	Structural equation modelling
SHE	Safety, health, and environment
STO	Shutdown turnaround and outage
UNISA	University of South Africa

CHAPTER 1
INTRODUCTION TO THE STUDY

1.1 Introduction

Shutdown projects are complex, yet critical events that are initiated to prevent unexpected breakdowns (Phokarel & Jiao, 2008, p. 110), maximize the production throughput, enhance the reliability of the plant (Duffua & Ben-Daya, 2009, p. 223), and ensure that the plant is safe to operate (Amaran et al., 2016, p. 422). Although these projects are essential in process plants, project failures are frequently experienced (Ertl, 2014, p. 1; Akbar & Ghazali, 2016, p. 76; Obiajunwa, 2012, p. 368). Project managers are constantly challenged with delivering successful shutdown projects against strict budgets, short timelines, a variable scope; and achieving all this at the highest safety and quality standards.

According to Ika (2009, p. 6), there has been longstanding belief that the careful use of planning and scheduling techniques contributes to better project management and ultimately, a successful project outcome. However, Andersen et al. (2006, p. 127), contended that project success may be improved if all participants have a clear understanding of what constitutes success and are conscious of the factors that contribute to that success. Thus, this research study intends to examine the variables that have a significant impact on the success of shutdown projects. In addition, the study intends to examine the association between the project outcome and the factors that drive success in the project using structural equation modelling. The results of this research provide an overview of the indicators that can be used to assess the performance of shutdown projects and provide project managers with the factors they should focus on when improving the outcome of their shutdown projects.

This chapter serves as an introduction to the problem that the research seeks to address. Following this introduction, the chapter provides an overview of the research and purpose of the research enquiry. In addition, the research questions are outlined together with the justification of how this research will contribute to the current state of the art. A brief overview of the methodological approach used to address the research questions is presented

prior to the listing of key terms frequently used in this research study. The chapter concludes with a layout of the thesis and a summary of key points.

1.2 Background

Shutdown projects are an essential part of the maintenance strategy of an organisation. These projects are necessary for the preventative maintenance of machinery that is continuously operational and cannot be stopped for repairs during plant operation (Hlophe & Visser, 2018, p. 83). During the shutdown period, the operation of the process plant is stopped so that the machines are thoroughly inspected and cleaned before the repairs can commence (Wenchi et al., 2015, p. 7).

Sahoo (2014, p. 15) is of the view that a typical shutdown project involves thousands of tasks, requires the coordination of a multi-disciplinary team, has a high probability of discovery work, has an excessive exposure to safety incidences and calls for a massive budget. Hence, the success of these projects is of significance to all involved in the project (Muller & Jugdev, 2012, p. 758). If the outcome of the project is not favourable, the reliability and the integrity of the plant might be compromised, and this could impact on revenues due to loss of production as well as environmental and safety consequences (Hameed et al., 2016, p. 9).

Despite the significance of shutdown projects to various process plants, numerous project failures have been reported (Obiajunwa, 2012, p. 368). Apparently, about 25% of shutdown projects fail completely, and 80% of these projects do not fulfil their performance targets (Akbar & Ghazali, 2016, p. 76). Furthermore, other researchers (Hansen & Schroeder, 2016, p. 1; Shirley, 2012, p. 2) reported that about 40% of shutdown projects fail to meet their overall performance targets by at least 30%. Similar sentiments were echoed by Ertl (2004, p. 25) whereby approximately 70% of shutdown projects were reported to have experienced delays and cost overruns.

South Africa is a unique setting with similar challenges. Studies on shutdown projects within the country indicate that delays and cost overruns are a part of any shutdown project (Ntoyanto, 2016, p. 5). Hlophe and Visser (2018, p. 82) also agree that the probability of shutdown projects being completed over-budget or being delayed is high. As of late, the

effect of poor maintenance has resulted in blackouts in South Africa due to the shortage of electricity supply from the power generation plants. Thus, the study of success in shutdown projects is justified in this context. The performance of shutdown projects needs to be reviewed and new avenues to improve on their success need to be explored.

Although projects are viewed as strategic means to implement organisational objectives, drive economic growth and competitiveness (Shenhar et al., 2001, p. 699), poor performance seems to be prevalent in shutdown projects. In this era of globalisation, it has become even more critical for organisations to prioritise the maintenance of their assets, to increase production capacity and to maximise profits for the sustainability of business (Al-Turki et al., 2013, p. 2). This suggests that the efficiency of a shutdown project is essential to the overall profitability and success of the organisation (Duffuaa & Ben-Daya, 2004, p. 184). However, projects ought to be delivered successfully to add value and create benefits to company success (Albert et al., 2017, p. 797).

Project success is a subject of much dialogue in many research fields. It is widely accepted that there is no clear definition of the concept "project success" and that it is understood differently by different authors (Albert et al., 2017, p. 797). Obiajunwa (2012, p. 368) further states that the different interpretations of project success are due to the context and the nature of the project. As a result, the definition of this concept has continuously changed with many authors taking a keen interest in the topic (Jugdev & Muller, 2005, p. 19). Nonetheless, the concept must be clearly defined in order to improve on the successful delivery of shutdown projects.

Previous research defined a successful project as the one which has met its performance targets of cost, time and quality performance (McLeod et al., 2012, p. 69). According to Belassi and Tukel (1996, p. 141), the classification of the outcome of a project is an intricate process and goes beyond this criterion. De Wit (1988, p. 165) argues that this criterion only evaluates the project management effort of the project and does not capture the overall outcome of the project. Literature also indicates that project success has been regarded as a multi-dimensional construct that incorporates the expectations of the stakeholders (Davies, 2014, p. 189), the overall project objectives (Baccarini, 1999, p. 26), the benefits provided to the customers (Shenhar et al., 2001, p. 699) and, most importantly, is according to the context of the project (Albert et al., 2017, p. 797).

Obiajunwa (2012, p. 369) points out that in most instances, the success of shutdown projects is measured using the wrong criteria. Ertl (2004, p. 25), also concurs that shutdown projects are managed and measured using the criteria for engineering, procurement and construction (EPC) projects. This should not be the case considering the distinct contrast that separates shutdown projects from the rest. Albert et al. (2017, p. 797) suggest that the correct criteria to assess project success must be clarified to allow for proper evaluation of the project outcome; and this also applies to shutdown project success. When the success criteria for evaluating the project outcome is not established, projects are managed intuitively (Chan & Chan, 2004, p. 219; Obiajunwa, 2010, p. 51). Hence, the criteria for measuring the success of the shutdown project must therefore be clarified to ensure the success of the project.

A number of efforts have been made to address the success of shutdown projects. Authors such as Raoufi and Fayek (2014, p. 169), Duffuaa and Ben-Daya (2004, p. 184) advocated for the application of best practices and guidelines to shutdown project management to ensure project success. However, according to Sahoo (2014, p. 232), a successful project outcome cannot be guaranteed by having work processes.

Critical success factors are recognised as essential elements used to improve project success and identify the key areas of concern in projects (Boynton & Zmud, 1986, p. 17; Muller & Jugdev, 2012, p. 758). Hence, many studies have been undertaken on factors that aid project success. Andersen et al. (2006, p. 129) indicated that the critical success factors are not universal because of the unique nature of projects and the different opinions that exist on these factors. Albert et al. (2017, p. 798) also pointed out an existence of specific set of success factors for the different industries. Montequin et al. (2016, p. 440) agree that lists of success factors differ based on the project stakeholders, type of the project, cultural and geographical contexts. Therefore, the factors associated with the success of shutdown projects in South Africa must be identified.

A research study by Obiajunwa (2010, p. 368) suggested that having a *project charter*, *support from the top management team*, *setting up realistic and measurable goals* as some of the factors influencing shutdown projects in the UK process industries. However, this study did not consider the extent to which these factors influence project success and did not uncover the underlying relationship between the success factors. Others (Hansen &

Schroeder, 2016, p. 1; Lenahan, 2011, p. 190; Vichich, 2006, p. 4) have recognised the factors that either cause overruns, delays or influence the successful implementation of shutdown projects. However, the findings of most of these studies are based on expert judgement and are narratives that are only limited to the identification of these factors. Research on critical success factors goes beyond just identifying the list of factors. Furthermore, literature suggests that focusing on the categorisation of the success factors to examine their interrelations provides a better evaluation of project success. (Belassi & Tukel, 1996, p. 141).

1.3 Research Problem

Shutdown projects are essential for all process plants. However, their success rates are often characterized by cost overruns and schedule delays. As indicated by Alias et al. (2014, p. 62), an analysis of project performance and critical success factors is one of the essential methods to consider when attempting to improve the outcome of a project. Thus, to improve success in shutdown projects, there is a need to thoroughly explore the concept and understand the variables that have a positive effect on the project outcome.

Although the outcome of a project is decided on the basis of several critical success factors, it is still unclear how these factors impact on the effectiveness of shutdown projects. Further to this, their underlying associations amongst these factors is yet to be determined. The aim of this research study is to determine which factors are essential to the success of shutdown projects based on the views of those engaged in these projects in South Africa; and to consider the extent to which these factors affect shutdown project success.

1.4 Research Questions

To enhance the outcome of shutdown projects, this study aims to explore the following main research question (MRQ):

To what extent do the critical success factors influence shutdown project success?

The main research question cannot be addressed in isolation. The following research sub-questions (RSQs) have been formulated to channel the study to the main research question:

RSQ1: How is the concept of project success in shutdown projects defined and measured?

According to Obiajunwa (2012, p. 368), the factors that impact on project performance can only be identified if the criteria used to measure success is understood. Therefore, RSQ1 seeks to investigate the definition and the criteria used to review the outcome of shutdown projects. RSQ1 will be addressed through a detailed review of previous literature and an involvement of the stakeholders of the projects to uncover their understanding of a successful shutdown project.

RSQ2: Which success factors influence the success of shutdown projects?

To improve the success of shutdown projects based on the critical success factors, the drivers that increase the success of shutdown projects must be identified. RSQ2 intends to identify from literature and probe the perceptions of stakeholders involved in the execution of these projects, the factors that impact the likelihood of success in shutdown projects.

By addressing the MRQ and the two research sub-questions (i.e. RSQ1 and RSQ2), project managers will gain a better understanding of the variables that affect the successful implementation of their projects and will be able to manage their projects much more effectively.

1.5 Research Objectives

This research is undertaken to achieve the following objectives:

- Determine how a successful shutdown project is perceived by defining the criteria used to evaluate the project outcome;
- Define the critical factors that have an impact on shutdown project success; and
- Develop a conceptual model analysing the association between the project success and the critical success factors.

1.6 Significance of the Study

According to Ertl (2004, p. 19), there are different levels of maturity when considering project management literature. Most of the research efforts is directed towards the software and construction industries, with shutdown projects receiving very little attention. To this end, the study of project success is well established in the construction and software projects. However, the same cannot be said about shutdown projects. Therefore, this study is of significance because it adds and expands on the current knowledge on shutdown project management with the aim of gaining a better understanding of how shutdown project performance can be improved through the investigation of the factors that are necessary for the success of shutdown projects.

Although several studies exist that have explored the factors that affect the outcome of shutdown projects, however, these studies have failed to examine the association between the success factors and project success. Therefore, the aim of this study is to address the currently existing gap by considering the extent to which these success factors influence shutdown project success. It is envisaged that this study would provide a solution for reducing cost overruns and delays in shutdown projects by highlighting important factors needing attention for the successful delivery of shutdown projects.

1.7 Theoretical Framework

This study drew from the extensive work of Pinto and Slevin on project success. These are the primary scholars in project success literature with authors such as Muller and Jugdev (2012, p. 758) acknowledging them as trailblazers of project success. Pinto and Slevin (1988, p. 67) have looked at the definition of project success and deliberated on the ambiguity surrounding this concept. Additionally, to understand the notion of project success, some authors (Ika, 2009, p. 10; Muller & Jugdev, 2012, p. 757) have adopted the approach of reviewing the development of the concept over time. For example, Ika (2009, p. 9) reviewed articles published between 1986 and 2004 on project success. The author concluded that studies on project success are diverse and that the definition of this concept remains vague and multi-dimensional. These studies serve as a guide for this current research for examining the meaning of project success in relation to shutdown projects.

Project success cannot be defined unless there is a predefined criterion to measure it. De Wit (1988, p. 164) pointed out that the most suitable method for evaluating project success is by considering the project objectives. In contrast, the author further indicated that it is impossible to objectively assess project success because not all stakeholders view the concept in the same way. Lipovetsky et al. (1997, p. 391) proposed a multi-dimensional framework of project success that not only addressed the different dimensions of measuring project success, but also emphasised the benefits that accrues to customers, stakeholders and the organisation. Such studies of the success criteria guided this research in finding a comprehensive measure for shutdown project success.

Pinto and Slevin (1987, p. 22) have also developed a Project Implementation Profile (PIP) framework which suggested a set of critical success factors that are essential for project implementation. Their work became a foundation for many subsequent studies and has been widely recognised by other notable authors such as Muller and Jugdev (2012, p. 757). The list of identified success factors and the survey instrument are still used in many research studies to this day. Belassi and Tukel (1996, p. 141) built on their work and provided a framework for clustering groups of success factors and examining the interrelationship between success variables. Their work served as a guide for evaluating the link between project success and the critical success factors in shutdown projects.

1.8 Research Design and Methodology

This quantitative analysis aims to explore the indicators used to evaluate shutdown project success, identify the success factors for shutdown projects and further examine the interaction for the critical success factors and project success. A conceptual model was proposed to evaluate the association between the project success and the critical success factors for shutdown projects. It is hypothesised in the conceptual model that project success is influenced by: *organisational, project-related, human-related, and project management factors*. These latent constructs are measured by a variety of observed items that were extracted from the literature and used in the survey instrument.

The data for this study was collected through a cross-sectional survey using a web-based questionnaire. The variables that measure the latent constructs in the conceptual framework were used as a base for the questionnaire. The research instrument of this study was pilot-

tested and reviewed by industry experts to ensure that it measured what it intended to measure and was amended according to the feedback received before data collection from the study sample was commenced. The target population of this study includes professionals in maintenance and engineering that are directly involved with the execution of shutdown projects in South Africa. Purposive sampling was used to select the respondents from the population. This technique was appropriate to ensure that only the respondents possessing the requisite knowledge and that are currently involved in the implementation of shutdown projects were sampled. To analyse the hypothesised relationships from the proposed conceptual model, structural equation modelling was used for hypotheses testing.

1.9 Definition of Terms

Unless stated otherwise, the following terms have the following meanings in this thesis:

Critical success factors are a group of variables through which the probability of completing the project successfully can be improved (Albert et al., 2017, p. 798).

Project is an undertaking initiated temporarily to produce unique results, product or service (PMBOK, 2013, p. 5).

Project management is the use of tools and techniques during the execution of the project to ensure that it achieves its expected outcomes (PMBOK, 2013, p. 443).

Project Success was initially characterised as the accomplishment of cost, time and performance objectives (Cooke-Davies, 2002, p. 186). It is also viewed as an elusive, construct, with interrelated measurements that are technical, financial, social, business, and strategic in nature (McLeod et al., 2012, p. 68).

Shutdown Project is a planned maintenance event that includes the critical tasks of inspection, repairs, replacements, and modifications of plant assets; and is performed periodically leading to plant production being stopped (Duffuaa & Ben-Daya, 2004, p. 184).

Success Criteria is a standard or a measure that is used to evaluate the outcome of a project (de Wit, 1988, p. 164).

1.10 Assumptions and Limitations

The focus of this enquiry is limited to organisations in South Africa that have shutdown maintenance as part of their maintenance strategy. Process organisations frequently implement different types of projects. However, the scope of this research study is limited to projects that are implemented when operations are stopped for shutdown maintenance purposes.

It is assumed that the participants in this study answered truthfully and as accurately as possible based on their experience and knowledge in executing shutdown projects. To increase the response rate, the questionnaire was distributed using two different modes of distribution namely web-based and paper survey. It is assumed that the use of the two methods did not introduce any bias in the results.

1.11 Layout of the Thesis

This dissertation is divided into six chapters. Following this chapter, current literature that reflects on project success with a specific focus on shutdown projects is reviewed in **Chapter 2**. The chapter explores how project success has been interpreted in literature, the criteria that scholars have used to define success in projects and the variables that are significant to the successful outcome of projects.

Chapter 3 provides a conceptual model for this research. The proposed model depicts the relationship between shutdown project success and the variables that have an impact on the project outcome.

The study design and approach used in this research study are outlined in **Chapter 4**. The chapter presents the philosophical stance adopted by the researcher, discusses data collection methods, sampling technique, the questionnaire design and the administration of the questionnaire. The chapter also gives a brief background of the methods used for data analysis.

The statistical analysis of the data is presented in **Chapter 5**. It outlines the data cleaning and preparation process, descriptive analysis, demographics analysis, factor analysis and the results emanating from structural equation modelling.

Lastly, the key results from the analysis of data are presented in **Chapter 6**. The conclusions are drawn and recommendations for future research are outlined.

1.12 Summary

This chapter is a synopsis of this research. It highlights the importance of a successful outcome in shutdown projects. The chapter briefly discussed the failure rates of shutdown projects and their effects. Hence, it was justified that research is necessary to clarify shutdown project success and to identify the drivers of success in these projects. The chapter provided the theoretical framework that was used as a guide for the literature review. It also reflected on the methodology used in order to attain the research objectives. In the next chapter, previously published literature relating to the phenomena of interest is reviewed.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

There are two important themes of research in project success literature (Muller & Jugdev, 2012, p. 758). The one theme involves the criteria for project success, while the other subject examines the critical elements that can enhance the likelihood of success in a project. To fully understand the concept under this research study, both themes need to be examined (Cooke-Davies, 2002, p. 185). Hence, the motivation behind this chapter is to evaluate previously published literature on project success, the critical success factors and the criteria used to evaluate success in the context of shutdown projects.

This chapter starts by looking at the description of a project to justify that a shutdown project is indeed a project on its own. Thereafter, the nature of shutdown projects and their challenges are discussed with the intention of distinguishing shutdown projects from other projects. The third section of this chapter looks at the development of literature on project success to understand its definition. Previous research on the criteria and drivers of success for shutdown projects are likewise presented.

This chapter also seeks to address two vital goals. The first two objectives of undertaking this research study is to understand the criteria used to define project success and to examine the factors that are significant for project success. Thus, from a theoretical perspective, this chapter aims to introduce preliminary findings of those variables that are essential to the success of shutdown projects, and further explores the indicators used to assess shutdown project success.

2.2 An Overview of Shutdown Projects

Before initiating any discussion on project success, the characterisation of a project is the foundation on which the success or failure is based (Pinto & Slevin, 1988, p. 68). Thus, it is

on that premise that the definition of a project is explored and further contrasted to what a shutdown project is.

2.2.1 Definition of a Project

A project is "an undertaking initiated temporarily to create a unique outcome, service or product" (PMBOK, 2013, p. 3). Pinto and Slevin (1988, p. 68) analysed this definition and concluded on two vital points. The idea of a temporary project implies that it has starting and end points. Additionally, the unique nature of a project suggests that the outcome produced by the project will vary from that of other projects. While this definition alludes to a project as a temporary and unique endeavour, there has always been a need to ascertain whether a shutdown project is a project as it is a periodically repeated event. Hence, it is crucial to understand why a shutdown project is classified as a project.

2.2.2 Definition of a Shutdown Project

According to Sahoo (2014, p. 3), a shutdown project is classified as a project because it is a unique and temporary undertaking that is executed differently from one organisation to the other. This view is also supported by Elwerfalli et al. (2016, p. 104), who emphasise that each shutdown project has unique features which are distinguished by financial aspects, technology, geographical area, external markets and process configurations within each process plant. Levitt (2004, p. 21) points out that shutdown maintenance is an ongoing process, with each shutdown project starting immediately after the completion of another. However, each shutdown period has clearly defined start and end dates. Furthermore, a shutdown project is managed like any other project using project management methods, techniques and tools (Sahoo, 2014, p. 22). Although shutdown projects have similarities with all other projects, the maintenance work performed during the event distinguishes these projects from other projects (Oliver, 2001, p. 95).

A further look into the definition of a shutdown project indicates that different terminologies are used to refer to these projects. Sahoo (2014, p. 11), differentiates between the terms "*shutdown*", "*outage*" and "*turnaround*". According to the author, a plant shutdown

involves performing a small scope of maintenance on separate areas of the process plant and at frequent intervals. An outage is bringing the entire plant facility down to perform major equipment overhaul, maintenance work or replacement. A turnaround, on the other hand, relates to a more extensive maintenance scope for plant upgrades, major maintenance and new expansion projects.

While Ertl (2004, p. 1) argues that all process industries have their preferred terminologies when using these three terms, other authors (Hansen & Schroeder, 2016, p. 1; Megow et al., 2011, p. 189; Raoufi & Fayek, 2015, p. 168) use these terms interchangeably. They are also regarded as shutdown turnaround and outage (STO) projects in some quarters (Sahoo, 2014, p. 1).

This research study has adopted the definition by Duffuaa and Ben-Daya (2004, p. 184) to refer to a shutdown project as: "*a planned maintenance event that involves the critical tasks of inspection, repairs, replacements and modifications of plant assets and is performed periodically when the entire plant or part of it is taken out of service.*" In a case where the plant is stopped a few days for an unexpected, unplanned breakdown, such a case does not fall within the scope of this study (Malmén et al., 2010, p. 249).

2.2.3 Nature of Shutdown Projects

Shutdown projects are often viewed as engineering, procurement and construction (EPC) projects; however, these projects are unique and have features that distinguish them from other projects (Obiajunwa, 2012, p. 368). One such aspect is the cost associated with a shutdown project. According to Duffuaa and Ben-Daya (2009, p. 223), between 30% and 40% of the annual maintenance budget is consumed by a shutdown project; the cost of which is high due to the project itself and the cost related to the loss of revenue while the plant is not operational (Levitt, 2004, p. 1). Sahoo (2014, p. 3) also argues that any delay in resuming process plant leads to an organisational loss that surpasses the value of the project. In addition to the actual project cost, cost overruns are common and are mostly due to changes in scope that occur during the discovery of emergent work (Raoufi & Fayek, 2015, p. 168). While it is easy to estimate the cost of replacing components that are on a planned worklist, Ertl (2004, p. 23) points out that a shutdown budget fails to have an accurate cost estimate due to the

discovery of emergent work. Obiajunwa (2012, p. 370) also argues that these projects are not like generic projects and thus cannot be treated as such when allocating the budget. The shutdown budget must accommodate contingencies due to the scope changes that were not considered earlier in the planning of the project. While agreeing with these sentiments, Sahoo (2014, p. 24) also calls for better management of the shutdown scope.

Another aspect that distinguishes a shutdown project from other projects is that the work scope remains partially defined until the actual project resumes (Ghazali & Halib, 2011, p. 32). According to Sahoo (2014, p. 23), successful projects are only achieved when there is a clearly defined scope of work and there is careful planning of the project. However, shutdown projects are known to be characterised by a loosely defined, yet varying scope compared to other projects (Obiajunwa, 2012, p. 370). Despite having advanced tools and techniques for predicting the condition of the equipment, additional work is always discovered when the equipment is stripped for cleaning and inspection (Duffuaa & Ben-Daya, 2004, p. 186). Levitt (2004, p. 43) also concurs that work items are not completely known until the equipment is opened, inspected and cleaned; thus leading to more work being discovered. Such scope additions increase the complexity of the project (Phokarel & Jiao, 2008, p. 111). Nevertheless, Obiajunwa (2012, p. 369), Amaran et al. (2016, p. 422) argue that estimating the duration of the shutdown project is another source of uncertainty.

An ideal shutdown project is one that has been executed at a minimised cost and duration (Sahoo, 2014, p. 3). However, an accurate estimate of the duration of a shutdown project is not possible due to the expected variation in scope. Additional work items on the scope affects the critical path of the project and consequently causes delays (Obiajunwa, 2012, p. 369; Raoufi & Fayek, 2015, p. 168). However, according to Megow et al. (2011, p. 189) minimising the duration could imply increasing additional resources.

Safety is viewed as an integral part of a shutdown project. The project involves individuals from different disciplines (many of whom are contractors) performing different tasks in a short time period (Obiajunwa, 2013, p. 63). In fact, in an olefin plant shutdown project reported by Ohlweiler et al. (2013, p. 264); it was stated that out of the 3 000 people that were involved in the project, 2 600 were contractors. According to Ghazali et al. (2014, p. 197), due to the high number of workers in the project, the work zone becomes congested and the chances of potential accidents and errors are very high compared to a normal work

environment. Thus, that possibly increasing the number of safety incidences during the shutdown and start-up periods (Hadidi & Khater, 2015, p. 115).

Another essential feature of a shutdown project is the number of start-up incidences that occur during plant commissioning. A measure of the efficiency of the shutdown execution involves monitoring the number of start-up incidences (Levitt, 2004, p. 7). Obiajunwa (2012, p. 371) points out that quality in shutdown projects means adhering to prescribed work procedures and technical specifications for maintaining the equipment. Any delay in starting the plant back to normal operation affects the time and cost of the shutdown project.

In essence, any uncertainty in the scope, duration, safety and quality of the project impacts on the cost of the project. This trade-off relationship of the performance objectives is often compromised in shutdown projects as many work items need to be achieved within a short period and these are often rushed resulting in the failure of the project (Akbar & Ghazali, 2016, p. 77). In this current business environment, organizations are striving to reduce costs and improve their operations. Thus, this analysis of shutdown project success will help improve the efficient execution of the project and identify factors that will help with executing the project at minimum cost and duration (Mathew & Pretorius, 2018, p. 609; Yong & Mustaffa, 2013, p. 960). On the other hand, Munns and Bjeirmi (1996, p. 85) argue that the effective management of the project is the solution to addressing cost overruns and time delays.

2.2.4 Managing Shutdown Projects

Project management involves using specific tools and techniques during the execution of the project to ensure that the expected outcomes are achieved within the allocated timeframe and predetermined cost (PMBOK, 2013, p. 5). Project management is the key to successful projects, and its tools and techniques contribute to project success (Albert et al., 2017, p. 796). However, Patanakul (2010, p. 42, 43) argues that it is the correct application of project management that influences the project outcome. These tools have developed over time and have been standardised to ensure that the best practices are applied when managing projects and the use of such practices have been found to increase project performance (Papke-Shields et al., 2010, p. 650).

In shutdown projects, Ertl (2004, p. 19) advocates for the use of the PMBOK as a source of reference guide for the management and execution of shutdown projects. According to Sahoo (2014, p. 22), conventional project management tools and techniques are used to oversee shutdown projects. Authors such as Duffuaa and Ben-Daya (2004, p. 184), Sahoo (2014, p. 1), Levitt (2004, p. 1) and Lenahan (2011, p. 1) have each proposed best practices when managing shutdown projects based on the project management philosophy. Even then, these studies are not empirically based, and no research has been undertaken on how these shutdown management practices influence project success. Despite following best practices, many challenges exist that relate to the management of shutdown projects. Examining and understanding these challenges is crucial for the efficient execution of shutdown projects. The following points have been identified as challenges that are encountered by project managers when managing shutdown projects:

Increased Health, Safety and Environmental Incidences

A shutdown project is a perilous event that exposes workers to confined workspaces, the discharge of hazardous chemicals and performing work at elevated heights, to name just a few (Sahoo, 2014, p. 143). One challenge faced by project managers when executing shutdown projects is providing a safe environment for everyone involved in the project because catastrophic accidents often occur during this period (Hadidi & Khater, 2015, p. 115; Malmén et al., 2010, p. 249). Although such incidences have severe and sometimes fatal consequences, many organisations do not have a dedicated safety management system for shutdown events but rather address safety issues for daily operations. The effort to prioritise safety in shutdown projects must be an ongoing process. However, that becomes a challenge due to the large number of contractors needed in the project that are only available on-site during the shutdown period (Hadidi & Khater, 2015, p. 116).

Ineffective Communication

Communication becomes a challenge during the implementation phase of the shutdown project. These projects involve many pieces of information that should be extracted from drawings, plans and schedules (Lenahan, 2011, p. 162). Since there are a huge number of personnel from different disciplines with different skill sets, the shutdown team will

normally be given a timeline for the execution of the project. However, there is no affirmation that the information has been successfully transmitted and can be applied when executing the worklist tasks (Cormier & Gillard, 2009, p. 77). Obiajunwa (2010, p. 266) concurs that the hindrance in communicating effectively during the shutdown period lies with the interpretation of the message received by individuals. However, Sahoo (2014, p. 157) argues that a successful shutdown execution requires effective and efficient communication.

Shortage of Critical Skills

According to Obiajunwa (2010, p. 266), another challenge with shutdown projects is the lack of relevant skills to implement the project. Due to the lack of suitable skills and for economic reasons, organisations rely on contractors to carry out their shutdown work. The issue is compounded when other organisations have a shutdown project during the same period and must recruit from the same pool of resources (Sahoo, 2014, p. 23). At times, project managers are compelled to execute their projects regardless of whether the competency level of their labour resource is low, and this affects the quality of the work carried out (Benaya, 2010, p. 76). In addition, Cormier and Gillard (2009, p. 77) insist that senior engineering personnel retire in numbers without the knowledge transfer to close the knowledge gap and yet skills are necessary for a productive shutdowns project (Levitt, 2004, p. 5).

Poor Management of the Work Scope

Obiajunwa (2010, p. 266) posits that the management of the work scope is one of the challenges that organisations must deal with. In every shutdown project, it is anticipated that there will be changes in the work scope arising from the discovery of additional work during the execution of the project. Some shutdown projects experience an extra 15% to 40% of emergent work, the management of which is a challenge to most project managers. When additional work is identified, it is often not clear if an assessment of its impact on cost, duration and resources is done. The priority during project execution is to attend to the worklist. Most of the time, the emergent work is not accounted for outside the base plans (Levitt, 2004, p. 203). Nonetheless, Lenahan (2011, p. 181) places particular

emphasis that the emergent work should get the approval of senior management, while Levitt (2004, p. 202) believes in the strict control of the shutdown scope of work.

Unavailability of Spares and Materials

A shutdown project requires a large number of spares and materials that ought to be readily available during the implementation of the project (Sahoo, 2014, p. 83). At times, the precise requirement becomes known only during the project execution as spare parts for emergent work are stocked based on anticipation. Thus, the unavailability of some spares sometimes occurs, and the progress of the shutdown work is as a result affected. At times, it is uncertain when the procured materials might be delivered and that could imply a delay in the delivery of the project (Amaran et al., 2016, p. 422).

The emphasis of this research is on those aspects that can help overcome such challenges and thus enhance the positive outcome of the project. An enquiry into the critical success factors allows organisations to pay attention to those elements that need to be addressed for the successful implementation of the project. The investigation of success in a project provides an opportunity to determine whether the project and the objectives of the organisation have been achieved (Mathew & Pretorius, 2018, p. 609). The efficiency of project management can be improved by identifying and knowing these issues, while working to minimize their related problems (Clarke, 1999, p. 139).

2.2.5 Shutdown Projects in South Africa

Several studies have revealed that shutdown projects in South Africa have similar characteristics and face similar challenges across various disciplines. According to Ntoyanto (2016, p. 5), cost overruns and time delays are common and expected in shutdown projects. Mhlanga (2016, p. 75) echoes the same views. Project managers have to overcome problems with the scheduling and execution of the project, increased safety occurrences, the shortage of critical skills and procurement of materials (Benaya, 2010, p. 3; Mhlanga, 2015, p. 2, 75). To this end, the analysis of project success must be contextualised to understand the challenges in these projects and to identify the key factors that will aid in the successful implementation of shutdown projects (Yong & Mustaffa, 2013, p. 960).

2.3 Project Success

Project success is a topic that has been examined extensively over the years (Albert et al., 2017, p. 797) with many authors (Baccarini, 1999, p. 25; McLeod et al., 2012, p. 6; Pinto & Slevin, 1988, p. 67) agreeing that there is still no common definition of the concept that can fit all project undertakings. Consequently, the concept has been vaguely defined in literature (Baccarini, 1999, p. 25). Considering the extensive research on project success, the concept has evolved and advanced over time (McLeod et al., 2012, p. 68). Studies by Ika (2009, p. 6), Davis (2014, p. 192), Jugdev and Muller (2005, p. 23) have looked at how this concept has progressed in project management literature. Hence, in this section, the definition of project success is discussed by focusing on the historical overview of this concept. To understand project success, Figure 2.1 (adapted from Ika 2009, p. 10) illustrates a timeline with three distinct periods.

Period 1: 1960s–1980s

Since the early works of project management (1960s – 1980s), the iron triangle of cost, time and performance targets has been considered as the main criteria for defining and evaluating project success (Albert et al., 2017, p. 797; Ika, 2009, p. 10; Muller & Jugdev, 2012, p. 762). The literature published during this period was criticised for not being empirically based (Muller & Jugdev, 2012, p. 762) and for failing to consider the needs of stakeholders and customers (Davis 2014, p. 192). Very few studies were published on critical success factors and the existing few consisted of narrated lists of factors (Ika, 2009, p. 10; Muller & Jugdev, 2012, p. 762). During this time, the research emphasised on the execution phase of the project life cycle while neglected to evaluate success over the entire lifecycle of the project (Jugdev & Muller, 2005, p. 24).

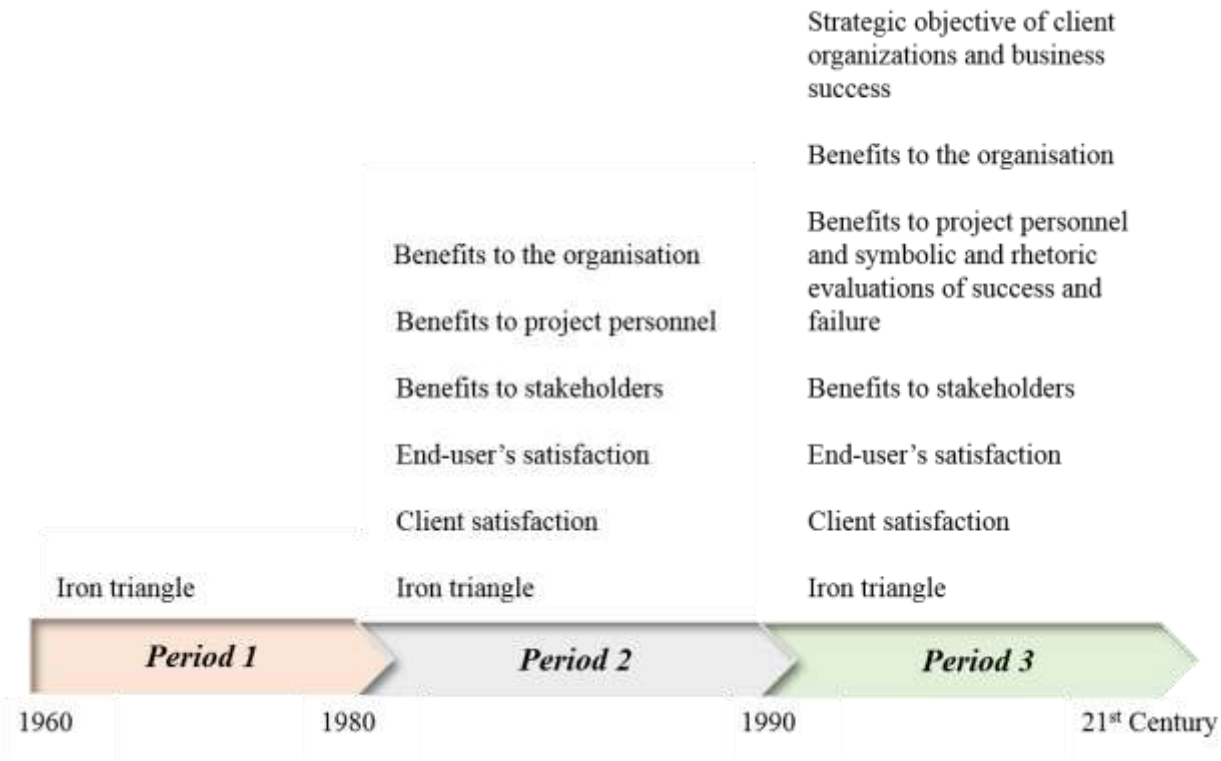

Figure 2.1: Project success over time

Source: (Ika, 2009)

Period 2: 1980s–1990s

Research progressed during the 1980s to 1990s with more empirically based studies being developed (Ika, 2009, p. 13). During this period, success was considered as a single measure as opposed to having different dimensions over the lifecycle of the project. The satisfaction of the stakeholders as an indicator of project success became significant (Muller & Jugdev, 2012, p. 762; Albert et al., 2017, p. 797). Studies on critical success factors received more attention; however these contributions were neither categorised nor coordinated coherently (Jugdev & Muller, 2005, p. 24).

Period 3: 1990s – 2000s

During the 1990s, the research work by Shenhar et al. (1997, p. 97) made a significant contribution to the different dimensions of evaluating project success (Muller & Jugdev, 2012, p. 762). It was recognised that projects create financial value and impact the overall success of businesses. Hence, the measure of business success and planning for the future

were part of the framework for evaluating project success. More research on critical success factors shifted from merely identifying the success factors into classifying the these success factors into groups to understand their interrelationships for improving project success (Belassi & Tukel, 1996, p. 142).

Lately, authors such as Muller and Jugdev (2012, p. 763), acknowledge project success as a broader and expansive concept, which still has different definitions for various stakeholders. Ika (2009, p. 7) also states that project success can be viewed as a multi-dimensional, complex and comprehensive concept whose definition is context-dependent. McLeod et al. (2012, p. 68) also agree that project success is an interlink between economical, technical, behavioural, strategic and business dimensions of success.

While extensive evidence on project success exist in the literature, it is widely accepted that a clear definition of the term still does not exist (Muller & Jugdev, 2012, p. 768). Nevertheless, project success has throughout the years advanced from a unidimensional, quantifiable measure to a complex, multi-dimensional concept incorporating different properties (Mir & Pinnington, 2014, p. 203; Joslin & Muller, 2016, p. 366). More so, it has been highlighted that the quest for better methods to assess project success will continue to the future, especially since each project has unique characteristics.

An overview of success in shutdown projects indicates that historically the maintenance of equipment and machinery was not planned and occurred only when the equipment completely failed or broke down. Shutdown projects were viewed as an extension of the maintenance function of the plant and not as projects. Between the 1950s and the 1960s, preventive maintenance was developed as a strategy with a set interval to perform maintenance regardless of the condition of the equipment. During this period, shutdown projects were viewed as a success based on the number of safety occurrences or fatalities. The objectives of the project were not measured, environmental regulations were not as restrictive and quality measurements were rarely met (Vichich, 2012, p. 3).

Organisations have now acknowledged shutdown projects as strategic components of competitiveness that are compatible with business objectives (Sahoo, 2014, p. 30; Vichich, 2012, p. 3). It has been acknowledged that organisations suffer a financial loss when their equipment are not in full operation in terms of availability and reliability (Ghazali & Halib,

2011, p. 32). As a result, shutdown projects are now viewed as whole business events rather than function-specific events (Sahoo, 2014, p. 1). Despite such advancements, research on shutdown project success is still not as rich as in other projects. Ghazali et al. (2009, p. 240) attribute this lack of research to the fact that literature on shutdown projects is mostly not empirically based and does not go beyond the individual experience of shutdown practitioners. However, McLeod et al. (2012, p. 68) have noted that while the characterisation of project success remains problematic to researchers, its definition is based on a predefined criterion.

2.4 Success Criteria

Joslin and Muller (2016, p. 378) suggested that to have common view of what project success is, it ought to be quantified and defined according to the success criteria. The success criteria is a standardised measure used to evaluate the outcome of a project (de Wit 1988, p. 164; Joslin & Muller 2016, p. 366). Various researchers have attempted to identify the criteria with which to define their project performance (McLeod et al., 2012, p. 68). However, it is noted that project success is interpreted differently based on the project type, industry and the project manager's characteristics (Muller & Turner, 2007, p. 290). Mir and Pinnington (2014, p. 203) also agree that the success criteria varies because of the uniqueness, size and the complexity of projects. Nonetheless, different viewpoints and frameworks have been presented concerning the success criteria (Albert et al., 2017, p. 797).

The Traditional Criteria of Project Success

The triple constraint of time, cost and performance goals is considered as the traditional criteria for evaluation project success (Pinto & Slevin, 1988, p. 68). Albert et al. (2017, p. 797) suggested that the main intention of this criterion was to visualise the trade-off relationship between the three project constraints. However, this criterion has been highly criticised and found to be limited when some projects were viewed as a success by their project teams yet were received as failures by their customers (de Wit 1988, p. 165; Pinto & Slevin, 1987, p. 67; Lipovetsky et al., 1997, p. 97; Belassi & Tukel, 1996, p. 41). Other projects had extensive delays and cost overruns yet ended up as business successes (Shenhar et al., 2001, p. 700). Other authors (Shenhar et al., 1997, p. 7) argued that this criterion of success indicates the internal measure of the efficient delivery of the project, it

focuses on the objectives of the project and neglects to take into account the views of the customers and stakeholders. It was then concluded that the iron triangle does not provide the whole picture of project success. Nonetheless, the iron triangle is currently perceived as the foundation of project management (Jugdev & Muller, 2005, p. 23), it remains relevant as a criterion of project management success and is frequently used by project managers because it is easy to quantify (Pinto & Slevin, 1988, p. 68).

Perceptions of Stakeholders

Lipovetsky et al. (1997, p. 97) emphasised that a project has many attributes, and that calls for several measures to evaluate its success. More so in shutdown projects, Sahoo (2014, p. 1) also agreed that a single measure of project success is misleading and that it is necessary to have several criteria to provide a balanced view of shutdown project performance. Montequin et al. (2016, p. 441) pointed out that after the project has been completed, meeting the project objectives becomes insignificant if the stakeholders are not satisfied with the outcome of the project. Subsequently, the component of customer and stakeholder satisfaction formed part of the indicators of project success (Dvir, et al., 1998, p. 918; Lipovetsky et al., 1997, p. 98). Obiajunwa (2010, p. 55) also highlighted the importance of the shutdown projects to realize the needs and expectations of stakeholders.

Davis (2014, p. 189) highlighted that the stakeholder's perceptions assume an essential role in assessing project success, however using these perceptions are often a challenge. Mir and Pinnington (2014, p. 203) argue that the stakeholder's perceptions vary based on the project type, nationality, and contract type. Albert et al. (2017, p. 798) also attribute the difference in perspectives, to the stakeholders' motivations to execute the project. Thus, Ika (2009, p. 7) resolved that the assessment of a project outcome is a subjective matter, and that perceived success is preferred rather than absolute success.

Different authors have diverse views about the stakeholders in shutdown projects and consequently, their opinions of shutdown project success may vary. As indicated by Levitt (2004, p. 28), the stakeholders in shutdown projects include top management, the production manager, accounting manager, maintenance manager and the end customer. Brown (2004, p. 111) stresses that the operations department has the most interest in the project outcome because the shutdown project is a risk to the continued operation of the

plant. On the other hand, Al-Turki et al. (2013, p. 1) argue that the entire supply chain of the process plant should form part of the assessment of the shutdown project outcome. Implying that contractors, operations, logistics, procurement and stores, quality personnel, safety and environmental, accounting and finance, planning and scheduling personnel are all stakeholders in the project. Obiajunwa (2012, p. 372) grouped the stakeholders of shutdown projects as top management, project participants and end-users. The author then evaluated how these stakeholder groups perceived shutdown project success:

Top Management: Top management is focused on the outcome of the project according to the project management effort and how the project contributes to the business success. These stakeholders are therefore happy when the management process of the project is a success and expect that the goals and the long-term benefits of implementing the shutdown project are realised.

The Core Project Team: This is the group of individuals who are directly involved with project planning and execution. Their view of success varies from one another, however are mostly concerned with the efficient delivery of the project according to the project objectives.

The End-User: This is a group of individuals who will be handed the project services and results (PMBOK, 2013, p. 32). In shutdown projects, end-users are the operations department and plant operators. Their perception of project success is based on the operational performance of the plant such as reliability and whether the plant is safe to operate (Obiajunwa, 2012, p. 372).

Project Objectives

Not only are the stakeholder's perceptions important when evaluating project success, but the project objectives are essential when defining the success criteria (de Wit, 1988, p. 164, 166). As indicated by Baccarini (1999, p. 25), projects are executed to accomplish a set of objectives and that success ought to be assessed in terms of how well these objectives have been achieved. Different projects have diverse objectives. Additionally, there could be various objectives within a project life cycle, and these could change for each stage in the project life cycle (De Wit, 1988, p. 164, 166). Consequently, project

success can be determined according to the extent to which these targets are achieved. Rolstadas et al. (2014, p. 639) extended de Wit's views and proposed that project success ought to be assessed according to any arrangement of objectives categorised as project objectives, business objectives, social and ecological objectives.

As per Baccarini (1999, p. 26), the words used to characterise project objectives varies amongst authors. The terms *"project goals"* and *"project purpose"* must be differentiated to understand the project objectives. The project purpose offers the guidance towards the project goal, determines the necessary project outcome and defines the project's short-term objective. The project goal provides the motivation behind the project effort and expresses the long-term objectives of the project. Shenhar et al. (2001, p. 700) suggest that project objectives must be defined in advance to achieve the projects' short-term and long-term objectives.

Long-term objectives: Different shutdown projects have different objectives. As per Duffuaa and Ben-Daya (2009, p. 223), the following objectives are the long-term objectives of executing a shutdown project:

- Improve plant throughput and efficiency;
- Increase the availability of the plant and the reliability of the equipment;
- Maintain safety during plant operation;
- Reduce daily maintenance costs;
- Upgrade technology by adopting modern machinery;
- Upgrade existing equipment to meet legal requirements such as environmental regulation.

Al-Turki et al. (2013, p. 6), also agree that the overall objective of initiating a shutdown project in any plant is to maintain its availability and operational utilisation. These objectives were recognised by Obiajunwa (2010, p. 368) as the resultant benefits to the organisation.

Short-term objectives: As indicated by Pinto and Slevin (1988, p. 69) a project has to achieve three main objectives: the project must be delivered within a predetermined timeframe, cost and must conform with quality requirements. However, based on Lenahan's (2011, p. 22) viewpoint, to achieve success in a

shutdown project; the quantity, quality, time, money and safety objectives have to be achieved.

Project Success vs Project Management Success

Rolstadas et al. (2014, p. 640) also stated that while the management of a project can ineffective, the outcome of which might be a success. In addition, a project can be effectively managed, yet the project outcome may fail to add any value. Hence, de Wit (1988, p. 165), resolved that the terms "*project success"* and *"project management success"* must be separated when characterising the success criteria. Authors such as Baccarini (1999, p. 25), Muller and Jugdev (2012, p. 765) pointed out that project success looks beyond the way the project was completed and focuses more on the overall outcome by considering the project's overall objectives. The achievement of project management success is more concerned with a cost-effective and efficient implementation of the project.

In shutdown projects, Obiajunwa (2012, p. 369) posited that project management success is an indication of the efficient delivery of the project. The author further alluded that project management success is assessed in terms of the achievement of time, cost, quality, safety, environmental and functional requirements. Al-Turki et al. (2013, p. 4) contended that success in shutdown projects is judged according to the achievement of the results as well as the performance of execution. Successful execution metrics include completion of the project according to the cost, time and quality objectives. Achievement of results expresses having a safe, reliable plant and continuous plant performance improvement.

Project Efficiency and Project Effectiveness

Others (Lipovetsky et al., 1997, p. 97; Shenhar et al., 1997, p. 5; Ika, 2009, p. 7) have argued that the indicators of time, cost and performance reflects the efficiency of the project and adopted the term project efficiency rather than of project management success. Shenhar et al. (1997, p. 6) also stressed the need to distinguish between the terms, *"project efficiency"* and *"project effectiveness"* as project effectiveness considers how well the project adds to the attainment of strategic objectives.

According to Al-Turki et al. (2013, p. 6), it may not be enough to complete a shutdown project within the time and cost targets. In addition to the operational criteria of budget and schedule, plant effectiveness measures must be considered. These measures must align with the organisation's strategic objectives and the effectiveness of a shutdown project should be revealed through the level of plant availability.

Hard and Soft Criteria of Success

Baccarini (1999, p. 30) distinguished between the terms: *"hard"* and *"soft"* dimensions of success. The hard criteria are regarded as tangible objectives, measurable and evaluate the constraints of cost, time and quality performance. The subjective measures of success are regarded as the soft criteria of success and closely linked to human factors such as stakeholder satisfaction (Albert et al., 2017, p. 810). The success criteria has focused beyond the project management effort to include business and strategic dimensions. Yet, this measure of project success is seen as being intangible, subjective and difficult to measure (McLeod et al., 2012, p. 70).

Time Dependence

De Wit (1998, p. 167) also pointed out that the evaluation of the project outcome is also time-dependent. According to Albert et al. (2017, p. 799), once the project has been executed as per the project requirements, project management success has been achieved. This is however, a short-term measure of project success. The evaluation of whether the project was executed according to quality requirements and whether it meets the stakeholder's expectations takes place throughout the project lifecycle (Baccarini, 1999, p. 30). As time passes, the project constraints are not as essential in project success. After project completion, the customer and stakeholder satisfaction become essential measures (Shenhar et al., 1997, p. 12).

Project Success Dimensions

The achievement of project success has advanced to include organisational and strategic objectives (McLeod et al., 2012, p. 70) such as impacting business and market

(Jugdev & Muller 2005, p. 27). Following these findings, Shenhar et al. (2001, p. 699) suggested that project performance is based on dimensions of *project proficiency, impact on the customer, direct business and organisational success and preparing for the future*. Obiajunwa (2012, p. 369) adopted the framework proposed by Shenhar et al. (2001, p. 699), to evaluate shutdown project success and suggested the following criteria for shutdown project success: *project management success, perception of stakeholders and resultant benefits to the business*.

It is clear from this analysis that the project success criteria have evolved from a simple measure of time, cost and performance goals to success dimensions that include subjective measures that are dependent on the stakeholder's viewpoint, measures that are based on a time frame, to measures that enquire about the benefits to the customer and the impact to business organisation (Joslin & Muller, 2016, p. 1378). Thus, this review needs to focus on the success criteria in the context of shutdown projects.

2.4.1 The Criteria for Shutdown Project Success

To obtain a more insightful conclusion of success in shutdown projects, both objective and subjective measures must be considered. As indicated by Chan and Chan (2004, p. 205), project success must be attached to project objectives. Lenahan (2011, p. 22) also stressed that a shutdown project has various goals which are interrelated and should all be managed together for the project to be a success.

According to Sahoo (2014, p. 28), the indicators for measuring shutdown project success are *budget control, duration, scope reduction, efficient preparation, leak-free start-up*. Levitt (2004, p. 7) suggested that the *budget, duration, number of jobs completed, start-up incidences, safety* and *environmental incidences* are the criteria for assessing shutdown project success. Lenahan (2011, p. 22) pointed out that to evaluate shutdown project success, *money, time, quantity, quality, safety* should be considered. Oliver (2001, p. 102) recommended more measures of shutdown project success as *shutdown costs, duration, frequency, total costs, predictability, unscheduled shutdown, start-up incidences, additional work, savings, mechanical availability, safety and environmental incidence*. Dyke (2004) in Al-Turki et al. (2013, p. 2) suggested that to improve on the performance of shutdown

projects, the following performance indicators must be included: *time and cost management, strategic objectives, management of risk, reliability and availability*. Table 2.1 presents a review of the criteria for evaluating shutdown projects success, as suggested by various authors.

Table 2.1: Summary of the success criteria according to different authors

Success Criteria	Sahoo (2014)	Levitt (2004)	Lenahan (2011)	Oliver (2001)	Obiajunwa (2012)	Dyke (2004)	Al-Turki et al. (2013)
Cost	•	•	•	•	•	•	•
Time	•	•	•	•	•	•	•
Safety, health and environmental incidences		•	•	•	•		
Leak-free start-up incidences/quality	•	•	•	•	•		
No. of completed tasks/ scope	•	•	•				
Risk						•	•
Amount of additional work				•			
Efficient preparation	•						
Plant availability				•		•	•
Profitability/savings				•			
Frequency				•			
Predictability				•			
Benefits to stakeholders and customers					•		
Benefits to the organisation					•		

It can be assumed from Table 2.1 that the indicators of success in shutdown projects is based on the objective measure of project management success and the achievement of the project objectives. It is also evident that there are different views and indicators of shutdown project performance. The table also reflects on the different objectives for executing shutdown projects in the process organisations. Obiajunwa (2012) brought a different perspective by using different dimensions of measuring shutdown project performance.

This study resolves that shutdown project success should be measured using a multi-dimensional approach that encompasses different dimensions of success. For a project to be

classified as successful, it must achieve the project's overall objectives and must reflect both long-term and short-term objectives. It was previously indicated that the stakeholder's perception assume an essential part of the assessment of the outcome of the project. Thus, the same applies to shutdown projects.

It was also established that shutdown projects contribute to the overall success of the business organisation and that the cost associated with the project is significant for process organisations. Thus, shutdown project success should include the efficient delivery of the project according to project objectives and the criteria must indicate how the project adds to the strategic objectives of the organisation in terms of the reliability, availability, increased throughput (Obiajunwa, 2010, p. 56). Table 2.2 incorporates the views of various researchers and provides a consolidated summary of the dimensions for measuring the outcome of shutdown projects for this research study.

Table 2.2: The proposed criteria for shutdown project success

Dimension	Success Criteria
Project Efficiency	Delivery of the project on time
	Delivery of the project within budget
	Delivery of the project according to quality specifications
	Delivery of the project according to safety and environmental specifications
	Number of completed tasks or scope
	Number of commissioning incidences
	Amount of additional, unplanned and discovery work
Impact on the customer and stakeholders	The project meets the needs of stakeholders and the end-users of the project.
Business and organisational success	The project contributes to strategic objectives of the organisation in terms of plant availability and reliability of the plant
	The project produces savings and contributes to the profitability of the organisation

2.5 Critical Success Factors

Critical success factors are those characteristics of a project that should be considered when improving the prospects of success of a project (Cooke-Davies, 200, p. 185; Andersen et al., 2006, p. 129). Such variables are referred to as circumstances, activities and conditions that improve the project outcome (Ika, 2009, p. 8). Success factors have been found to improve competencies in project management and to enhance the level of success in projects (Jugdev & Muller, 2012, p. 758). Although these factors are vital for project success, they cannot be used to evaluate the project outcome; however, ignoring these factors increases the probability of project failure (Albert et al., 2017, p. 799; de Wit, 1998, p. 166). Consequently, there is an increasing interest devoted to defining, ranking and analysing such factors (Montequin et al., 2016, p. 441).

There is no consensus in literature on the drivers of project success (Papke-Shields et al., 2010, p. 651). Every individual working in a project has their own view of the factors influencing project success. These factors are subject to the opinions of those engaged in the development of the project, depending not just on the stakeholders in the project but also on geographical or cultural differences. A combination of different factors have certain degrees of influence that result in project success or failure (Montequin et al., 2016, p. 440).

Andersen et al. (2006, p. 129) also indicated that due to the uniqueness of each project, different views exist about which factors are significant in project success and a unifying framework has not been identified. Dvir et al. (1998, p. 915) adopted a similar approach by postulating that critical success factors are not the same for all projects. Projects have unique attributes and are thus affected by unique sets of performance variables. As such, success factors are developed according to different industries and project type (Cooke-Davies, 2002, p. 185).

The study of success factors in project management was first introduced in 1967 by Rubin and Seeling after examining how the experience of the project manager affects project performance. The research indicated that the size of the previous project to which the project manager was exposed to is more significant than the experience of the project manager (Belassi & Tukel, 1996, p. 142). The most widely referenced set of success factors are those

developed by Pinto and Slevin (1988, p. 67). In their study, Pinto and Slevin (1988, p. 67). found the following ten success factors to influence project success: *troubleshooting, top management support, project mission, client acceptance, project schedule/plan, client consultation, monitoring* and *feedback, technical tasks, personnel recruitment* and *communication.* Although this study was not industry-specific, other authors (Jugdev & Muller, 2012, p. 762) have recognised that their seminal contribution to the topic provided a solid foundation for subsequent research.

Fortune and White (2006, p. 54) evaluated previous literature on the critical drivers of successful and unsuccessful projects. From their study, it was confirmed that although some of the factors identified by the various authors are common, most factors affecting project success vary. The most quoted factors in the articles that were reviewed are *having clear and realistic objectives, producing an efficient plan, support from senior management* and *good communication.*

Belassi and Tukel (1996, p. 142) conceded that although different lists of success factors have been found in various studies, their impact on project success might be more effective if the factors are grouped and organised. Thus, a combination of various factors could contribute to the project outcome and arranging them to some criteria can assist in analysing the relationship between the success factors and their possible implications. To this end, the success factors were categorised according to the following clusters: *factors related to the project, the organisation, the environment, the project manager* and *the team members.*

2.5.1 Success Factors in Shutdown Projects

The variables that have a significant impact on the execution of shutdown projects have been considered by different authors. The limitation to these findings is that they are not empirically based and, as indicated by Ghazali et al. (2009, p. 239), studies on shutdown maintenance are descriptive, narrative and based on expert judgement. The variables that influence both the success and the failure of shutdown projects are considered in this review taking into account that failure can provide an understanding of how to prevent attributes that will hamper success in shutdown projects. Lenahan (2011, p. 190) suggested that the execution of shutdown projects is influenced by the following factors: *unrealistic targets,*

counter-productive policies imposed by the steering committee, and *inadequate planning and preparation.* Other factors include *sub-standard communication, the amount of emergent work, contractors that may be unable to fulfil their objectives* and *concentrating on one target that may cause others to be missed*.

In a published magazine article, Johnson et al. (2001) state that the problems frequently experienced in shutdown execution are: *uncertain work definition, uncoordinated procurement of shutdown materials, the absence of integrated management strategy, an insufficient planning effort, communication, incomplete work scope definition* and *poor contractor management.* The article also points out the key factors in achieving a successful shutdown as being: *the planning is a continuous activity* and *clear communications between all stakeholders.*

According to Vichich (2006, p. 3), variables that affect the success of shutdown projects are categorised into *controllable and uncontrollable factors*. The uncontrollable factors that were identified are: a*vailability of skilled workers, the complexity of the project,* and *equipment congestion*. The level of control that the shutdown organization has over these characteristics is very limited. The following controllable factors were identified: *team alignment, scope definition and control, capital integration, contract strategies, comprehensive planning practices, realistic cost estimation* and *level of preparedness*.

As far as Hansen and Schroeder (2016, p. 1) are concerned, the main causes of shutdown delays and cost overruns are: *poor scope control, poor planning and preparation prior to the shutdown event, high rates of discovery work during the event, unrealistic cost* and *schedule targets*. Furthermore, it was suggested that the following should be considered for improving shutdown performance: *planning for the turnaround starts early, there is effective integration across all plant functions, senior management recognizes the importance of shutdown projects to the business and the scope is effectively managed* (Hansen and Schroeder, 2016, p. 1).

Schroeder and Crager (2016, p. 4) scrutinized the importance of shutdown projects to business success and concluded that the causes of shutdown overruns are: *unrealistic cost and schedule targets, poor scope control, poor planning and preparation,* and *high rates of discovery work*.

Vichich and Rennie (2016, p. 5) proposed that the *evaluation of the readiness* of the shutdown project execution is the main contributor to project success. The following factors have also been identified to contribute to poor shutdown performance: *unrealistic targets for shutdown success, ineffective shutdown strategy and steering teams, lack of resource for optimum preparation, delayed decontamination and unit handover, inability to integrate with capital projects, significant scope growth, inadequate or incapable execution organisation, improper management of contractor resources, incomplete adherence to shutdown work processes, quality issues at start-up, late scope freeze* and *late definition of a project.*

Shirley (2006, p. 25) concluded that the outcome of shutdown projects depends on: *the leadership role in the organisation; an adequately staffed organisation with no shortages in key positions; the ability of the site to manage the scope of activities; a disciplined approach to shutdown preparations by the entire site; and a disciplined scope control*.

Duffuaa and Hadidi (2016, p. 3) established the requirements for the successful implementation of shutdown projects in order to identify deficiencies in shutdown practices. The authors have suggested the following the attributes as being essential for the successful implementation of shutdown projects: *the shutdown committee, project manager, spare parts, safety and quality assurance, the scope, communication and reporting, budget, logistics, contractors, learning* and *improvement*.

Obiajunwa (2010, p. 209) identified the following success factors for shutdown projects: *the shutdown project philosophy, scheduling, top management support, project goals and objectives, the project manager, work scope, the organisational structure, adequate resource allocation, the project team, personnel recruitment, technical tasks, contract strategy, safety, health and environment, communication, troubleshooting, logistics, planning, monitoring* and *feedback, technology and regulatory bodies*.

A summary of the success variables highlighted by the different authors is presented in Table 2.3. Based on the factors that have been identified in the literature reviewed for this research study, it is evident that there are different opinions relating to the factors that influence success in shutdown projects. Table 2.3 also indicates that the most common

factors are: *poor planning, the amount of discovery work, scope control, top management support and unrealistic targets*.

Table 2.3: Summary of a literature review of success factors

Success Factors	Lenahan (2011)	Obiajunwa (2010)	Vichich & Rennie (2016)	Hansen & Schroeder (2016)	Hadidi & Duffuaa (2016)	Johnson (2001)	Vichich (2006)	Shirley (2006)	Schroeder & Crager (2016)
Efficient project planning and preparation	●	●		●		●	●	●	●
Strict control of scope		●	●	●	●			●	●
Top management support		●	●	●	●				
Realistic strategy or vision	●	●	●			●			
Realistic targets/goals and objectives	●	●	●	●					
Communication	●	●			●	●			
Amount of discovery work	●		●	●					●
Complete scope definition			●			●	●		
Management of contractors	●		●			●	●		
Availability of skills/personnel		●					●	●	
Integration with other projects			●	●			●		
Procurement of materials and spares					●	●			
Adequate resource allocation		●	●						
Project Manager		●			●				
Organisational structure		●							
Project Team		●							
Clearly defined roles and responsibilities						●			
Team alignment							●		
Early project initiation				●					
Complexity							●		
Realistic cost estimates							●		
Monitoring and feedback		●						●	
Troubleshooting		●							
Quality issues and adherence to work			●						
Site management/contract issues		●					●		
Safety, Health and environment		●			●				
Risk management	●								
Level of preparedness							●		
Lessons learned					●				

2.5.2 Categorisation of Success Factors

As suggested by Belassi and Tukel (1996, p. 143), the categorisation of success factors into different groups provides a better evaluation of project success. Subsequent studies exist on project success based on the clustering of the critical success factors. Chan et al. (2004, p. 153) classified the success factors according to the following clusters: *project procedures, project management actions, external environment, human-related factors, and project-related factors*. Nguyen et al. (2004, p. 4) used principal component analysis (PCA) to establish a structure of success factors and classified them in terms of *competence, communication, commitment* and *comfort*. Yong and Mustaffa (2013, p. 962) drew from the framework suggested by Chan et al. (2004) and categorised their success variables according to *factors related to the project stakeholders, procurement-related factors, factors related to the external environment, project-related factors,* and *factors related to project management and planning.* Tabish and Jha (2013, p. 1133) have classified success factors according to *human-related and project management actions traits*.

None of the key performance drivers are individually responsible for ensuring project success, however, they are all interdependent and thus require a holistic approach to be used (Clarke, 1999, p. 141). Considering the categorisation of factors based on Belassi and Tukel (1996, p. 143) and considering the list of identified success factors for shutdown projects in this review, it was established in this research study that the evaluation of shutdown success factors can be clustered under the following groups of success factors, which are discussed briefly immediately thereafter*: organisational, project-related, project management* and *human factors*.

Organisational factors: This category of factors advocates for complete support from the organization to successfully complete the project initiative (Belassi & Tukel, 1996, p. 145). Thi and Swierczek (2010, p. 573) recognised the factors related to the organization to include the *organisational structure, top management support, project champion and the functional manager's support*. For the current research study, the factors considered under this category are: *top management support, the organisational culture, the shutdown strategy* and *the organisational structure of the project.*

Project-related factors: As mentioned by Chan et al. (2004, p. 153), the variables used to evaluate this category of factors are *project complexity, type, size and value*. To characterise shutdown projects, Ghazali et al. (2009, p. 242) have suggested that the number of workers in the project and the total cost and the planning duration of the project must be considered. Levitt (2004, p. 3) is of the view that the cost of the shutdown, the duration, the lead time, the percentage of contractors used in the project and the shutdown organisation determine the characteristics of a project. Based on the success variables identified in this review, this study considered *the size of the project in terms of monetary value, shutdown project interval* and *the lead-time used to plan the project* as the project characteristics of shutdown projects.

Project Management factors: Project management is an essential component of project success (Chan et al. 2004, p. 154; Obiajunwa, 2013, p. 61). According to Radujković and Sjekavica (2017, p. 609), project management factors are variables that influence the project management process of the project undertaking. Project management factors are linked to the traditional constraints of cost, time and performance (Cooke-Davies, 2002, p. 187). Other authors (Thi & Swierczek, 2010, p. 571) refer to project management factors as those factors proposed by Pinto and Slevin (1988, p. 7). Similar sentiments indicate that the following attributes fall under project management factors were expressed by Chan et al (2004, p. 154): *plan and schedule followed, feedback capabilities, monitoring, adequate communication, project organization structure, control mechanisms, decision making effectiveness, troubleshooting, related previous management experience* and *coordination effectiveness.* Based on the factors identified in this research study, the following factors have been categorised under project management factors: *goals and objectives, communication, monitoring and feedback, planning and scheduling, scope management, cost and time estimates, readiness review, safety management, risk management, troubleshooting, site management and lessons learned.*

Human-related factors: Although researchers emphasize the different sets of success variables influencing project success, they all agree on the significance of human factors in project success (Gudiene et al. 2013, p. 392; Toor & Ogunlana, 2009, p. 152). Cooke- Davies (2002, p. 189) also confirmed that when considering project management, it should be borne in mind that it is the individuals who deliver the

projects. Human factors concerns the attributes of the individuals that are involved in the project. Their skills, competence, commitment, previous experience, motivation, selection, training and authority are considered when characterising human factors (Chan et al., 2004, p. 154). Tabish and Jha (2013, p. 1133) have recommended *good coordination between project participants, the availability of trained resources, project manager's competence,* and *the commitment of all project participants* as human-related success factors. In shutdown projects, the project manager and the project team are actively engaged in the successful implementation of the project. Thus, this research study will focus on the impact of the *project manager's competence, qualification, commitment, leadership style and experience* on shutdown project success. The attributes of the *project teams' skills, motivation, cohesion, competence and commitment* were considered as the project team's factors that influence shutdown project success.

2.6 Gaps in Literature

The aim of this literature review was to evaluate previously published literature and attempt to address the following research sub-questions (RSQs) of the study:

RSQ1: How is shutdown project success defined?

This review has revealed that the concept of project success is an abstract concept that has been vaguely defined by many researchers. Further to this, the definition of the term is not consistent for different stakeholders, different project objectives and dimensions. While studies exist on defining project success in construction (Al-Tmeemy et al., 2011, p. 337) and software (Crowston et al., 2003, p. 327; Agarwal & Rathod, 2006, p. 358) projects, such an enquiry has not been addressed in shutdown projects. Nevertheless, other authors (Sahoo, 2014, p. 28; Levitt 2004, p. 7; Lenahan 2011, p. 22; Elemnifi & Elfeituri, 2007, p. 31) have mentioned the indicators used to assess shutdown project success based on the project objectives. Even so, the existing literature suggests that there is no commonly agreed criteria for evaluating shutdown project success and the studies are not empirically based. Additionally, most of these authors have addressed the concept of project management success in shutdown projects, while neglecting to address the subjective measures of success in shutdown projects.

From this review, it has been iterated that project success goes beyond the traditional criteria of project success. Save for Obiajunwa (2012, p. 377), who proposed using a multi-dimensional approach towards measuring project success, shutdown project management literature has however remained stagnant in evaluating success based on the project management criteria.

RSQ2: What are the factors that contribute to the success of shutdown projects?

It has been observed that the elements of success are project-specific and depend on the stakeholders involved in the projects. Lists of factors believed to impact on the performance of shutdown projects have been considered. However, the existing reports on shutdown projects are highly descriptive and narrative. This is due to the fact that most of them are written by subject matter experts and practitioners (Ghazali, et al., 2009, p. 239). Apart from the study by Obiajunwa (2010, 209), Duffuaa and Hadidi (2016, p. 3), all publications on shutdown factors are not based on empirical evidence.

Research on success factors in shutdown projects goes as far as identifying factors that impact on shutdown project success or failure. Thus, these factors have not been ranked according to their importance to shutdown project success. More so, a study that links these factors to project success has not been realised. Additionally, it was indicated in literature that the studies on critical success factors are context-dependent. However, evidence of shutdown success factors from a South African context is lacking. For this reason, this research study attempts to fill that dearth in knowledge by examining project success based on the critical variables of success.

2.7 Summary

In this chapter, previously published literature on project success, success criteria and success factors was presented. The chapter started by defining a shutdown project and appreciating the unique nature of shutdown projects. While there are various terms used to express shutdown projects, it is however patently clear that these projects are characterised by high costs, short duration, high amount of emergent scope and increased number of safety incidences.

It was also observed that project success has received the attention of many authors, hence the definition of project success evolved and expanded over time reflecting different dimensions of success. More so, the criteria used to evaluate project success depends on the perceptions of stakeholders, project objectives, time of the assessment and incorporation of different dimensions.

The chapter also examined existing literature on critical drivers of success in projects, and it became clear that the existing studies are context-dependent and are according to project type, industry and perceptions of stakeholder. The chapter also sought to identify the variables that influence the performance of shutdown projects. These factors were categorised into *project-related, organisational, human-related and project management factors* based on previous studies. In the next chapter, the theoretical model used in this research study is discussed.

CHAPTER 3
THEORETICAL MODEL AND HYPOTHESES DEVELOPMENT

3.1 Introduction

This research aims to examine the association between the success factors and the success of shutdown projects. In the preceding chapter, categories of success factors for shutdown projects were identified. This chapter intends to formulate the conceptual framework that will specify the theorised relationships between project success and the success factors; and further guide the research study. The chapter also explores the literature used in the conceptualisation of the conceptual model and the research hypotheses.

3.2 Conceptual Framework

The foundation upon which the hypothesis is built is known as the conceptual framework and depicts the interaction between the variables that are theorised (Sekaran & Bougie, 2016, p. 71). The conceptual framework for this study explores the connection between project success and the success factors in shutdown projects. The framework is drawn from the theoretical assumptions proposed by Belassi and Tukel (1996) and Chan et al. (2004). The framework by Chan et al. (2004, p. 154) portrayed how project success is influenced by *the external environment, project-related, human-related, project management actions,* and *project procedures*. The theoretical framework proposed in this study incorporates a similar analogy as that of Chan et al. (2004, p. 154), which consists of groups of factors that represent different dimensions of project success. To understand the association between shutdown projects success and the success factors, the model was selected to reflect the study's objectives. The model was also modified so that it incorporates the findings of the literature review identified in the previous chapter. Figure 3.1 illustrates the conceptual framework proposed in this study.

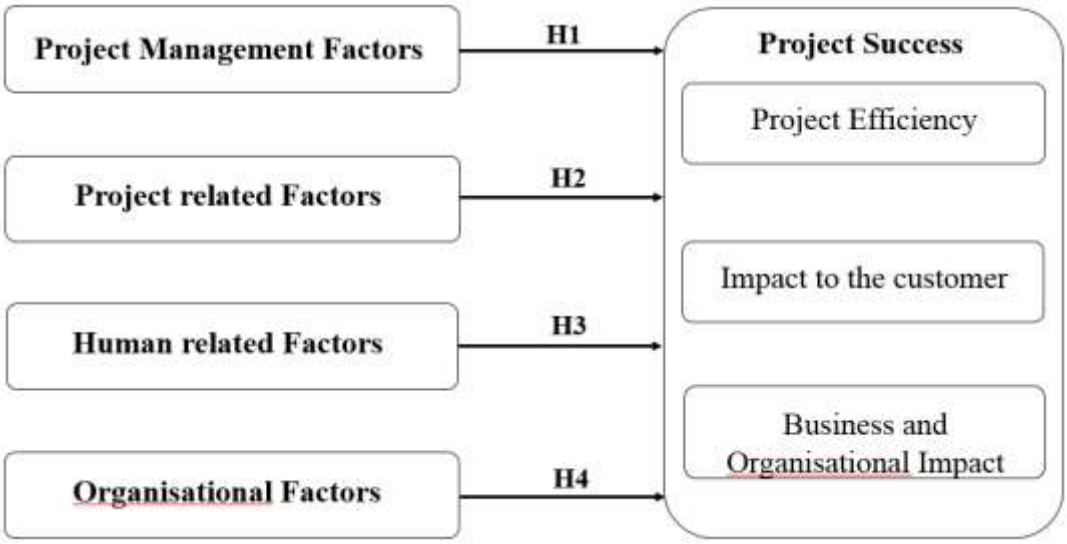

Figure 3.1: Proposed conceptual model for shutdown project success

According to Figure 3.1, the performance of shutdown projects is defined in terms of the following dimensions: *project efficiency, impact to the customer,* and *business and organisational impact.* In this study, it is argued that shutdown project success is influenced by the following groups of factors: *project-related, project management, organisational and human-related factors.*

3.3 Hypotheses Development

To understand the association amongst the constructs in the conceptual model, several hypotheses were formulated. This section discusses the variables that are used to observe the constructs in shutdown project success with a justification for including each of these variables within the proposed model.

3.3.1 Project Management Factors

Project management factors are the variables that have a direct connection with the project management process of a project. Such processes are in place in order to enhance the success of projects (Papke-Shields et al., 2010, p. 651; Tabish & Jha, 2012, p. 1131). Evidence suggests that there is a significant connection between project success and project management performance (Mir & Pinnington, 2014, p. 202), project management factors

(Tabish & Jha, 2012, p. 1136), and project management tools (Sekar et al., 2018, p. 254). Based on these considerations, it is hypothesised in this research study that:

H1: Project management factors have a significant relationship with shutdown project success.

According to the findings of the literature review, the attributes used to observe the construct project management factors include *planning and scheduling*, *goals and objectives, time and cost estimates, communication, monitoring and feedback, readiness review, risk-based inspection, risk management, troubleshooting, safety management, site management* and *lessons learned*. The association of these items with project success is briefly discussed below.

- *Planning and scheduling*: The planning of projects refers to the specification of the tasks, schedules, workers, and equipment requirements in a project (Chua et al. 1999, p. 145; Pinto & Slevin 1988, p. 187). Dvir et al. (2003, p. 89) expressed the view that while planning does not guarantee success, the lack of planning leads to the failure of the project. Phokarel and Jiao (2008, p. 112) concur that the planning of maintenance activities is crucial for shutdown project success. However, Vichich (2016, p. 2) laments that it is the attention to detail and the quality in planning that contributes to the preparedness for the successful shutdown execution. Shutdown projects need to be planned efficiently to guarantee safe and effective implementation (Cormier & Gillard, 2009, p. 77). Plans with the right amount of detail serve as helpful instruments for communication and efficient project monitoring systems (Clarke, 1999, p. 141). Effective planning and control are closely related to clearly defined goals (Toor & Ogunlana, 2009, p. 161) and insufficient planning leads to projects being delayed or completed with cost overruns (Clarke, 1999, p. 141).

- *Goals and objectives:* Pinto and Slevin (1988, p. 172) defined the project mission as the prerequisite for the organisation to have clear goals and objectives. Having clear goals and objectives helps to stay focused on what needs to be attained in the

project (Lim & Mohamed, 1999, p. 243). According to Nguyen and Ogunlana (2004, p. 410), being aware of the goals and objectives of the project helps to ensure visibility of the targets, enhances stakeholder commitment and reduces conflict. Clearly defined goals have been found to be correlated to project management success (Belassi & Tukel, 1996, p. 146). The project team in shutdown projects consists of individuals from various disciplines. It takes one group or department with misaligned priorities to cause a discourse, delay and cost overruns. Thus, an agreement on the common goals and objectives are essential for project success (Cormier & Gillard, 2009, p. 78).

- *Cost and time estimates*: Estimation is the approximation of the financial and schedule resources needed for the project execution (PMBOK, 2013, p. 435). Shutdown budgets are seldom based on the accurate scope due to the discovery of emergent work, and this often leads to cost overruns (Ertl, 2014, p. 23). Furthermore, the development of accurate estimates and strict cost controls are not a priority in shutdown projects because emphasis is placed on driving the schedule to minimize the loss of production time (Lawrence, 2013, p. 3). Hence, realistic cost and schedule estimates should be considered for shutdown project success.

- *Communication:* Communication refers to the adequacy and the efficiency of exchanging information (Chua et al., 1999, p. 145). Project success relies on the effective communication between the stakeholders and the team members of the project (Yong & Mustaffa, 2013, p. 974). In shutdown projects, clear communication channels are essential for information transfer from the planning team right through to the execution team (Cormier & Gillard, 2009, p. 77) and for having a shared understanding of the project goals (Obiajunwa, 2013, p. 61). However, communication is more of a challenge in shutdown projects due to the number of individuals involved in the project (Lenahan, 2011, p. 106). Hence, a suitable project organisational structure must be specified to promote clear communication channels.

- *Monitoring and feedback:* As indicated by Chua et al. (1999, p. 146), monitoring refers to the observation and reporting of the current performance based on the expected results. Monitoring and feedback does not only apply to observing the

project schedule and expenditure, but also includes monitoring the performance of the project team members (Pinto & Slevin, 1988, p. 175). Several authors (Tabish & Jha, 2012, p. 1136; Pinto & Slevin, 1988, p. 175) have cited monitoring and feedback as a key variable for project success. This is because monitoring and feedback processes enable the project manager to foresee challenges, to take corrective action, and to ensure that shortcomings are not disregarded (Pinto & Slevin, 1988, p. 175). Moreover, the project manager of the shutdown project must constantly monitor the event to exercise control and to ensure that safety is adhered to on site (Lenahan, 2011, p. 174). The project participants need to pay attention to project monitoring to ensure the efficient execution of the project as recommended by Tabish and Jha (2012, p. 1137).

- *Readiness review:* A review of readiness involves an assessment of the level of preparedness for project execution (Vichich, 2012, p. 4). Readiness is essential for shutdown projects because of short timelines of the project. To this end, all team members must be prepared with their tools and spares for project execution to retain control of the event (Lenahan, 2011, p. 24). Research evidence suggests a significant connection between a state of readiness of the shutdown project and the project outcome (Vichich, 2012, p 4). Schroeder and Crager (2016, p. 4) have also stated that shutdown projects are characterized by the factors that promote better readiness, which in turn drive better outcomes.

- *Risk-based inspections:* Sahoo (2014, p. 121) argues that the traditional inspection methods of equipment contribute to the increase in operational costs and are currently regarded as reactive means to maintenance rather than proactive maintenance. Thus, these methods may not be as reliable. Risk-based inspections have been commended for using the risk profile of the equipment to determine the inspection and maintenance of the equipment. The aim of risk-based maintenance is to reduce the amount of risk that can occur due to unexpected failures in the plant (Obiajunwa, 2010, p. 35). This strategy is also preferred due to its ability to balance between maintenance of assets and the value gained by the business (Sahoo, 2014, p. 122).

- *Risk management:* As mentioned by Schroeder and Crager (2016, p. 2), most shutdown projects lack a clear approach for documenting and mitigating potential risks in a project. There is also a significant link between the presence of formal risk management procedures and project success. Furthermore, there are many risks associated with the shutdown project. For one, the magnitude of the internal damage of equipment is unknown until it has been cleaned and inspected. Another risk factor involves the procurement of spares and materials. At times, even when the materials are ordered on time the delivery of the materials may be delayed due to external factors (Sahoo, 2014, p. 33; Brown, 2004, p. 17). Thus, the team needs to be aware of the possible risks in the project so that they can be managed and mediated without causing unnecessary delay or cost overruns.

- *Safety management:* A shutdown project is a hazardous event and safety is therefore a priority when executing a shutdown project (Sahoo, 2014, p. 153; Lenahan, 2006, p. 134). Paying attention to safety practices assists in preventing injuries and thus avoiding delays and cost overruns (Bansal, 2011 in Albert et al., 2017, p. 798). Furthermore, a shutdown project that is not efficiently implemented poses serious risks to the safety of the operators of the plant. Thus, safety measures and processes must be adhered to during shutdown execution and the project must be efficiently completed to guarantee the safe operation of the plant.

- *Troubleshooting:* Problems do arise in any project implementation process; however, it is impossible to predict when these issues will occur in a project. The shutdown project consists of risks, uncertainties and many tasks that must be completed in a short time period (Obiajunwa, 2012, p. 368). Therefore, it is essential to have troubleshooting mechanisms as part of the implementation plan of the project. Not only do these mechanisms facilitate a quick response to uncertainties, they also enable potential problem areas during project execution to be identified (Pinto & Slevin, 1988, p. 176).

- *Site management:* Site management and supervision relate to the monitoring and supervision of the work of the contractor and the availability of skilled labourers (Yong & Mustaffa, 2013, p. 974). Most shutdown projects depend on a large work-

force of contractors. Late engagement or poor communication with contractors could lead to project failure. Additionally, as stated by Ghazali and Halib (2011, p. 36), what is on the plan and schedule might be different from what is happening on site. Hence, the continuous monitoring of the site and the progress of the contractors are essential.

- *Lessons learned:* The documentation of lessons learned is a formal process for capturing the experiences of the shutdown event. The results of this documentation process are communicated as a record of best practices that will strengthen the knowledge across the entire organisation. Failing to keep this record and insight obtained from the project is a challenge in the present industry practices (Al-Turki et al., 2013, p. 6). Sekar et al. (2018, p. 250) acknowledge that it is essential to draw from the experience of previous projects and to use the collected data and information to improve the project implementation process. Lessons learned from the past can only prove effective when they are used in future projects (Tripathi & Jha, 2018, p. 13).

3.3.2 Project-related Factors

Project-related factors are considered as those project characteristics that must be taken into consideration when attempting to improve the success in projects (Gudiene et al., 2013, p. 39). The impact of these characteristics is often overlooked in literature, yet many projects fail due to the size and the project complexity (Belassi & Tukel, 1996, p. 144; Thi & Swierczek, 2010, p. 574). Chan et al. (2004, p. 155) found that project-related factors have a direct correlation with project success, whereas Tabish and Jha (2012, p. 136) suggest that a trained committed, competent project team can enhance project success if the project characteristics are fully understood. Therefore, this research study postulates that:

H2: Project-related factors have a significant relationship with shutdown project success.

The attributes that define project-related factors in this research study include *project size and complexity, project duration, project frequency the project lead-time.* The next section briefly discusses why these items relate to project success.

- *Project size and complexity:* Shutdown projects are known to be complex, as they require large amounts of personnel and financial resources (Duffuaa & Hadidi, 2016, p. 2). Based on Vichich's (2016, p. 2) findings, high complexity projects exceed cost and schedule targets by more than 20% when compared to low complexity projects. Furthermore, the amount of time and effort spent on shutdown planning depends on the size and complexity of the project (Levitt, 2004, p. 3; Ghazali et al., 2009, p. 240). However, Belassi and Tukel (1996, p. 147) observed that the size of the project has no significant effect on project success. On the other hand, Papke-Shields (2010, p. 650) asserts that project management tools can alleviate the negative influence of the project size and complexity on project success. Even then, the project size and complexity have been used to observe project-related factors by other authors (Belassi & Tukel, 1996, p. 147; Papke-Shields, 2010, p. 650; Chan et al. 2004, p. 155).

- *Project lead-time:* The lead-time of a project is the time taken to initiate and plan a project; and is critical for project success. Oliver (2001, p. 4) expresses that the initiation of a new shutdown project should start immediately after the completion of the former one. Shutdown planning should be prepared with enough lead-time so that all planning and coordination should be completed prior to the execution of the project (Duffuaa & Ben-Daya, 2009, p. 225; Al-Turki et al., 2013, p. 4).

- *Project duration:* The duration of the shutdown project is typically short owing to the cost associated with the loss of production. Hence, Hameed and Khan (2014, p. 19) argue that the shutdown project is a duration driven event. The priority in any shutdown projects is to reduce the duration so that the availability of the plant can be increased (Sahoo, 2014, p. 28). Thus, during the shutdown period, only critical tasks are attended to and the scope is kept at a minimum with a risk deferring other items to the next shutdown project (Lenahan, 2011, p. 17).

- *Project frequency:* The frequency of a shutdown project varies based on the type, the technology, the condition and the legal requirements associated with the plant (Hameed & Khan, 2014, p. 19). The reliability of the plant is increased when the frequency of the shutdown project is reduced (Elemnifi & Elfeituri, 2007, p. 2). Thus Obiajunwa (2010, p. 310) advocates for a long-term frequency to avoid unscheduled shutdowns and to maximise the production.

3.3.3 Human-related Factors

The people who execute the project work are of utmost importance to the outcome of the project. Tishler et al. (1996, p. 167) argue that the most critical drivers of success in every project are those that concern the quality of the project participants. Other authors such as Chua et al. (1999, p. 144) have repeatedly emphasised that project success depends on the attributes of the project manager. Obiajunwa (2013, p. 62) is of the view that due to the nature and complexity of the shutdown projects, it is imperative that the project manager possesses a set of management knowledge and other requisite skills that are specific for the shutdown project. In the same vein, project success depends on the effective organisation of project teams, each having their own competency, knowledge and skills to successfully execute the project (Gudiene et al., 2013, p. 392). Tabish and Jha (2012, p. 1136) found human factors to have a significant correlation to project success. Thus, this research study hypothesises that:

H3: Human-related factors have a significant relationship with shutdown project success.

The attributes that are used to observe human-related factors in this research study relate to the project team and the project manager; and are as follows: *competence, commitment, leadership, qualification, roles and responsibilities, alignment of the team, team cohesion, conflict resolution, the availability of skilled personnel* and *training.* The next section addresses how these attributes relate to project success.

- *Competence:* Competence is an essential requirement for the successful completion of the project (Nguyen et al., 2004, p. 409). Competence is defined as a combination of attributes, experience, skills, behavioural as well as personal characteristics (Nguyen & Hadikusumo, 2017, p. 74). Thi and Swierczek (2010, p. 567) have shown that the competencies of the project team and project manager are significantly correlated with project success.

  While Nguyen and Hadikusumo (2017, p. 74) have advanced that the competency of the project team is an essential success factor throughout the project cycle. Yong and Mustaffa (2013, p. 962) described a competent team as one with the knowledge, skills, experience and proficiency to successfully execute a project. A shutdown project requires that the entire project team be competent and that the project manager must use a strict criterion to select suitable workers to be part of the team. This is because some of the major causes of accidents in a shutdown project are due to inadequately skilled and incompetent workers (Lenahan, 2011, p. 25).

  According to Belassi and Tukel (1996, p. 145), the project commitment and competence of the project manager are essential to the project. For the project to be a success, competency enables the project manager to efficiently respond to different situations (Yong & Mustaffa, 2013, p. 973) and to take decisive actions within a project (Thi & Swierczek, 2010, p. 577). Chua et al. (1999, p. 144) are of the opinion that the successful application of project management practices relies on the competency and the authority of the project manager.

- *Commitment:* Commitment refers to whether the project participants are willing to combine their efforts towards making the project a success (Tabish & Jha, 2012, p. 1136). According to Nguyen et al. (2004, p. 410), commitment is widely recognised as an essential factor for the success of projects and organisations. It is an indication that all project participants are strongly concerned with the outcome of the project. Not only is commitment the responsibility of project participants to improve the overall performance of the project, but also of top management (Yong & Mustaffa, 2013, p. 962). Furthermore, a strong commitment fosters an environment of trust,

which is a key factor in encouraging the spirit of cooperation among team members (Yong & Mustaffa, 2013, p. 974).

- *Leadership:* Competency of the project manager does not only include having good technical and managerial skills, it encompasses good leadership skills (Nguyen et al., 2004, p. 409). The leadership capabilities of a project manager have been found to influence project success (Toor & Ogunlana, 2009, p. 162). Successful leadership can promote an environment for empowerment, learning, support and innovation (Triphathi & Jha, 2018, p. 12). A project team remains committed to the project through the effective leadership skills of the project manager (Iyer & Jha, 2006, p. 873).

- *Qualification:* A highly qualified project team contributes to the success of the project (Tishler et al., 1996, p. 167). The project manager must have strong academic and managerial qualifications to contribute to the success of the project. According to Tripathi and Jha (2018, p. 12), the availability of dynamic leadership and that of qualified resources are essential for project success in the organisation.

- *Roles and responsibilities:* The clarification of the roles of each team member assists in contributing to the project being on schedule and according to the budget. It also assists in achieving technical specifications as it ensures that the roles and activities are executed without any internecine conflict (Papke-Shields et al. 2010, p. 660). The project participants should be informed of the course of the project, expected project outcome, and especially their roles (Nguyen et al., 2004, p. 410).

- *Team cohesion:* Team cohesion is an essential practice that is linked to project success. A more cohesive and integrated team yields better performance results because the team members can function together successfully to solve problems (Papke-Shield et al., 2010, p. 660). Several authors have noted the benefits of cohesion within a team. Others (Ghazali & Halib, 2011, p. 34; Al-Turki et al., 2013, p. 4) have proposed that a shutdown project team must be a multi-disciplinary, effective, cohesive and coordinated by representatives from all departments.

- *Conflict resolution:* A shutdown project consists of a network of interactions amongst different people from different disciplines and thus provides unlimited possibilities for conflict amongst the project team (Ghazali & Halib, 2011, p. 36). The conflict between the project participants can damage the morale of the team; and at times leads to division and a lack of cooperation between the conflicting groups (Iyer & Jha, 2012, p. 875). However, conflict can be managed through effective communication, careful planning and scheduling, effective control and coordination systems; and formal authority (Ghazali & Halib, 2011, p. 36).

- *Team Alignment:* According to Akbar and Ghazali (2016, p. 78) alignment refers to the manner in which individuals with different priorities are brought together to a common objective which has direct links with the business needs and success. Shutdown projects draw individuals from different disciplines to work together on the shutdown project to achieve the project goals and objectives. Hence the alignment of the project participants is vital for shutdown project success.

- *Skilled Personnel:* In this competitive business environment, the provision of skilled workers is an essential resource and it is necessary for the success of any organisation (Triphathi & Jha, 2018, p. 12). The lack of skills within the project team has been identified as a contributor to project failure (Benaya, 2010, p. 3; Vichich, 2016, p. 3). In addition, Obiajunwa (2013, p. 71) points out that although the capabilities of the managers are not evaluated in most organisations, their expertise are essential for project success. According to Oliver (2001, p. 96), in addition to having an effective team, an assessment of the team's ability to work as a cohesive unit should be carried out and appropriate training should be provided. Thus, training and development are an essential strategy for improving individual, team and ultimately organisational performance (Nguyen & Hadikusumo, 2017, p. 73).

3.3.4 Organisational Factors

Project management varies from one organisation to the other mainly because of the culture within different organisations. Organisational factors affect projects in different ways

and the project teams must understand and address these factors (Cooke-Davis, 2003, p. 473). Several studies have been undertaken to assess the effect of organisational factors on project success. In a study by Sekar et al. (2018, p. 252), organisational factors were found to be significantly correlated to project success. This was also confirmed by Maqbool and Sudong (2018, p. 998). Thus, this study hypothesises that:

H4: Organisational factors have a significant effect on shutdown project success.

In this research study, the indicators that measure organisational factors include *top management support, organisational culture, organisational structure* and *having a realistic strategy*. These indicators are discussed briefly below.

- *Top Management Support:* This factor is the most widely cited success factor in project management literature and relates to how top management is accountable for the project activities within an organisation (Belassi & Tukel, 1996, p. 145; Fortune & White, 2006, p. 53; Munns & Bjeirmi, 1996, p. 82). Support from top management can be offered through the commitment and approval of the project activities (Pinto & Slevin, 1988, p. 7), through funding and provision of project resources (Nguyen et al., 2004, p. 410; Tabish & Jha, 2012, p. 1136), through providing direction (Belassi & Tukel, 1996, p. 145), through established policies and strategies; and through supporting the project manager (Zwikael & Globerson, 2006, p. 343). Furthermore, the support from top management can determine the ease and ability of addressing problems arising from the project (Chua et al., 1999, p. 144), and a lack of such support may lead to failure of the project (Fortune & White, 2006, p. 53).

  In shutdown projects, the steering committee has the greatest influence on the project during the initiation phase when strategic decisions are taken (Lenahan, 2006, p. 22; Sahoo, 2014, p. 19). According to Oliver (2001, p. 2), the steering committee ensures that the shutdown project meets the needs of the business, the scope and budget for the shutdown are in alignment with the shutdown strategy and provide the final approval on project processes. The steering committee is also responsible for ensuring that the project supports the organisations' maintenance, operations and business objectives. They are the stakeholders of the shutdown project and they have the overall view of the business environment (Ghazali & Halib, 2011, p. 44).

- *Organisational structure:* The organisational structure also plays an essential part in the success of shutdown projects (Lenahan, 2006, p. 103). Ghazali and Halib (2011, p. 41) also agree that establishing a shutdown organisation is necessary. The shutdown project organisation is regarded as a blend of people who will implement the project. Larson and Gobeli (1987) in Belout and Gauvreau (2004, p. 3) noted that each structure has its strengths and weakness; and the type of project structure chosen within the organisation affects the outcome of the project. Different types of organisational structures have been presented in literature. However, as far as Sahoo (2014, p. 90) is concerned, a shutdown project is a matrix organisation that comprises of different functional departments within the same organisation and are brought together during the shutdown period. These groups of people have different functional and administrative reporting. Thi and Swierczek (2010, p. 573) alluded to the fact that the matrix or project type projects have challenges with the availability of resources, but resources are not an issue for functional projects since the functional manager is typically also the project manager. When the project has a matrix organisational structure, the support from top management is needed to help organise the project scheduling and resource allocation issues.

- *Organisational culture:* Organisational culture refers to the organisational behaviour, and explores what individuals do in an organisation and how their behaviour affects the efficiency of the organisation (Nguyen & Watanabe, 2017, p. 3). According to Yong and Mustaffa (2013, p. 962), human factors with cultural integration are critical for project success. Within the project team, the diverse workforce holds different cultural views and behaviours such as the management styles, work-related beliefs, conflict management and collaboration (Ghazali & Halib, 2011, p. 33). Thus, cultural differences could generate conflicts within the team, and in turn influence the organisation's ability to achieve project objectives. Culture should be regarded as a key element of conflict resolution, quality improvement, enhancing communication and the ease with which project objectives are achieved (Nguyen & Watanabe, 2017, p. 2).

- *Strategy:* Poli and Shenhar (2003, p. 231) place utmost importance to strategy as a necessary component for project success. There is a significant relationship between the project management strategy and project success (Mir & Pinnington, 2014, p. 203). The project strategy is an essential tool that assists the project to focus on the desired strategic results, to attain the most competitive advantage and to obtain the best value out of the project initiative. In shutdown projects, the project charter is a policy document intended to describe the mission, objectives, scope and the expectation of the shutdown project. The document also includes the organisational structure and a detailed schedule of the operations, resources, and funding required to undertake the shutdown (Sahoo, 2014, p. 22). It is through the full support from top management that incorporates these strategy document to complete projects successfully (Belassi & Tukel, 1996, p. 145).

3.4 Summary

The aim of this chapter was to formulate a conceptual model that can be used to examine the association between project success and the success factors in shutdown projects. In the research model, it was emphasised that the success in shutdown projects is influenced by *project-related, human-related, organisational* and *project management factors.* A survey of literature was presented, which supported the hypothesised relationships between the project success factors and project success. The next chapter presents the research methodology that was adopted for the undertaking of this research study.

CHAPTER 4
RESEARCH METHODOLOGY

4.1 Introduction

This chapter is based on a discussion of how the objectives of this research study are achieved. The chapter reflects on the philosophical stance that underpins the research study, the research design that guides the research and elaborates on the instrument used for data collection. The chapter then concludes with an explanation of the methods used for data analysis.

4.2 Research Philosophy

Saunders et al. (2016, p. 106) reported that the word philosophy refers to a range of basic assumptions about how knowledge is acquired and interpreted in a research study. There are unique methods in which knowledge is obtained when research is conducted, and these methods are driven by a system of convictions or worldviews about how the world is perceived. Creswell (2014, p. 3) refers to these worldviews as paradigms and asserts that the selection of research paradigms affects the nature of research that is brought to a research enquiry. Likewise, Saunders et al. (2016, p. 107) agree that there are significant philosophical assumptions in a research study that guide the research process. Furthermore, Leavy (2017, p. 11) reiterates that research paradigms guide the research practice and shape the philosophical structure of research, thus affecting research choices from the selection of methods for data collection to the interpretation of research findings.

Easterby-Smith et al. (2012, p. 17) highlighted the following three reasons why research study requires consideration of the research philosophy:

- Firstly, the research philosophy clarifies and supports which research designs are appropriate for addressing the research questions in a study;
- Secondly, it guides the research by providing a range of methodologies and techniques that are available to the researcher;

- Finally, an awareness of the research philosophy increases the quality of the research and it motivates the researcher to be more creative by considering research methods that are beyond the knowledge and understanding of the researcher.

The two dimensions of thinking that influence the research process are ontology and epistemology (Saunders et al., 2016, p. 107). Ontology is concerned with the study of being and the nature of truth and reality (Easterby-Smith et al., 2012, p. 17). It informs what can be acquired and how to perceive the nature of the social environment (Leavy, 2017, p. 12). Ontologically, reality can either be internal and autonomous from social actors; or it can be created socially and is grounded on the belief that people contribute to the social phenomena (Wahyuni, 2012, p. 69).

Epistemology alludes to a system of assumptions that define how and what constitutes knowledge (Leavy, 2017, p. 12). This implies that epistemology is concerned about what is considered as acceptable knowledge in a particular research study (Saunders et al., 2016, p. 107). Another fundamental belief that also considers how knowledge and reality are determined is axiology. Axiology refers to judgements of value and addresses the concept of moral and ethical behaviour in a research study (Wahyuni, 2012, p. 69; Saunders et al., 2009, p. 116).

When developing research methodologies, researchers can derive from different ontological, epistemological and axiological assumptions (Easterby-Smith et al., 2012, p. 17). This implies that different research methods have different philosophical considerations about what is truth and knowledge, and this is supported by a chosen research approach (Scotland, 2012, p. 9). There are various methods in literature for naming and grouping research philosophies. One method by Saunders et al. (2016, p. 109) considers four research philosophies that are prominent in management research in relation to their ontological, epistemological, axiological and methodological views. Table 4.1 presents a summary of that comparison.

Table 4.1: A comparative analysis of the four research philosophies of management research

	Positivism	Realism	Interpretivism	Pragmatism
ONTOLOGY	External, objective and independent of social actors	Objective. Exists independently of human mind but is interpreted through social conditioning	Socially constructed, subjective, may change, multiple	External, multiple views chosen best to answer the research question.
EPISTEMOLOGY	Only observable phenomena can provide credible data and facts. Focus on causality and law-like generalisations, reducing phenomena to simple elements	Observable phenomena provide credible data, facts.	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question
AXIOLOGY	Research undertaken in in a value-free way, the researcher is independent of the data and maintains an objective stance.	Research is value laden, the researcher is biased by world views, cultural experiences and these impact on the research.	Research is value bound, the researcher is part of what is being researched, cannot be separated and thus will be subjective.	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view.
METHODOLOGY	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must be suitable for subject matter, qualitative and quantitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method, quantitative and qualitative

(adopted from Saunders et al., 2009, p. 119)

Project success is viewed as an elusive, context-dependent concept whose definition relies on project objectives and perceptions of stakeholders. This suggests multiple truths to reality. This research study aims to uncover from the perceptions of individuals involved with shutdown projects about what constitutes to success in their projects and critical success factors of their projects. Thus, this research notes that the concept of project success is socially constructed by the perceptions of stakeholders involved in the project, and their views might change due to these perceptions and the context of the project. Ontologically, this agrees with the philosophy of interpretivism. Nonetheless, project success consists of quantifiable dimensions that can be measured objectively. Although the concept of project success is an abstract phenomenon, it can be quantitatively observed through scientific models. This is also consistent with the positivist perspective that asserts that ontologically, the social universe of the truth and reality can be found and that it can be evaluated through objective methods (Easterby-Smith et al., 2012, p. 21; Saunders et al., 2016, p. 113). Furthermore, the purpose of this study is to employ a structured, scientific method to examine a set of hypothesized relationships between project success and success factors based on the constructs proposed in the conceptual model. Hence, the philosophy of positivism has been adopted in this research.

Often referred to as the scientific paradigm (Scotland, 2012, p. 9), positivism declares the suitability of scientific methods to all types of knowledge development (Saunders et al., 2016, p. 114). This implies that the methods and techniques used in natural sciences are suitable for social reality. Positivism focuses on causalities, the connection between factors, and generalisations or the reduction of phenomena to simple evidence (Biedenbach & Muller, 2011, p. 86). This research study assumes a scientific method to investigate the association between the success factors and project success.

Positivists conduct value-free work using quantitative methods and other tools to achieve objective evidence (Biedenbach & Muller, 2011, p. 86). If a research enquiry is carried out in a value-free manner, the researcher is not biased against the data and thus takes an objective view towards the research (Saunders et al., 2016, p. 119). As per the positivist philosophical position, this study uses quantitative research methods to gather information. Thus, the researcher remains impartial to the data gathering process and maintains an objective position towards the research.

The positivist philosophy is appropriate for this research. Through this approach, the causal relationship between the project success and success factors of shutdown projects can be explored based on the views of those engaged with shutdown projects. This enquiry involves the gathering of quantitative data from a representative sample of the population under this study. Although the concept of project success is socially constructed by the project participants, the analysis of the data provides scientific evidence.

4.3 Research Design

A research design is the method of investigation (Creswell, 2014, p. 3) and an outline, or a framework of logical steps taken on how to proceed with a research study (Kumar, 2011, p. 94). Leedy and Ormrod (2015, p. 85) advocate for the importance of the research design as it is the general approach for addressing the research problem. The main purpose of the research design is to provide a structure to the methods adopted in a research study, how data ought to be gathered from the respondents, the sampling procedures utilized, how the data will be analysed and how findings ought to be interpreted (Saunders et al., 2016, p. 137; Kumar, 2011, p. 94).

Babbie (2011, p. 118) however, recommends that the research study must be defined first before outlining the research design. Research can be defined from three perspectives, namely: from the objectives of the study, the method of enquiry and from the interpretation of research results (Kumar, 2011, p. 8). The following section attempts to characterise research based on the research objectives.

4.3.1 Nature of the Research

Research is conducted for various reasons. Saunders et al. (2016, p. 139) suggest that research can be defined as one of exploratory, correlational, explanatory and descriptive nature.

Research is said to be exploratory if it is aimed at obtaining a new perspective on a topic, exploring a subject or approaching the subject from an alternative point of view. Such a study is conducted to satisfy the interests and desires of the researcher for

comprehension, to examine the practicality of carrying out a more thorough study and to create strategies used in any subsequent research (Babbie, 2011, p. 95; Saunders et al., 2016, p. 139).

The objective of correlational research is to discover the presence of an association or connection between two or more elements of a situation (Kumar, 2011, p. 8). Correlational research is suitable for research whose goal is to examine the connection between two or more variables in order to understand how these variables impact on each other (Creswell, 2014, p. 12).

An explanatory study attempts to explain why and how two elements of a condition or phenomenon relate to each other (Kumar, 2011, p. 8). The motive behind explanatory studies is to construct causal links between factors and clarify why they are linked. Such an enquiry emphasizes the study of a situation or an issue to understand the links between factors (Saunders et al., 2016, p. 140; Leavy, 2017, p. 5).

Descriptive research seeks to explore conditions or occurrences and explain them further while the researcher observes and explains what is being observed (Babbie, 2011, p. 96). The focus of a descriptive enquiry is to reveal a precise profile of individuals, occasions, circumstances or events and to portray descriptions of a social situation from the view of individuals residing in that situation. Such a study may be an expansion of exploratory research or be a part of explanatory research (Leavy, 2017, p. 5; Saunders et al., 2016, p. 139).

This research study is both exploratory and correlational in nature. The objective of this study is to explore and evaluate, in the context of shutdown projects, the general topic of project success. The researcher explores general concepts of project success so as to discover new insights into the concept in relation to shutdown projects. The research study is correlational because the analysis investigates the association between success factors and project success to determine the extent to which these factors influence the success of the shutdown projects. The knowledge of strength of the association would enable an improvement in project success based on the correctly identified success factors.

4.3.2 The Research Approach

The research design, as iterated by Leavy (2017, p. 9) is a process of building a structure for the research project. While developing the structure of the research study, several approaches to the research design have been suggested. In literature, the research approach infers to theory construction (Babbie, 2011, p. 23) and the research mode of enquiry (Kumar, 2011, p. 8).

Considering the research approach in relation to theory construction, the approach describes the way theory is formulated and thereafter tested in a research study. The research approach aims to assist the researcher to make informed decisions about the research design and the research strategy (Saunders et al., 2016, p. 126). The development of theory has two main approaches, namely inductive and deductive approach.

> Deductive theory construction assumes that a theoretical stance prior to data collection is established (Saunders et al., 2016, p. 41). In this approach, research is used to test ideas and patterns known from theory using new empirical data (Babbie, 2011, p. 57). On the other hand, inductive theory building relies on the notion of developing theory from the data that has been gathered (Saunders et al., 2016, p. 41). Theories are generated through analysing research data to infer theoretical ideas and trends (Babbie, 2011, p. 57).

This research study applies a deductive approach to theory construction. The theory is used deductively, according to the positivist philosophical position, with the aim of testing or validating a concept rather than creating it (Leavy, 2017, p. 9). Creswell (2014, p. 59) further suggests that the theory becomes a framework for the research and a guide for the hypotheses' development and methods of data collection. This study began by reviewing currently existing literature on project success. A theoretical basis for creating a conceptual framework for this research was based on the literature review.

4.3.3 The Time Horizon

According to Babbie (2011, p. 109), time assumes an essential position in the design and implementation of research. Time also affects the generalisation of the research findings. It is important to characterise when the observations and measurements are produced in a study. Thus, literature distinguishes between a cross-sectional and a longitudinal study.

> A cross-sectional research study includes taking measurements of a sample of a population at one period at a time. Such studies relate to exploratory and descriptive research. On the other hand, a longitudinal study is intended to allow findings of the same phenomenon over a long span of time (Babbie, 2011, p. 110). In such a research study, the study population is visited several times at periodic intervals to gather the necessary data (Kumar, 2011, p. 109).

A cross-sectional study suits the purpose and objectives of this research study. This study involves making observations from the study sample at the same time. Furthermore, positivism is inclined towards the use of cross-sectional designs with large samples to simultaneously measure multiple factors (Easterby-Smith et al., 2012, p. 42). It is also essential to consider defining the research project based on the mode of enquiry.

4.3.4 The Research Method

While structuring the research design, different research methods are selected for data collection. The choice of which method to use depends on how suitable these methods are for answering the research questions (Leedy & Ormrod, 2015, p. 98). A research method is defined in the context of this research study as data collection tools and techniques (Saunders et al., 2016, p. 3). These methods vary by the type of data (Leavy, 2017, p. 14) and techniques used for collecting the data (Brynard et al., 2014, p. 37). Literature distinguishes between qualitative research and quantitative research methods.

> Qualitative research is concerned with the use of descriptive data (Brynard et al., 2014, p. 39) and with finding characteristics or attributes that cannot be reduced to numerical

scores (Creswell, 2014, p. 4; Leedy & Ormrod, 2015, p. 28, 94). This type of research addresses an in-depth understanding and explores views and emotions rather than facts and numbers (Kumar, 2011, p. 394). This research method also suggests that the research enquiry takes an adaptable unstructured approach. Qualitative research is committed to perceiving the world from the perspective of the social actors, and hence advocates for the close involvement of the researcher in the research study (Brynard et al., 2014, p. 39).

A quantitative research analysis involves the development of quantifiable data which can be subjected to structured analysis or measurement (Creswell, 2014, p. 4). The evidence used in quantitative research is based on concepts derived from numbers and the analysis of such is conducted through statistical analysis. This type of research is grounded on the belief that objective theory counts as valid knowledge and follows a structured, rigid and predetermined methodology (Brynard et al. 2014, p. 39). The aim of this method is to quantify the differences in phenomenon and to generalise the findings to the total population (Kumar, 2011, p. 394).

This study uses a quantitative research method where a structured questionnaire survey is used for data collection. The research analyses the data using statistical methods to quantify the magnitude and strength of the relationship between the success factors and project success. Furthermore, quantitative research is characterised by deductive approaches to knowledge building (Leavy, 2017, p. 9; Creswell, 2014, p. 4), which are adopted in this study.

4.3.5 The Research Strategy

The different ways in which data is collected in a research study forms part of the research strategy. According to Saunders et al. (2016, p. 141), certain factors, such as the scientific methodology guiding the research, the research questions, research objectives and the amount of time or resources available to the researcher, influence the selection of a research strategy. The most commonly used strategies for gathering data are archives, action research, a case study, ethnography, an experiment and a survey.

Archival research is based on textual data and its analysis. The source of information for such a study is secondary data from administrative records and documents. Although the term archival has a historical meaning, it can also refer to both recent and historical records (Saunders et al., 2016, p. 146).

Action research is often suitable for addressing organisational problems. This type of research strategy focuses on the involvement of a skilled practitioner in the research study with the aim of discovering a solution to organisational problems. Often referred to as research in action, this research involves introducing changes within the organisation to understand the dynamic forces within it, and the study findings may both derive from or contribute to practical intervention (Easterby-Smith et al., 2012, p. 49).

A case study is based on an analysis of a particular event in its real-life sense, especially if the distinction between the context and the phenomenon are not clear. A case study includes the use of several data collection techniques. These may include observations, interviews, documentary analysis and questionnaires (Saunders et al., 2016, p. 145).

Ethnography is rooted in the study of anthropology. The objective of this strategy is to place the researcher in the position of the research subjects to understand their social world. The aim of this investigation is to explore a cultural group in a natural environment over a certain timeframe and to obtain information while watching their social environment (Creswell, 2014, p. 13). Such a study further aims to define and clarify the social world in which the research subjects live, in a manner that they would define and clarify it (Saunders et al., 2016, p. 149).

An experiment is grounded in a laboratory-based environment (Saunders et al., 2016, p. 141), where various participants or subjects are selected to engage in multiple treatments and tests proposed by the researcher (Leedy & Ormrod, 2015, p. 102). Such a study seeks to examine whether an outcome is influenced by a specific treatment. The motive behind such an analysis is to examine causal relationships between factors and can be used in both exploratory and explanatory studies to address questions of ‘how’ and ‘why’ (Saunders et al., 2016, p. 141).

The survey approach aims to obtain a large amount of data through the administration of a questionnaire to a large population sample (Saunders et al., 2016, p. 143). The primary emphasis of this approach is to explore the main characteristics of the population through the examination of a population sample. Such a strategy is often appropriate when the researcher aims to investigate incidences, prevalence and the distribution of certain characteristics in a population (Leedy & Ormrod, 2015, p. 102).

A survey is the most fitting strategy for this research enquiry. The study aims to enquire from a sample of those involved in shutdown projects, the key factors believed to have the most influence on shutdown project success. The gathered data using a survey as a strategy can be used as a tool to show the possible causes for relationships between variables and to generate models of those relationships (Saunders et al., 2016, p. 142). Furthermore, in accordance with the positivist philosophical stance, the survey provides minimal interaction between the researcher and the participants and is usually associated with the deductive approach (Easterby-Smith et al., 2012, p. 49; Saunders et al., 2016, p. 142), which was adopted for this study.

4.3.6 The Research Process

The foundation of the research design has been laid out through the choice of the research approach, the time horizon, the research method and the research strategy selected for this research study in the previous sections of this chapter. This section puts all the concepts of the research design together in the form of a schematic process diagram to outline the research process of this study in Figure 4.1.

This research is a quantitative, exploratory and correlational analysis using structural equation modelling to explore the causal relationship between the project success variables and project success. In a literature review, the research study examined the main concepts under this research namely, project success, success criteria and success factors in relation to shutdown projects. Drawing from the literature review, groups of success factors and a comprehensive set of performance indicators were identified from previous studies, forming the basis for the conceptual framework.

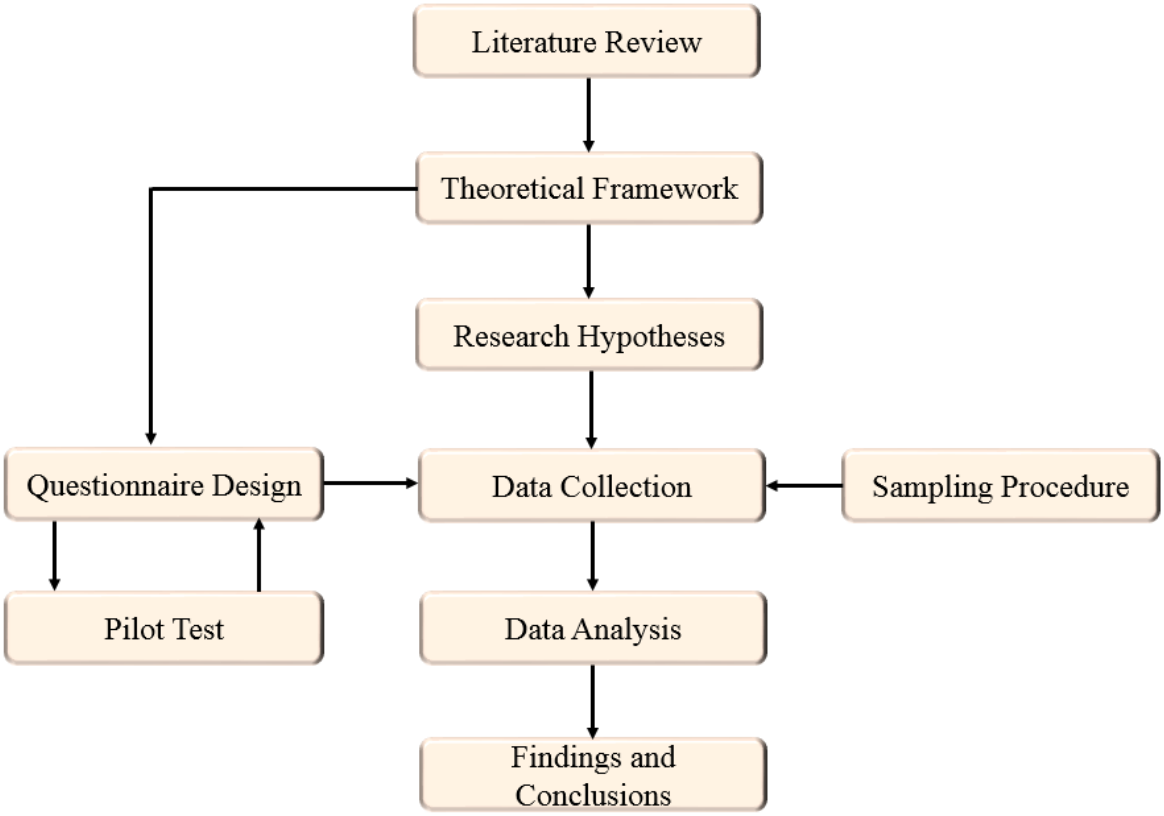

Figure 4.1: Schematic diagram of the research process for this study

A theoretical framework was established to review previous theories from which the constructs and the variables are derived. A conceptual model was proposed to visualise the relationship between shutdown project success and the success factors. The conceptual model suggests that shutdown project success is influenced by five-factor groups, which are *project-related, human-related, project management* and *organisational factors* groups. These factors are regarded as the independent variables in the model and are interrelated to each other. The model also defines shutdown project success as measured according to project efficiency, stakeholder satisfaction and business success.

In this research, a cross-sectional survey was adopted as a strategy for data collection. A structured self-administered questionnaire was used as a tool for the collection of the data. The questionnaire was developed according to the constructs of the conceptual model. The questionnaire was pilot tested to ensure that it was relevant, comprehensive and without errors. Purposive sampling was adopted to select the sample of individuals directly involved with executing shutdown projects in various process organisations in South Africa. A structural equation modelling approach was used to analyse the data and to explore the

hypothesized relationships between the shutdown project success and the success factors. The final phase of this research process involves interpreting the results and providing recommendations for the improvement of shutdown project success.

4.4 Data Collection

A research study consists of several methods of collecting data. It is, however, essential to consider the kind of data that is required in the study as well as the method of collecting and interpreting that data (Leedy & Ormrod, 2015, p. 93). The two types of data that are mentioned in literature are primary data and secondary data.

Primary data is regarded as the original information collected for the current research by the researcher from primary sources (Kumar, 2011, p. 139). Such information often contributes to a fresh perspective and provides greater confidence in the research outcomes (Easterby-Smith et al., 2012, p. 12).

Secondary data is data that is not generated for the current research but is accessible from other references (Kumar, 2011, p. 139). Easterby-Smith et al. (2012, p. 12) highlight several advantages of using secondary data, one of which is that this type of data is readily available to the researcher thus saving time and energy. The information is often of high quality and can provide historical insights for the researcher.

4.4.1 Data Collection Instrument

There are various instruments available for collecting primary data. The most frequently used data collecting instruments are a questionnaire, interviews and observations.

A questionnaire is a collection of written questions that the respondents ought to answer and record. The response of the questionnaire is based on the interpretation by respondents (Kumar, 2011, p. 145; Christensen et al., 2015, p. 340).

According to Kumar (2011, p. 144), an interview is a verbal exchange between the researcher and the respondent; and is used in cases where the researcher tries to evoke

information, opinions and the beliefs of the respondent. An interview process involves the researcher reading the questions to the respondent and recording their responses. Interviews are chosen as a way to secure valuable information from the respondent by allowing the interviewer to explain the question to the respondent and to probe more deeply after the respondents have answered (Christensen et al., 2015, p. 340).

Observations are a descriptive and selective way to observe and analyse a phenomenon or an interaction as it occurs. This tool relies on the actions of the subjects rather than provoking their perceptions. It is useful when the subjects under the study are so involved in their interaction that they cannot provide accurate data (Kumar, 2011, p. 140). Where the observation involves the participants, the main aim of such an observation would be to expose accounts which cannot be reached through formal approaches such as interviews (Easterby-Smith et al., 2012, p. 142).

This research adopts the use of a questionnaire as an instrument for data collection. A questionnaire has been selected for this study because it is easy to use in a large sample, more affordable to administer and are suitable for gaining quantitative data (Kumar, 2011, p. 148).

4.4.2 Questionnaire Development

This section outlines the general steps that were taken by the researcher to develop the questionnaire according to Ruel et al. (2016, p. 8). For an efficient collection of data, the first phase of the questionnaire design involves the consideration of the research problem that the survey attempts to address. This phase aims to define the goals of the survey and to ensure that the questionnaire is based on the goals and objectives of the study.

The aim of the research survey used in this research study is to analyse how shutdown project success is perceived and to identify the critical factors that affect the performance of shutdown projects according to the perceptions of those involved in the projects. Further to this, the questionnaire was developed from the synthesis of literature on critical success factors and the conceptual model of this research study.

4.4.2.1 Format of the Questions

Certain considerations must be given attention when developing a questionnaire. To ensure a good response to the survey, the structure of the questions in a questionnaire is essential (Babbie, 2011, p. 278). Saunders et al. (2016, p. 374) cautioned that the questions must be easily understood by the participants of the survey. The questionnaire should be spread out and uncluttered as advised by Babbie (2011, p. 278). Christensen et al. (2015, p. 345), suggest that to ensure a good response rate, the questions must be brief, correctly formulated and must be in accordance with the research objectives. Easterby-Smith et al. (2012, p. 17), point out that simple expressions must be used and that each question in a questionnaire must address one idea. Questions can be classified according to how they are answered as structured or unstructured questions.

Structured questions are regarded as closed-ended questions. These questions provide a list of options to answer them and the comments of the respondent are kept to a minimum. Close-ended questionnaires use a scale arrangement to restrict the amount of possible answers given to the respondent (Flick, 2015, p. 135). On the contrary, unstructured questions are regarded as open-ended questions and do not provide specified responses in advance but allow respondents to communicate their views openly. The possible answers are not provided in an open-ended question (Babbie, 2011, p. 272).

All recommendations concerning questionnaire development, such as the length, types of questions or structure used were strictly followed in this research study. The questions in the questionnaire were based on previous literature, the conceptual model and the research objectives of the study. The questions were mostly close-ended type of questions.

4.4.2.2 Content of the Questionnaire

The next step in designing the survey is the drafting of the questions of the questionnaire. The questions in the questionnaire were mainly based on the literature review outlined in Chapter 2 and more specifically on the proposed research model outlined in Chapter 3. The questionnaire for this research study (Appendix C) consists of four sections and is organised as follows:

Section A of the questionnaire seeks to understand the biographic information of the respondents. This section of the survey is necessary to enable the researcher to make a comparison according to the respondents of the study. Thus, it enquires about the years of experience in shutdown projects, qualification in project management, the respondent's position and type of organisation of the respondents.

Section B requires the participants to consider a project that has been recently completed. This section seeks to distinguish between the characteristics of shutdown projects by enquiring about the value of the project, the lead time that the project was initiated and the total duration of the project.

Section C of the questionnaire again requests that the participant refers to a completed shutdown project and probes their views on a suitable criterion used to define a successful shutdown project based on the criteria proposed in the conceptual model.

Section D is concerned with the factors that are believed to be impactful towards the success of shutdown project success. The questions are subdivided further into four sections to address the success factor groups as identified in the conceptual model, which are *project-related factors*, *organisational factors*, *human-related factors* and *project management related factors*.

4.4.2.3 Measurement Scales

As an instrument for collecting data, questionnaires use different scales of measurement. In a questionnaire, a measurement scale is used to assign scores to the responses. There are two types of measurement scales which are used in questionnaires, namely category scales and continuous scales (Easterby-Smith et al., 2012, p. 75).

Category scales are characterised as ordered scales and unordered scales. Unordered scales are also known as nominal scales and have no natural order. They represent categories of data by assigning titles or labels (Leedy & Ormrod, 2015, p. 25) and the scale has no numeric value (Easterby-Smith et al., 2012, p. 75). Thus, the data is classified according to categories that can then be compared with each other and such scales are used in demographic data. Ordered scales are considered as ordinal measurement scales which

consists of numbers arranged in order. Thus, the scale compares information in terms of one being greater or larger than another. This type of scale has a natural ordering system and is concerned with rankings (Leedy & Ormrod, 2015, p. 26; Easterby-Smith et al., 2012, p. 75).

Interval and ratio scales fall under the category of continuous scales. These types of scales are also known as rating scales, however, the difference between the two scales lies in whether there is a true zero point (Easterby-Smith et al., 2012, p. 75). An interval scale uses equal units of measurements, and its zero point is established arbitrarily (Leedy & Ormrod, 2015, p. 26). If a ranking scale has a true zero, then it is considered as a ratio scale (Easterby-Smith et al., 2012, p. 75). A ratio scale also has equal measurement units and has an absolute zero point that represents a total absence of the quantity being measured.

One scale that is used in questionnaires for the measurement of attitudes and views is an interval type of rating scale developed by Rensis Likert (Easterby-Smith et al., 2012, p. 78). A Likert scale shows that every statement in the questionnaire has equal attitudinal significance or importance of reflecting an attitude towards the issue in question (Kumar, 2011, p. 209).

The questionnaire in this study makes use of an interval and nominal scale. The nominal scale was used to measure the demographics of the respondents and their projects. The Likert type scale was used for scoring responses in the questionnaire. Respondents were asked to indicate the importance of the success criteria and the success factors in relation to shutdown project success using a 5-point Likert scale.

4.4.2.4 Operationalisation of the Constructs

According to Sekaran and Bougie (2016, p. 197), abstract constructs such as project success are operationalised using observable and measurable elements. In this study, the variables used to measure the abstract constructs of project success and project success factors were drawn from the previous literature based on their proven reliability and validity. The adapted items were revised to suit the purpose of this research study. The following section outlines the operationalisation of each factor in the questionnaire.

Project Success: Project success measurement captures the degree to which a project is perceived to be successful. Project success was measured according to the dimensions proposed by Shenhar et al. (2001, p. 699). Obiajunwa (2012, p. 68) presented the same analysis in relation to shutdown projects in the UK process industries. Some of the measurement items of this construct were previously used and validated by Musa et al. (2015, p. 35) and Alashwal et al. (2017, p. 62).

Project-related factors: These factors are related to the level of influence the project characteristics have on project performance. The items used to measure this construct were derived from the following authors: Chan et al. (2004, p. 154), Belassi and Tukel (1996, p. 145), Alashwal et al. (2017, p. 62); Sudhakar (2012, p. 549), Gudiene et al. (2013, p. 395) and Alias et al. (2014, p. 67).

Organisational factors: The indicators of organisational factors are related to the level of influence the organisational characteristics have on project performance. The attributes used to measure this construct were derived from Alashwal et al. (2017, p. 62), Belassi and Tukel (1996, p. 145).

Human-related factors: This measure enquires about the influence of the project participants on project success. The measures for human factors were adopted from Chan et al. (2004, p. 154), Sudhakar (2012, p. 549), Gudiene et al. (2013, p. 395) and Alias et al. (2014, p. 67).

Project Management factors: These indicators were drawn from the following authors and aligned with this research study: Chan et al. (2004, p. 154), Alias et al. (2014, p. 67), Belout and Gauvreau (2004, p. 4) and Sudhakar (2012, p. 550).

4.4.2.5 Pre-testing of the Questionnaire

According to Kumar (2011, p. 158), pre-testing a research instrument involves the critical evaluation of each question and its interpretation as understood by a participant. This seeks to improve the questionnaire so that the respondents may easily answer the questions (Saunders

et al., 2009, p. 394) and to identify the limitations that may influence the instrument of data collection (Christensen et al., 2015, p. 356).

The questionnaire of this study was pre-tested using a team of academics, several maintenance and engineering personnel in the process industry. The pretesting of the questionnaire was conducted under the similar field conditions using a group of individuals that was comparable to the study population. The objective was to highlight errors in either understanding or interpreting the questions and to test the relevance of the questions to the study objectives. The questionnaire was revised and refined based on the feedback from the respondents of the pilot test.

4.4.2.6 Administering the Questionnaire

A questionnaire can reach its participants in various ways.

According to Kumar (2011, p. 148), sending a questionnaire by mail is regarded as the most common approach for collecting data. However, this method implies that the researcher has the postal address of the respondents. Postal questionnaire surveys may be cost-effective, however, the researcher is not certain whether the questionnaire was completed by the intended respondent (Easterby-Smith et al., 2012, p. 230).

Another method of administering the questionnaire to the respondents is by collective administration. In collective administration, the researcher believes that all the respondents are assembled in one location, however, this implies that the researcher has a personal contact with the respondents (Kumar, 2011, p. 147).

The most recent and common method used to administer questionnaires, is the use of electronic questionnaires. Invited participants complete an electronic survey accessed through their computer. One of the key benefits of this method is that it is cost-effective. Electronic questionnaires can further be classified as email surveys or web-based survey. An e-mail survey involves sending an email to the respondents with a request for the survey instrument to be completed and the survey forms part of the message or is in an attached file. A web-based survey is an electronic survey that is hosted on online (Christensen et al., 2015, p. 342).

A web-based survey was used in this study to collect data for this research. The questionnaire was hosted on Limesurvey, an online survey website. In accordance with their professional status, the participants were recruited on LinkedIn site for professionals. The targeted respondents were sent an email which requested their participation and directed them to Limesurvey. Additionally, each respondent was requested to complete the survey based on the previous project they had worked on regardless of whether the project was successful or not. This condition was necessary so that the respondents did not only report on successful projects.

4.4.3 Sampling

The collection of data from the entire study population is difficult, hence research is conducted using a subset of the population and thereafter generalizations are made about the population based on the findings of the sample (Christensen et al., 2015, p. 356). Sampling is a process used for the selection of a small sample group to determine the features of the larger population group. If correctly determined, the sample should be a representative of the population and be capable of displaying the same properties and features as the entire population (Brynard et al., 2014, p. 56). The first step in designing the sample for a research study is to define the target population.

4.4.3.1 Target Population

Population is a term used to describe the total quantity of objects, occurrences or individuals having common properties with the subject of the research study (Mouton, 1996, p. 134). The purpose of the research determines which units of analysis are chosen as the population from which the sample will be chosen.

The definition of project success varies based on those involved in the project. Shutdown projects involve various stakeholders that are directly involved in the implementation of the project. Thus, to study this concept from the perspective of the different stakeholders, the target population of this research study are all the project executives, managers and the team members in maintenance and engineering that are directly involved with shutdown projects.

These may be the shutdown project manager, shutdown planners, engineers, technicians and contractors.

4.4.3.2 Sampling Frame

A sampling frame describes the cases in the population where the sample will be derived (Saunders et al., 2009, p. 214). There are two ways of creating a sampling frame, namely by compiling a list of all the cases that match a specific definition or by establishing a rule that will define membership (Mouton, 1996, p. 135).

Shutdown projects are performed in organisations where there is a continuous operation of heavy assets. The sampling frame for this study includes a list of organisations in the process industry in South Africa where there is continuous operation of machinery and shutdown projects are adopted as one of their maintenance strategy.

4.4.3.3 Method of Sampling

Methods of sampling are differentiated between probability sampling and non-probability sampling (Saunders et al., 2016, p. 213). In probability sampling, each element in the population has an equal opportunity to be chosen for sampling. This sampling method is preferred in research because it represents the complete sampling population and can generalise the inferences to the entire sampling population (Kumar, 2011, p. 181). Survey and experimental research are often associated with probability sampling method (Saunders et al., 2016, p. 213). Probability sampling is further differentiated between stratified sampling, cluster sampling and simple random sampling.

Stratified random sampling is a random sampling method that separates the population into two or more layers based on one or several attributes (Saunders et al., 2016, p. 226). In cluster sampling, the population must be subdivided into groups or clusters depending on certain features in the population (Saunders et al., 2016, p. 230; Kumar, 2011, p. 186).

Nonprobability sampling is used when the number of elements in a population is unclear or cannot be defined individually. The selection of sample elements relies on other factors in the sample (Kumar, 2011, p. 187). There are five frequently used nonprobability sampling

techniques that are common in research. These are accidental sampling, purposive sampling, snowball sampling and quota sampling.

Accidental sampling relies on the number of available participants in a research study (Kumar, 2011, p. 189). This method makes it impossible to regulate the representativeness of a sample and is best suited for studying the characteristics of the population at a specified time (Babbie, 2011, p. 206).

Quota sampling method is done by selecting units in a sample based on the visible features of the study population, so that the overall sample is distributed equally between the features presumed to have existed among the studied population (Kumar, 2011, p. 188; Babbie, 2011, p. 208). Quota sampling is completely non-random and is usually used for interview studies. (Saunders et al., 2016, p. 235).

Snowball sampling is selecting a sample based on networks within the population. A few participants can be selected, and the required data is collected from them. The participants are then requested to identify other possible participants in their network or organisation and those selected individuals are included in the survey (Kumar, 2011, p. 188). This method is considered ideal when the individuals of that population are difficult to locate (Babbie, 2011, p. 208).

The units to be observed in the purposive sampling are chosen according to the judgement of the researcher about which units are most relevant or the most representative. The sampling population consists of specialists in the field of investigation and is appropriate when there are a limited number of participants that can contribute to the study. This method of sampling includes an intentional and purposive choice of specific units of the population for constituting a sample that represents the population (Babbie, 2011, p. 207).

Nonprobability purposive sampling has been chosen in this study for the selection of the respondents from the populations that are being studied. This technique is used to only select respondents that have the knowledge, experience and are directly involved in the implementation of shutdown projects.

4.4.3.4 Sample Size

This research study requires a suitable sample size to enable structural equation modelling. However, there are different ways of estimating a minimum sample size needed for a structural equation model. One approach proposed by Hair et al. (2014, p. 20) is the 10-times rule of thumb. The method implies that the sample may be 10-times the largest number of structural paths directed at a construct or 10-times the largest number items used to measure a construct in the structural model.

Schumaker and Lomax (2004, p. 99) proposed that a reasonable sample should consists of about 100 elements. Another method by Kline (2013, p. 16) suggests a sample size as a ratio of the number of cases (N) to the number of model parameters that include statistical estimates (q). Kline (2013, p. 913) also suggests a median sample size of about N = 200 or larger for structural equation modelling. Based on the proposed criteria by Kline, the minimum sample size of 200 was adopted as a guideline for this research study.

4.5 Validity and Reliability

Validity and reliability in research are essential concepts because they affect the degree to which one can know about the phenomenon being studied, and how meaningful conclusions can be drawn from the research instrument. Validity and reliability can be determined in two time-frames of the research study. The first instance is before the survey is distributed to the sample population. The second time-frame occurs after the collection of the data and during the analysis of the survey results (Leedy & Ormrod, 2010, p. 28; Creswell, 2014, p. 7).

4.5.1 Validity

Validity is the capability of the research instrument to accurately measure what it is expected to measure and it is generally classified into internal and external validity (Leedy & Ormrod, 2015, p. 28).

Internal validity means that the results and the conclusions of the research are sufficiently valid for inferring cause and effect relationships among variables. External

validity refers to the extent to which the research findings can be generalized to other circumstances or settings. Internal validity is further characterised into content validity, criterion validity and construct validity (Creswell, 2014, p. 149). Content validity is the extent to which the items on the research instrument are linked with the objectives of the research study and are able address all the issues that the research tool is supposed to measure (Kumar, 2011, p. 165). Construct validity is based on statistical processes and assesses whether the instrument measures hypothetical concepts or constructs in a research study (Creswell, 2014, p. 149).

In this study content validity was established through the adoption of a validated measurement items that were previously used by other researchers as indicated in section 4.4.2.3. Caution was exercised by the researcher to ensure that the constructs that the items are measuring were identified through a comprehensive literature review. The research instrument was also validated through a pilot study using the professionals and academics in the engineering and maintenance field to ensure that the instrument addresses the research problem and the research objectives of this research study. Therefore, it was established that the questionnaire had valid items to measure the constructs.

To establish construct validity, the measures of the constructs were assessed to test whether they correlate through the results for Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) values. Exploratory factor analysis using principal components was used as further confirmation of the construct validity of the measurement items. The correlation matrix of the constructs was used to test if the constructs were separated from other constructs.

4.5.2 Reliability

Reliability implies that the data collection techniques or the research instrument of a related study would reproduce consistent findings if they were repeated in another occasion (Leedy & Ormrod, 2010, p. 29). Reliability indicates the precision, stability and predictability of the research instrument (Kumar, 2011, p. 181). For a questionnaire to be valid, it must be reliable (Saunders et al., 2016, p. 451). The most widely used method to evaluate reliability is the use of the Cronbach's alpha index. In order to ensure that the questionnaire items

consistently measure the same thing, the Cronbach's alpha coefficient should be 0.7 or higher (Christensen et al. 2015, p. 156). Field (2009, p. 675) further cautions that the Cronbach's alpha coefficient depends on the number of scale items and it can be used to assess the deletion of items should the need to improve the overall reliability arise.

4.6 Data Analysis

Following the collection of the data from the representative sample, the next step in the research design is the analysis of the data (Sekaran & Bougie, 2016, p. 271). In this research study, statistical techniques that can analyse the data from the questionnaire survey and test the hypothesised model proposed in Chapter 3 were considered. The methods used to analyse the data are briefly discussed in this section. Data analysis was divided into different phases in this review. The first part of the data analysis involves the analysis of the profiles of the respondents. The second part of the data analysis includes the use of structural equation modelling for hypothesis testing.

4.6.1 Descriptive Statistics

The first part of the data analysis process involves the descriptive analysis of the survey items. The aim of descriptive statistics is to portray and summarise the data so that it provides insights into the variability and the central tendency of the data (Creswell, 2014, p. 152; Christensen et al., 2015, p. 394).

Descriptive statistics was used in this study to describe the characteristics of the respondents of the questionnaire, to understand the projects that the respondents were involved with and to analyse the responses of the participants on the variables that measure the constructs in this research study. Statistical Package for Social Sciences (SPSS) version 25 was used to define the standard deviation of the subscales, the mean values, the frequencies and percentages for categorical scaled variables.

4.6.2 Structural Equation Modelling

Structural equation modelling (SEM) is a statistical approach used for evaluating the interactions between a set of variables using a confirmative approach (Byrne, 2012, p. 3; Schumacker & Lomax, 2012, p. 2). A conceptual model was developed in Chapter 3 of this research study to determine the success factors that influence project success and define how these variables are related to project success. SEM aims to confirm or reject the conceptual model with a sample of data (Schumacker & Lomax, 2012, p. 2). The goodness-of-fit indices are used to assess the adequacy of the model and, if found to be suitable the model confirms that the hypothesised relationships between the factors are plausible. If found to be inadequate, the tenability of such relations is rejected (Byrne, 2012, p. 3).

Justification for using Structural Equation Modelling

SEM offers superior statistical advantages compared to other statistical methods. When studying theoretical constructs which cannot be measured or observed accurately, these constructs are inferred through observed variables (Wang & Wang, 2012, p. 1). While SEM is a quantitative approach that can analyse both latent constructs and observed variables, traditional methods are based solely on observed measurements (Byrne, 2012, p. 4). Furthermore, other statistical methods can only evaluate a small number of variables and are not able to handle complex hypotheses. However, SEM enables the statistical analysis of complex phenomena (Schumacker & Lomax, 2010, p. 7).

SEM can also assess the quality of measurement of the observed scores, thus incorporating the analysis of the validity and reliability of the measurement instrument (Wang & Wang, 2012, p. 1; Schumacker & Lomax, 2010, p. 7). SEM is focussed on evaluating the relations between constructs and observed variables without the influence of measurement errors (Wang & Wang, 2012, p. 1). Conventional methods are not able to analyse or modify measurement error, and this has been addressed independently from the statistical analysis (Byrne, 2012, p. 3). Thus, SEM is more advanced in that it can consider the measurement error by presenting estimates of these error variance parameters (Wang & Wang, 2012, p. 1; Schumacker & Lomax, 2010, p. 7). Thus, SEM was adopted in this research study because of

its ability to measure the overall model fit, to predict from multiple dependent variables, to assess both direct and indirect effects, and its ability to handle abstract data.

Model Development

Figure 4.2 shows a graphic representation of the theoretical model of this research study, specifying the causal relationship between the variables and the structure of the model. Through specification, the types of variables and the relationship between the variables are highlighted in this section. The diagram indicates the constructs of project success represented by a set of observed variables and their corresponding error terms. The aim of SEM is to evaluate the causal relationship between observed and latent variables. There are five latent constructs in this research study, *project-related factors* (PR), *project management factors* (PM), *organisational factors* (OF), *human-related factors* (HR) and *project success* (SC). Abstract factors that are not directly observed or measured are latent variables. Such variables are measured indirectly or inferred from a set of observed variables (Hair et al., 2014, p. 2). These latent variables are denoted in the SEM diagram using an oval shape.

The variables observed in the model are shown in the diagram with a rectangle shape. The observed variables are a set of indicators that are directly measured in the research study and are used to measure or infer the abstract variable (Hair et al., 2014, p. 3). In the model, the observed variables OF1 to OF4 are used as indicators for the latent variable *organisational factors* (OF). The observed variables used to infer *project-related factors* (PR) are denoted as PR1 to PR4 in the model, while the observed variables that measure *project management factors* (PM) are denoted as PM1 to PM14. Lastly, the observed variables HR1 to HR10 are used to measure the *human-related factors* (HR) construct. There are two types of relationships within the model. The association between the latent constructs and the observed variables are indicated as single-headed arrows, implying a direct causal relationship of an independent variable on a dependent variable.

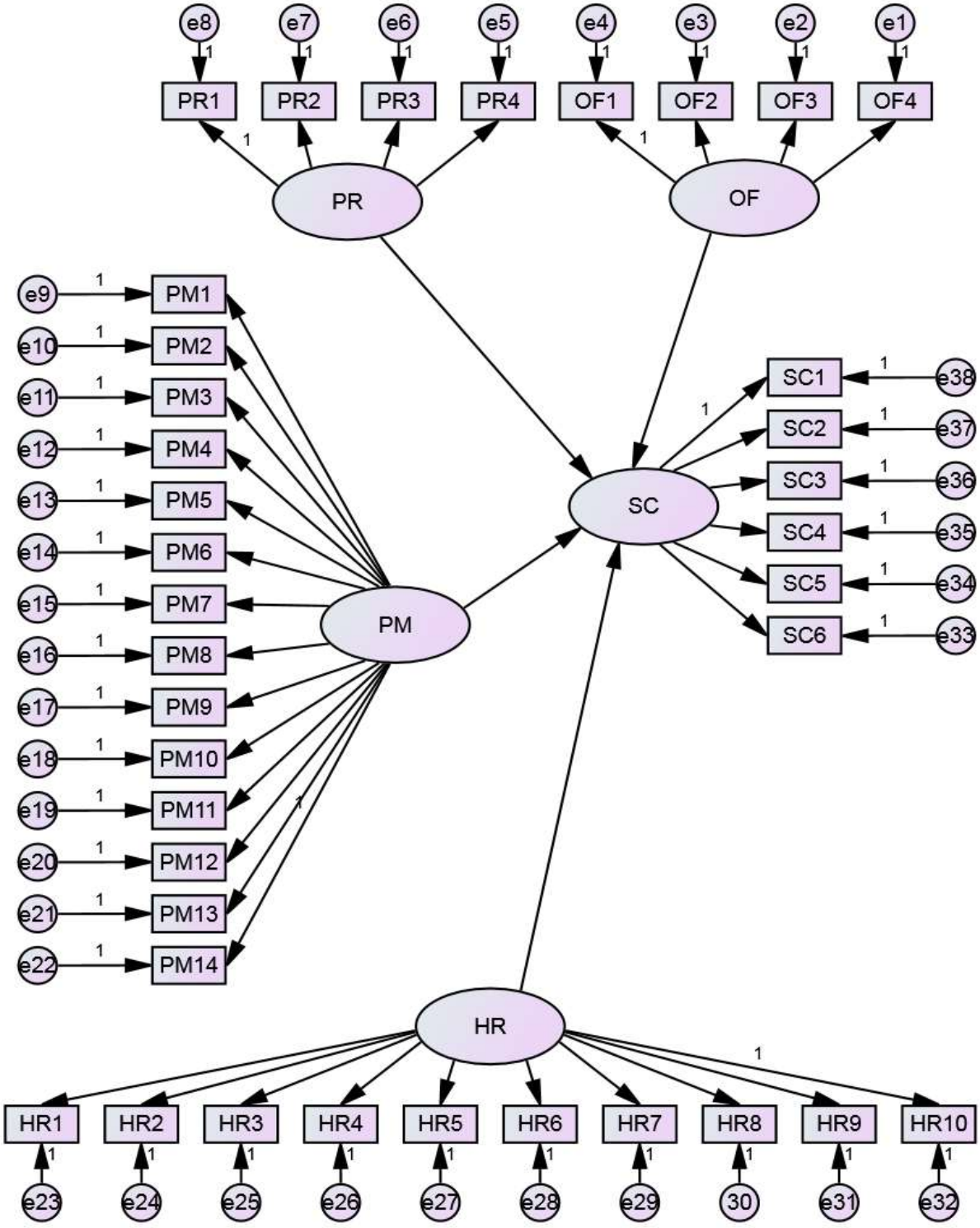

Figure 4.2: Graphical presentation of the SEM model

Figure 4.2 illustrates the direct effect of the observed variables on the constructs, the direct effect of the latent variables (OF, PR, HR and PM) and the construct project success (SC). The other relationship is defined by a curved double-headed arrow, which indicates the correlation between the constructs. The covariation between the constructs are not indicated

in the diagram, however, it is assumed that there are covariances among the success factors constructs.

The small circles are the error terms associated with the observed variables. Error terms signify the unexplained variance when the path models are estimated (Hair, et al. 2014, p. 12). In SEM terminology, the variables are described as either dependent or independent variables; and as exogenous or endogenous variables. An independent variable is a variable without any influence from other variables in the model while a dependent variable is a variable that is influenced by other variables. Exogenous variables are variables whose causes are not included in the model and are variables that explain other variables in the model while endogenous variables are influenced by other variables in the model (Hair et al., 2014, p. 3). The observed variables in this study (OF1 to OF4, PM1 to PM15, HR1 to HR13, PR1 to PR4) are not influenced by other variables and are thus termed exogenous variables. The latent constructs (SC, PM, PR, OF and HR) are termed endogenous variables.

4.7 Ethical Considerations

Ethics in research refers to the correct conduct in relation to the rights of those involved as subject of the research (Saunders et al., 2009, p. 183). The term "*ethical*" implies conforming to a certain code of conduct for a group of professionals (Babbie, 2011, p. 67). While doing research that involves the contribution of human beings, the ethical treatment of the participants is essential to consider. Research ethics involves those ethically relevant issues created by the interference of the researcher that may affect the individuals with whom they are conducting the research. It also focuses on those measures adopted to ensure that the individuals who participate in the research are protected (Flick, 2015, p. 32). Furthermore, researchers must foresee and solve all possible ethical problems that may arise in their research (Creswell, 2014, p. 88).

Ethical clearance was obtained from the Research Ethics Committee of the University of South Africa (UNISA) prior to the undertaking of the pilot survey. Throughout this research, the following key ethical themes were considered for this research study: informed consent, anonymity and confidentiality, voluntary participation, protection from harm, and honesty.

Informed Consent

Informed consent means that the voluntary participation of the respondent in the research project is based on their full understanding of the potential risks involved (Babbie, 2011, p. 69). Whenever human beings are selected to be part of a research study, they need to be notified of the type of research undertaken and thus be given the choice of whether to engage in the research study or not (Leedy & Ormrod, 2015, p. 101). This principle highlights the importance of providing participants with accurate information on the nature of the research and the consent to participation (Babbie, 2011, p. 74).

The research was done in accordance with the established ethical standards of the University. The respondents were notified of their voluntary consent to participate. The cover letter of the questionnaire presented information about the context, the intent of the research, the research objectives and the possible results of the study in order to make an informed decision to participate or withdraw from the research study. The first page of the survey contained all the elements of the informed consent, including, the contact details of the researcher, and the agreement to participate in the survey.

Anonymity and Confidentiality

Anonymity and confidentiality involved the assurance that the identity of the participants will not be disclosed. Anonymity in research is when no one can connect a respondent to the research nor the findings of the research. A research study ensures confidentiality if the researcher can identify the response of a participant but promises not to do so in public (Babbie, 2011, p. 67). Any research study involving human beings must respect the rights of the participant to privacy. No outcomes of a research should be recorded in such a way that others become conscious of how a participant responded (Leedy & Ormrod, 2015, p. 102)

For this research study, all the information and data that was provided by the participants was handled with utmost confidentiality and anonymity. Access to the raw data provided by the participants was strictly limited to the researcher and the supervisor of the research. The names of the organisations were not disclosed anywhere in the study to preserve their anonymity. Furthermore, no questions soliciting identifiable information were posed in the survey.

Voluntary Participation

According to Babbie (2011, p. 67), research involves the disruption of peoples' lives. Research starts an activity which the participants have not requested and could require considerable time and effort from them. It is essential that the respondents are prepared to share information with the researcher. It is therefore, the researcher's responsibility to encourage the respondents to participate in the research study by clearly explaining the intent and the benefits of the research study in the accompanying letter of the questionnaire or through an interactive statement in the questionnaire or during the interview (Kumar, 2011, p. 150).

The respondents were informed about the research objectives and the study background to solicit their participation. They were also informed that their participation in the study is voluntary and that they can withdraw at any stage without providing an explanation for their withdrawal.

Protection from harm

When a research study requires the participation of human beings, the risk associated with the study should not be more than the normal risks of the participant's daily life (Leedy & Ormrod, 2015, p. 101). Potential for harm differs according to the research method, it is more likely in experimental research with clinical trials where the analysis involves the manipulation or doing something to the subject. Although physical harm is not common in survey research, the obligation of the researcher not to harm participants implies that the participants should not be embarrassed, belittled, ridiculed or subjected to any emotional or mental stress (Babbie, 2011, p. 75).

The current research requires the completion of the questionnaire and that might take time to fully complete the questionnaire. Thus, the study procedure involves very minimal personal risk and no physical risks or psychological threats associated with those participating in this study was expected.

Honesty

Researchers must fully and honestly report their findings without misrepresenting what has been achieved or failing to be honest about the nature of the findings (Leedy & Ormrod, 2015, p. 103). Honesty involves the way the research findings are reported. A research should always and under all circumstances report the truth and should not do it in a biased manner (Brynard, 2014, p. 6). The results of this research study were reported according to the analysis of the data and information provided by the respondents of the questionnaires. Finally, the researcher strived to be honest and objective in the presentation of the research results and findings.

4.8 Summary

In this chapter, the research methodology used to address the research questions of this research study was presented. A positivist philosophical approach was adopted as a guide for selecting the methods and techniques used to achieve the objectives of this study. This study was considered as an exploratory and correlational study, which seeks to examine the relations between the success and the critical success factors of shutdown projects. An inductive approach to theory building was selected. A cross-sectional survey was selected as the most suitable strategy for collecting data and the steps taken by the researcher to design the questionnaire were also discussed. Different sampling techniques were explored, and purposive sampling was found suitable for this study. Furthermore, a rationale was provided for the choice of structural equation modelling (SEM) as a technique of data analysis.

CHAPTER 5
DATA ANALYSIS

5.1 Introduction

This study is designed to explore the key drivers of success in shutdown projects and to analyse how these factors affect shutdown project success. The research methods and techniques used in this enquiry were presented in Chapter 4. This section introduces the statistical examination of the data and presents the findings of the data analysis.

Firstly, this chapter addresses the analysis of the demographic profiles and the project attributes of the respondents of the questionnaire survey. Thereafter, the descriptive statistics of the variables used to observe the latent constructs are provided. The details of the steps taken to prepare the data for further analysis by addressing missing values, outliers, normality and multicollinearity are also outlined. The theoretical model and the causal relationships among the constructs are analysed using structural equation modelling.

5.2 Characteristics of the Sample

One of the objectives of this analysis is to consider the views of those involved with shutdown projects on the criteria used for measuring the shutdown project outcome and identifying the key drivers that they perceive to be essential for shutdown project success. A survey was conducted from a sample of respondents involved in shutdown projects in various organisations in South Africa. The number of valid responses received from the survey was 246. About 19% of these responses were partially completed and consequently were excluded from the analysis. The data was analysed using the Statistical Package for the Social Sciences (SPSS) version 25.

5.2.1 Project Respondents

First, the respondents of the survey were requested to indicate the industry they were working in. The results presented in Figure 5.1 indicate that most of the respondents of this survey were from the oil, gas and petrochemical industry (34%), followed by the electricity generation (17%), metal processing (14%), mining (13%) and engineering (13%) industries. Only 9% of the respondents were from the manufacturing industry. This suggests a fair representation of the process industry sectors.

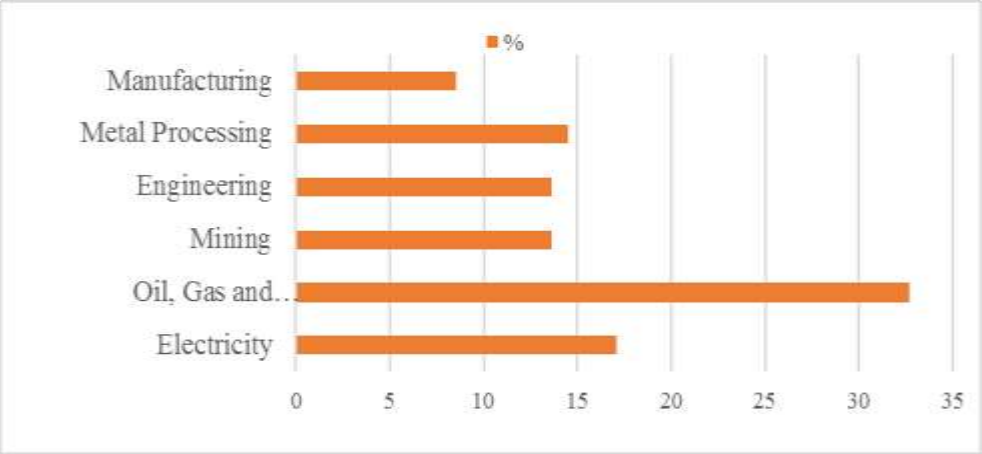

Figure 5.1: Type of industry in which the respondents are working

The respondents were requested to suggest the functional role they occupied in their projects and the results are illustrated in Figure 5.2. Most of the respondents (59%) to the survey were team members, while 32% of project managers participated in the survey. At 5% and 4%, respectively, the executive managers and contractors were the least represented.

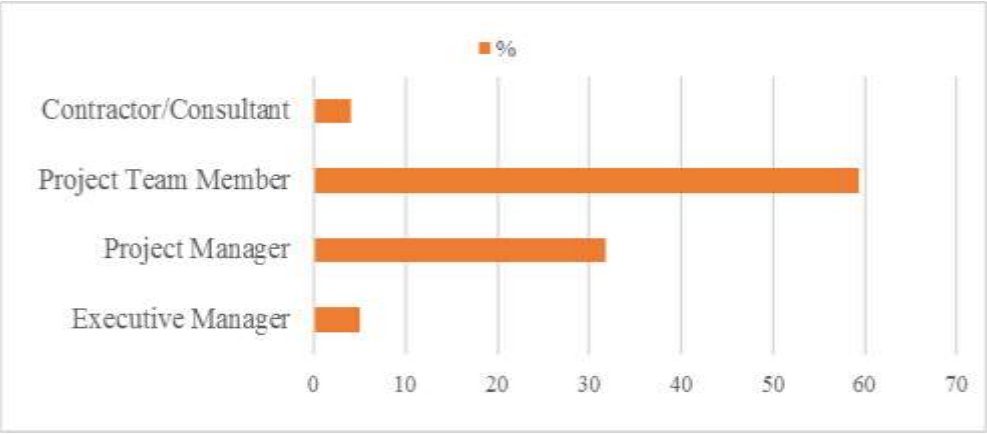

Figure 5.2: Respondent's role in the project

In terms of the years of experience in shutdown projects, Figure 5.3 shows that most of the respondents (32%) were found to have more than 11 years of work experience, while 29% of the respondents had between 7-10 years' experience, 25% had between 3-6 years' experience. Only 14% of the respondents professed to have less than 3 years' experience in shutdown projects.

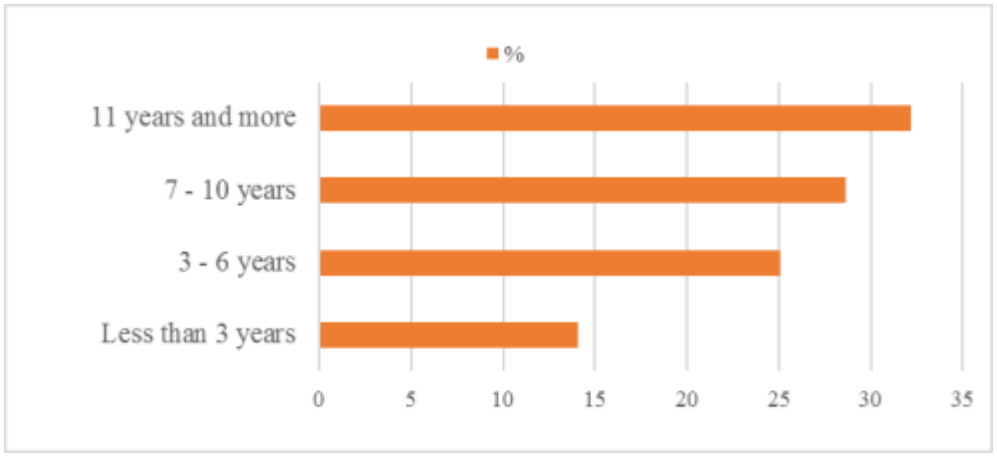

Figure 5.3: Years of work experience in shutdown projects

The respondents were also requested to indicate whether they had formal certification in project management. The results, as displayed in Figure 5.4, illustrate that most of the respondents (68%) to this research study did not have a formal qualification in project management, and 32% of the respondents have qualifications in project management.

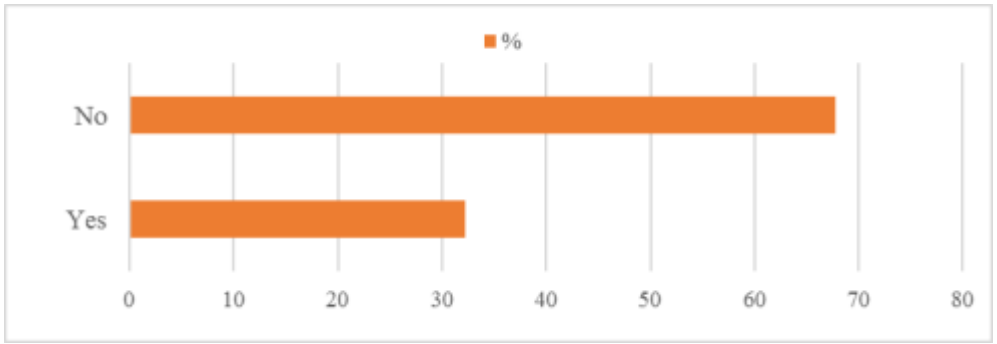

Figure 5.4: Project management qualification

5.2.2 Project Characteristics

In this section, the descriptive statistics related to the projects that the respondents were involved with are discussed. Levitt (2004, p. 3) classified the size of projects according to the monetary value of the project, the duration, the lead-time, the use of project software and the percentage of contractors involved. In this research study, the value, the duration, the lead-time, the amount of subcontracted work and amount of discovery work were used to classify and analyse the projects that were reported by the respondents.

The study respondents were asked to indicate the value of their shutdown projects. Figure 5.5 shows that various sizes in terms of monetary value of shutdown projects were well represented in this survey. Majority of the projects (28%) ranged from R1-R5 million in budget. Projects that were worth more than R50 million accounted for 23% of shutdown projects, projects that were worth R10-R50 million accounted for 19.6%, projects that were between R5-R10 million accounted for 16.1%. Only 13% of the projects were valued at less than R1 million.

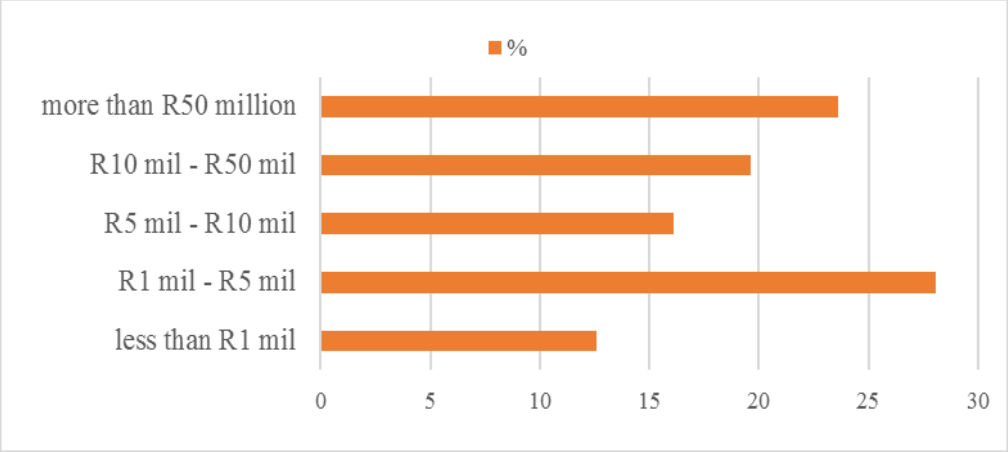

Figure 5.5: Value of the project

The respondents were requested to indicate the duration that their project took to execute. Figure 5.6 indicates that most of the projects (28.1%) took between 3 and 6 weeks to execute, and 24.6% of the projects were carried out over 12 weeks. The respective durations of the remainder of the projects were as follows: projects that took less than three weeks to

complete (19.1 %); projects that lasted for about 9 to 12 weeks (16.6%); and projects that had a duration of between 7 to 9 weeks (11.6%).

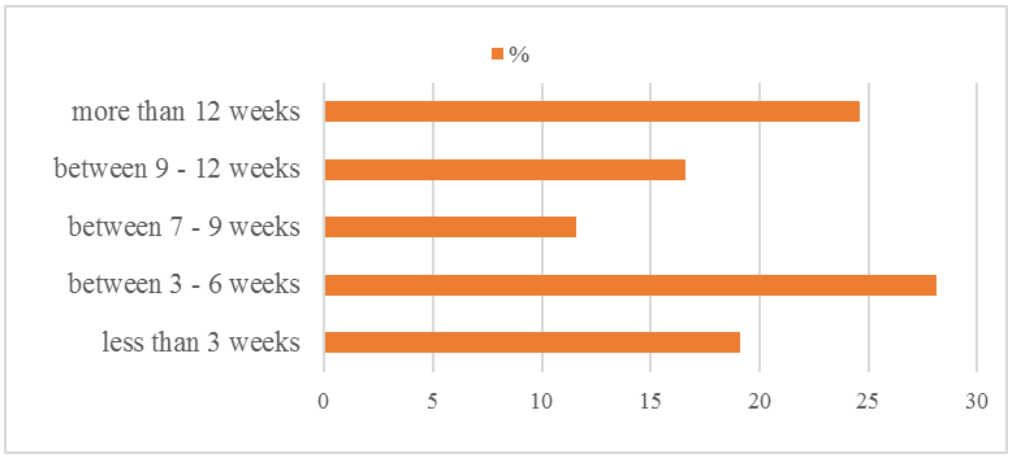

Figure 5.6: Project duration

It is essential to have enough lead time to ensure proper planning of the shutdown project. In this regard Figure 5.7 indicates the results of the lead time when the projects were initiated. Most of the projects (35.6%) had the least lead time of less than 6 months, about 27.1% of the projects were initiated within 7 and 12 months, 20.6% of the projects had a lead time of more than 18 months and 16.6% of the projects had a lead time of between 13 and 18 months.

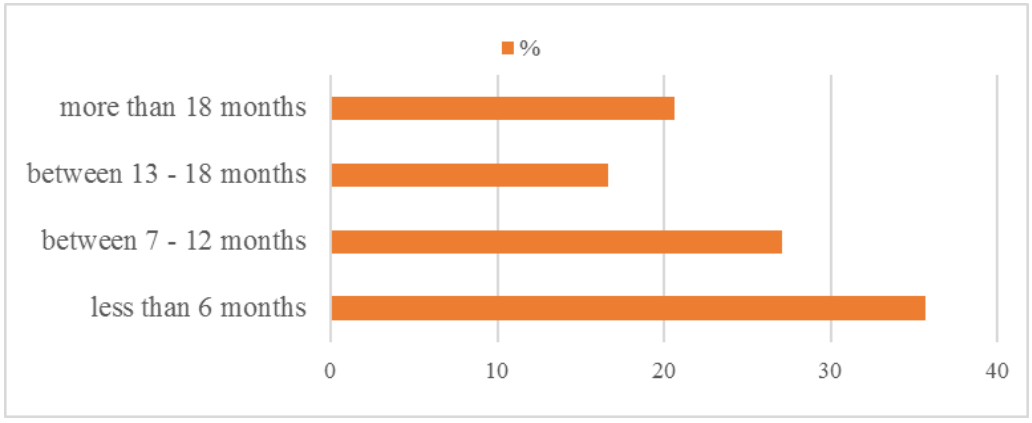

Figure 5.7: Project lead time

In terms of the amount of work that was allocated to contractors, Figure 5.8 indicates that 30.2% of the projects had more than 76% of work subcontracted. A similar percentage of projects (30.2%) had between 51% and 75% of their work allocated to subcontractors. While 20.6% of the projects had between 26% and 50% of work being subcontracted, only 19.1% of

the projects had less than 25% of subcontracted work in their projects. This highlights the importance of contractors in shutdown projects.

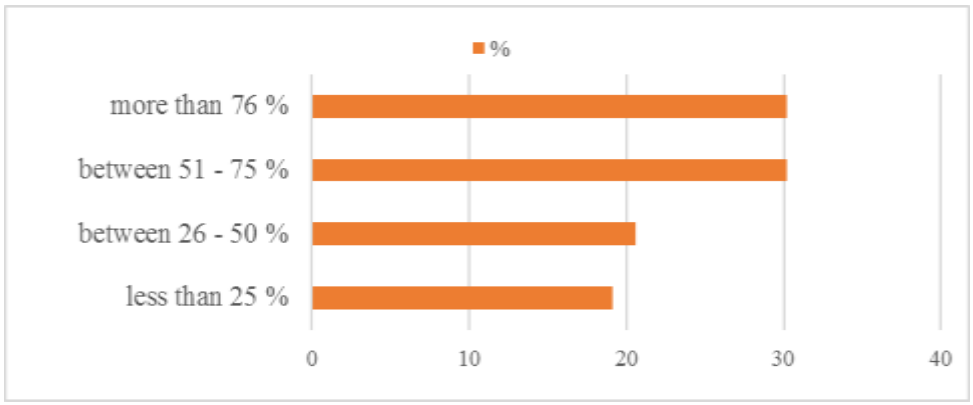

Figure 5.8: Amount of subcontracted work

Shutdown projects are characterized by the amount of additional work discovered when the equipment is opened. The respondents were requested to suggest the amount of additional work discovered during the project implementation. The results in Figure 5.9 suggests that most of the respondents surveyed (65%) experience between 0-25% of additional work during project execution. In addition, 30.2% of the respondents indicated that their projects experienced between 26-51% of additional work, and about 3% had 51-75% of additional scoping work.

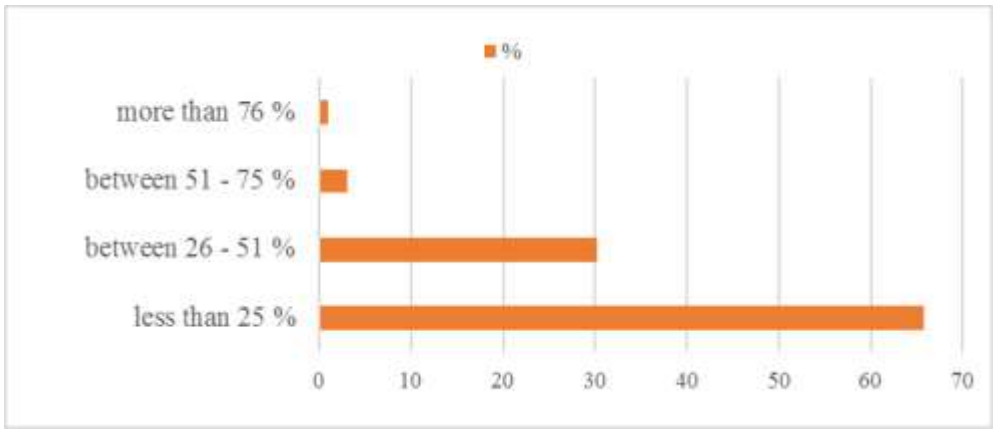

Figure 5.9: Amount of unplanned/discovery work

5.3 Data Screening and Preparation

In this section, the manner in which data screening and preparation were handled before proceeding with statistical analysis is reported. Consideration is also given to the fact that the

data must meet multivariate assumptions and the preparation of the data set for structural equation modelling is as a result discussed.

The first concern in data screening is the accuracy of the data that was captured (Schumacker & Lomax, 2010, p. 18). The data from the web-based survey were exported from Lime survey database to SPSS version 25. The data from the paper survey was manually recorded onto the SPSS software. To assess an accurate recording of the data, the frequency distribution tables were generated and analysed. Based on the frequency scores, the data was carefully examined to see whether it was within range and whether the coding was done correctly. All the data was found to be within range and no input errors were found in the data set.

5.3.1 Missing Data

Missing data is an issue in most research studies since it can potentially affect the validity of the research findings (Hair et al., 2014, p. 40). According to Tabaschnick and Fidell (2013, p. 63), it is essential to assess how much data is missing, the pattern of the missing data and why the data is missing. In this study, the missing values for both cases and variables were assessed.

To evaluate the missing values based on each case in the data, all partially completed and incomplete cases were not considered for purposes of the data analysis. While evaluating the standard deviation for each case in the data set, it was found that there were cases where the standard deviation was below 0.4, indicating very little variance in the responses. These were regarded as unengaged answers in which the respondents provided the same response to all questions. Similarly, these cases were not considered for the analysis.

The missing values were then assessed according to variables. Most of the variables with missing values had less than 5% of the missing values which can be considered acceptable (Schumacker & Lomax, 2010, p. 21). To understand the type of missing data, the test for Little's Missing Completely at Random (MCAR) was used. For ($p > 0.05$), it is assumed that the missing values are missing at random. It is indicated in Table 5.1 that the significance

level of the MCAR test as 0.031. This means that the missing values in this research study are NMAR (non-random missing data).

Table 5.1: Results of Little's MCAR

Chi Square (χ^2)	df	Sig.
523.161	428	0.031

Data that is not missing at random (NMAR) cannot be overlooked. The generalizability of the results will be affected if the missing values are non-randomly distributed (Tabachnick & Fidell, 2013, p. 62). In this research study, the missing values were replaced using multiple imputations. Multiple imputations involve creating multiple estimates for each missing value, considers the uncertainty in the imputations and yields more accurate results. The missing value is imputed based on another case or cases of similar response pattern over a set of matching variables (Schumacker & Lomax, 2010, p. 21). The advantage of this approach is that unlike other methods it makes no assumption that the missing values are randomly distributed, and the method can retain sampling variability (Tabachnick & Fidell, 2013, p. 63).

5.3.2 Outliers

Outliers are scores or a combination of scores that are isolated from the rest of the scores and can affect the results of the analysis (Zygmont & Smith, 2014, p. 40). According to Hair et al. (2014, p. 58), outliers can influence the outcome of the multivariate analysis and can be evaluated from three different perspectives, namely: univariate, bivariate and multivariate. Of interest to this research study are the univariate and multivariate outliers.

To identify univariate outliers, the frequency distribution table was used to ensure that all variables were within the range of the 5-point Likert scale. Boxplots of the variables were also generated and scrutinized by locating cases near the median value and extreme values that were away from the box.

To detect multivariate outliers, the value for Mahalanobis distance (D^2) was computed for each case in the data set. The Mahalanobis distance (D^2) static measures the distance between the coordinate for each case and the multivariate mean of the group of variables (Tabachnick & Fidell, 2013, p. 74). Each case was evaluated using the chi-squared (χ^2) distribution ($p < 0.001$). Cases that reached this significant threshold were considered as multivariate outliers. Twelve (12) cases of multivariate outliers were found. These cases were not considered for purposes of the analysis and no transformation of the data was performed.

5.3.3 Normality

Normality in the data was assessed by means of skewness and kurtosis statistics. Skewness is the indicator of the asymmetry of the data while kurtosis indicates the height of the distribution of the data (Tabachnick & Fidell, 2013, p. 79). To examine data for skewness and kurtosis, the frequency distribution tables of all variables were analysed.

Opinions vary on an acceptable level of skewness and kurtosis (Meyers et al., 2006, p. 48). According to Kline (2010, p. 76), a true normal distribution should have the skewness and kurtosis value of 0, however, suggested a liberal threshold value of ±3 for normality distribution. Visual inspections of the histograms with normal curves indicated the extent of skewness and kurtosis within the variables. No significant skewness in the variables was observed and no transformations were as a result performed for normality.

5.3.4 Multicollinearity

Multicollinearity occurs when two or more variables are highly correlated in a matrix. The presence of multicollinearity gives a lower value of the unique variance explained by each independent variable (β-value) and it inflates the shared prediction percentage (Hair et al., 2006, p.186). To avoid multicollinearity, Tabaschnick and Fidell (2013, p. 90) suggested the deletion of one of the two variables that possess a bivariate correlation equal to or higher than 0.90. Multicollinearity was examined using the correlation matrix populated during the

statistical analysis. No multicollinearity issues were encountered, as the values did not exceed the threshold of 0.90.

5.4 Descriptive Statistics of the Construct Items

This study intends to explore the perceptions of the individuals involved in shutdown projects regarding the criteria used to assess the outcome of their projects; and additionally, identify the factors that are essential for the success of the shutdown projects. This segment presents the findings of the items that were used to measure the constructs success criteria and the success factors in shutdown projects. The measures of central tendency (mean) and dispersion (standard deviation) were summarized using SPSS version 25.

Success Criteria

The respondents were requested to show the extent of their agreement (1 = strongly disagree and 5 = strongly agree) that the following variables of success were used by their organization when evaluating the outcome of their project. The results of the scores of the mean (M) and standard deviation (SD) ratings for each item of the construct (success criteria) are presented in Table 5.2.

Table 5.2: Descriptive statistics for the measured item - success criteria

Variables	Item	M	SD
SC1	Completion of the project within budget or cost	4.075	1.137
SC2	Completion of the project on time	4.161	1.107
SC3	Completion of the project according to quality requirements	4.207	0.984
SC4	Start-up or commissioning incidences	3.969	0.945
SC5	Safety, health and environmental incidences	4.333	0.987
SC6	Amount of additional/unplanned/discovery work	3.601	1.031
SC10	If the project contributes to the strategic objectives of the organization	4.332	0.739
SC11	If the project meets the needs of the customers or end-users of the project	4.206	0.824
SC12	The project benefits in commercial value and market share	4.025	0.901

The highest scoring item was SC5 (M = 4.333, SD = 0.987), which relates to the assessment of safety, health and environmental incidences. The least scoring item was SC6 (M = 3.601, SD = 1.031), which is a measurement item for unplanned or discovery work. The

overall mean score of the construct was M = 4.101 showing that the respondents agreed with the items measuring the success criteria in shutdown projects.

Organisational Factors

Table 5.3 illustrates the descriptive data of the items measuring the construct organisational factors. The respondents were requested to communicate the extent of their agreement (1 = strongly disagree and 5 = strongly agree) that the items used to observe organisational factors contributed to the outcome of their shutdown project. The mean rating of the construct (M = 4.064) signifies that the respondents moderately agreed that the items are relevant to influence project success. The factor OF1 was the highest scoring item (M = 4.525, SD = 0.752), and it relates to the support from top management. The lowest score was obtained for OF4 (M = 4.202, SD = 0.901), which refers to the organisational culture.

Table 5.3: Descriptive statistics for the measured items - organisational factors

Variable	Item	M	SD
OF1	Support from top management	4.525	0.752
OF2	A realistic strategy	4.348	0.796
OF3	Organizational structure of the project	4.227	0.815
OF4	Organizational culture	4.202	0.901

Project-related Factors

Table 5.4 explains the findings of the items used to observe the construct project-related factors. The respondents were requested to show the extent of their agreement (1 = strongly disagree and 5 = strongly agree) that the project-related factors contributed to the outcome of their shutdown project. The score of PR1, which denotes the size and complexity of the project, was high (M = 4.192, SD = 0.909). The lowest scoring item was PR3 (M = 3.747, SD = 1.006), which relates to project frequency. Overall, the project-related factors had a mean score of M = 4.326; this implies that the respondents agreed that the items contributed to the success of their projects.

Table 5.4: Descriptive statistics for the measured items- project-related factors

Variable	Item	M	SD
PR1	The size and complexity of the project	4.192	0.909
PR2	Project duration	4.187	0.843
PR3	Project frequency	3.747	1.006
PR4	The lead time when the project was initiated	4.131	0.891

Human-related Factors

The human-related factors construct addresses two aspects. The one enquires about the characteristics of the project manager, while the other aspect relates to the project team. Table 5.5 details the findings of the items used to observe the construct of human-related factors.

Table 5.5: Descriptive statistics for the measured items - human-related factors

Variable	Item	M	SD
HR1	Project Manager's competence	4.52	0.738
HR2	Project Manager's formal qualification	3.55	1.083
HR3	Project Manager's experience	4.51	0.772
HR4	Project Manager's leadership style	4.475	0.71
HR5	A competent Project Team	4.574	0.708
HR6	Project Team's commitment	4.581	0.706
HR7	A motivated or incentivized team	4.335	0.776
HR8	Clearly defined roles and responsibilities for all team members	4.584	0.654
HR9	The team's alignment with organizational goals and strategy	4.278	0.86
HR10	A well-integrated and cohesive team	4.459	0.702
HR11	Effective conflict resolution	4.354	0.765
HR12	Adequate training and education of the project team	4.121	0.852
HR13	Availability of specialized skills within the team	4.000	1.028

The item HR1, which represents the competence of the project manager, was found to have the highest-ranking score (M = 4.520, SD = 0.738). HR2 was the lowest scoring item (M = 3.550, SD = 1.803) signifying qualification being regarded as being the least relevant to project success.

HR8 (M = 4.584, SD = 0.654) was the highest-scoring item that relates to the project team. This item indicates the roles and responsibilities within the project team. The items HR12 (M = 4.121, SD = 0.852) and HR13 (M = 4.000, SD = 1.028), which relates to education and specialised skills, had the least scores. The average mean scores of the construct (M = 4.333) shows that the respondents agreed that the items were relevant to the success of their projects.

Project Management Factors

The variables presented in Table 5.6 measure the construct project management factors. The results indicate the perceptions of the respondents of the survey concerning project management factors that are essential for their successful project outcome.

Table 5.6: Descriptive statistics for the measured items - project management factors

Variable	Item	M	SD
PM1	Clear and realistic project objectives	4.459	0.695
PM2	Realistic time and cost estimates	4.424	0.714
PM3	Efficient and detailed planning	4.568	0.678
PM4	Review of readiness prior the project execution	4.515	0.674
PM5	Risk-based inspection	4.303	0.779
PM6	Freezing of the scope	3.894	0.974
PM7	Strict scope control and management	4.222	0.879
PM8	The ability to recognize the amount of additional/ discovery during project execution	4.298	0.752
PM9	Clear communication channels for all team members	4.51	0.666
PM10	Safety awareness and training	4.459	0.695
PM11	Integration of shutdown projects with other projects	4.177	0.821
PM12	Identification, assessment and addressing risks	4.489	0.627
PM13	Effective site management	4.332	0.756
PM14	Effective monitoring and feedback	4.534	0.669
PM15	The importance of the shutdown report and lessons learned for the success of the next project	4.625	0.601

The highest scoring item in the category of project management factors was PM15 (M = 4.625, SD = 0.601), which represents the shutdown reporting and lessons learned. The least scoring item was PM6 (M = 3.894, SD = 0.974), which suggests the freezing of the scope is the least relevant to project success. Overall, the mean score of the construct (M = 4.387) suggests that the respondents agreed with the contribution of the item to the success of their shutdown projects.

5.5 Reliability Analysis

According to Kline (2016, p. 92), the Cronbach's alpha indicator assesses the reliability and the internal consistency of the items measured on a Likert scale. The Cronbach's alpha value must be higher than 0.7 to meet the acceptable threshold. A Cronbach's alpha value of between 0.8 and 0.9 are considered very good, and value that is higher 0.9 is deemed excellent.

Table 5.7 indicates the findings of the reliability analysis of the constructs. The Cronbach's alpha coefficients for project-related factors were found to be higher than 0.7, which is considered acceptable. For all the other constructs, the Cronbach's alpha was higher than 0.8 implying that the internal consistency of the constructs was sufficiently reliable.

Table 5.7: Reliability measures of the measurement items

Item	Constructs	Number of Items	Cronbach's Alpha
SC	Success Criteria	9	0.845
OF	Organizational Factors	4	0.801
PR	Project related Factors	4	0.732
HR	Human related Factors	13	0.887
PM	Project Management related	15	0.897

The analysis of the reliability of the items was also carried out to assess the correlations between the items and to assess whether the Cronbach's alpha value of the constructs could be improved. A trustworthy scale has items that correlate well with the total. When the Cronbach's alpha value of the items exceeds the overall value of the construct, such variables can be removed to increase the reliability of the construct. The corrected item-total correlation shows the link between the variable and the overall reliability of all other items in the questionnaire. The items with the corrected-item correlation that is less than 0.4 indicates no correlation with the overall scale (Field, 2009, p. 678).

Item Total Statistics for the Construct – Success Criteria

For the construct success criteria (SC), the Cronbach's alpha index was found to be 0.845, which is considered good (Kline, 2016, p 92). This implies that all the measurement items

represent the same latent construct. Table 5.8 shows the item-total statistics of the observed variables under this construct. The Cronbach's alpha value for the measurement items was above the minimal acceptable threshold for reliability. It can therefore be concluded that these items measured the same construct. Table 5.8 shows that the alpha coefficient of the construct will not significantly improve upon the deletion of any of the items. However, the corrected item-total correlation for the item SC6 was below the threshold of 0.4. This item was monitored and the decision to remove it was considered during the principal component analysis (PCA).

Table 5.8: Item-total statistics for the scale item project success

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SC1	32.8238	23.075	0.588	0.827
SC2	32.7621	22.607	0.666	0.817
SC3	32.7181	23.345	0.699	0.814
SC4	32.9207	23.613	0.673	0.817
SC5	32.6035	24.187	0.566	0.828
SC6	33.2467	26.045	0.326	0.855
SC10	32.6123	25.592	0.590	0.829
SC11	32.7269	25.704	0.500	0.835
SC12	32.8811	25.353	0.493	0.836

Item-Total Statistics for the Construct – Organisational Factors

The item-total statistics for the items measuring the construct organisational factors is shown in Table 5.9. The overall reliability for the construct organisational factors (OF) was 0.801. It was noted that the alpha coefficient of the construct will not significantly improve with the deletion of any of the items under this construct. It was also observed that the minimum of the corrected item-total correlation exceeded the minimum threshold of 0.4 (Field, 2009, p. 679). Therefore, the removal of any of the items would not improve the internal consistency of the construct.

Table 5.9: Item-total statistics for the scale item organisational factors

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
OF1	12.6960	3.859	0.606	0.772
OF2	12.8458	3.662	0.650	0.751
OF3	12.9515	3.453	0.725	0.714
OF4	12.9692	3.632	0.543	0.807

Item-Total Statistics for the Construct – Human related Factors

The overall Cronbach's alpha coefficient for the construct human-related factors (HR) was found to be 0.887. The corrected item-total statistics for the measurement items under this construct is shown in Table 5.10. The table indicates that the removal of any of the variables would not substantially increase the Cronbach's alpha of the construct. The measurement items also produced a scale with an appropriate level of internal consistency. The corrected item-total correlation of the measurement items HR2 and HR13 were below the acceptable threshold of 0.4. To this end, the removal of these items would increase the Cronbach's alpha coefficient of this construct to 0.897 and 0.893, respectively. Thus, these items were highlighted as poor items.

Table 5.10: Item-total statistics for the scale item human-related factors

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
HR1	51.3700	36.535	0.629	0.876
HR2	52.2203	37.394	0.319	0.897
HR3	51.3833	36.547	0.597	0.878
HR4	51.4141	37.359	0.554	0.880
HR5	51.3304	36.709	0.633	0.876
HR6	51.3216	36.308	0.685	0.874
HR7	51.5374	36.205	0.648	0.875
HR8	51.3304	36.709	0.662	0.875
HR9	51.5859	35.341	0.670	0.874
HR10	51.4273	36.228	0.711	0.873
HR11	51.5198	35.879	0.696	0.873
HR12	51.7225	36.157	0.589	0.878
HR13	51.8282	37.267	0.363	0.893

Item Total Statistics for the Construct – Project Management Factors

The findings of the reliability analysis for the construct project management factors (PM) are shown in Table 5.11. The Cronbach's alpha coefficient for this construct was noted to be 0.897. This shows an internal consistency well beyond the recommended threshold of 0.7 (Hair et al., 2014, p. 125). PM6 was found to possess a poor correlated item score with other variables. The removal of this item would improve the value of the Cronbach's alpha to 0.906; however, it was flagged for removal.

Table 5.9: Item-total statistics for the scale item project management factors

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PM1	60.6784	39.697	0.657	0.887
PM2	60.7093	39.712	0.639	0.888
PM3	60.5903	40.031	0.622	0.889
PM4	60.6344	39.959	0.641	0.888
PM5	60.8150	39.647	0.591	0.890
PM6	61.1718	41.541	0.280	0.906
PM7	60.8855	38.863	0.595	0.890
PM8	60.8194	39.839	0.594	0.890
PM9	60.6344	39.277	0.739	0.885
PM10	60.6784	40.361	0.573	0.891
PM11	60.9251	40.972	0.416	0.897
PM12	60.6520	40.431	0.629	0.889
PM13	60.8018	40.071	0.573	0.891
PM14	60.6256	39.987	0.644	0.888
PM15	60.5507	40.753	0.599	0.890

5.6 Principal Component Analysis

Principal Components Analysis (PCA) was used to gain more insight into the underlying structure surrounding the variables and to identify the representative constructs that better define the data. It was also used for the testing construct validity of the instrument (Hair e al., 2014, p. 92).

Prior to factor extraction, a few tests were performed to determine the fitness of the data for factor analysis (Williams et al., 2010, p. 5). The Kaiser-Meyer-Olkin (KMO) measure of

sample adequacy and the Bartlett's test of sphericity were used to evaluate the appropriateness of the data. A KMO significance of 0.878 is reported in Table 5.12. A sample is viewed as meritorious if the KMO index is more than 0.8 (Hair et al., 2014, p. 102). The Bartlett's test is considered reasonable ($p < 0.05$) for factor analysis to be suitable (Williams et al., 2010, p. 5). The results indicate significance ($p = 0.000$) and show that the variables can be classified into sets of underlying factors.

Table 5.10: Kaiser-Meyer-Olkin measure and Bartlett's test of sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin measure of sampling adequacy		0.878
Bartlett's test of sphericity	Approx. Chi-Square	3275.712
	df	465
	Sig.	0.000

The data were subjected to Principal Components with Varimax rotation to examine the components that can best portray the interrelations between the set of variables. The components were extracted based on Kaiser's criteria (eigenvalue > 1) (Hair et al., 2014, p. 107). The initial output of the component analysis yielded 11 components. However, the components were not well defined by the factor solution, some variables were found to load poorly (< 0.50) on the components, while some were found to be cross-loading to more than one component. Communalities were examined if the variables were well-defined by the solution (Tabaschnick & Fidell, 2013, p. 664).

Table 5.11: Communalities

Communalities					
	Initial	Extraction		Initial	Extraction
SC1	1.000	0.679	HR1	1.000	0.748
SC2	1.000	0.716	HR3	1.000	0.717
SC4	1.000	0.655	HR4	1.000	0.705
SC5	1.000	0.680	HR7	1.000	0.571
SC10	1.000	0.692	HR9	1.000	0.647
SC11	1.000	0.745	HR11	1.000	0.644
SC12	1.000	0.720	HR12	1.000	0.695
PR1	1.000	0.634	HR13	1.000	0.584
PR2	1.000	0.618	PM4	1.000	0.513
PR3	1.000	0.561	PM5	1.000	0.566
PR4	1.000	0.558	PM10	1.000	0.548
OF1	1.000	0.628	PM11	1.000	0.396
OF2	1.000	0.644	PM12	1.000	0.606
OF3	1.000	0.746	PM13	1.000	0.577
OF4	1.000	0.578	PM14	1.000	0.616
			PM15	1.000	0.578
Extraction Method: Principal Component Analysis.					

The communality of a variable is the estimate of the share of its variability between the variables and how much an item correlates with other elements in the component (Hair et al. 2014, p. 103). Table 5.13 shows the communality explained by each variable. A low value for communality (< 0.40) is not desirable as it could mean that the items may not be well correlated with other variables in its component (Hair et al., 2014, p. 106). It was observed that the communalities of the variables were reasonable, and this implied that the variables fitted well with other variables in their component.

Figure 5.10 is a representation of the scree plot generated during the extraction of the components. The scree plot is a useful tool for confirming the number of factors to retain. However, Williams et al. (2010, p. 5) points out that this remains a subjective judgement. The graph was interpreted by drawing a linear line through the set of eigenvalues when the line breaks out (Williams et al., 2010, p. 6). The scree plot confirmed a 7-component solution with Kaiser's criteria (eigenvalue > 1).

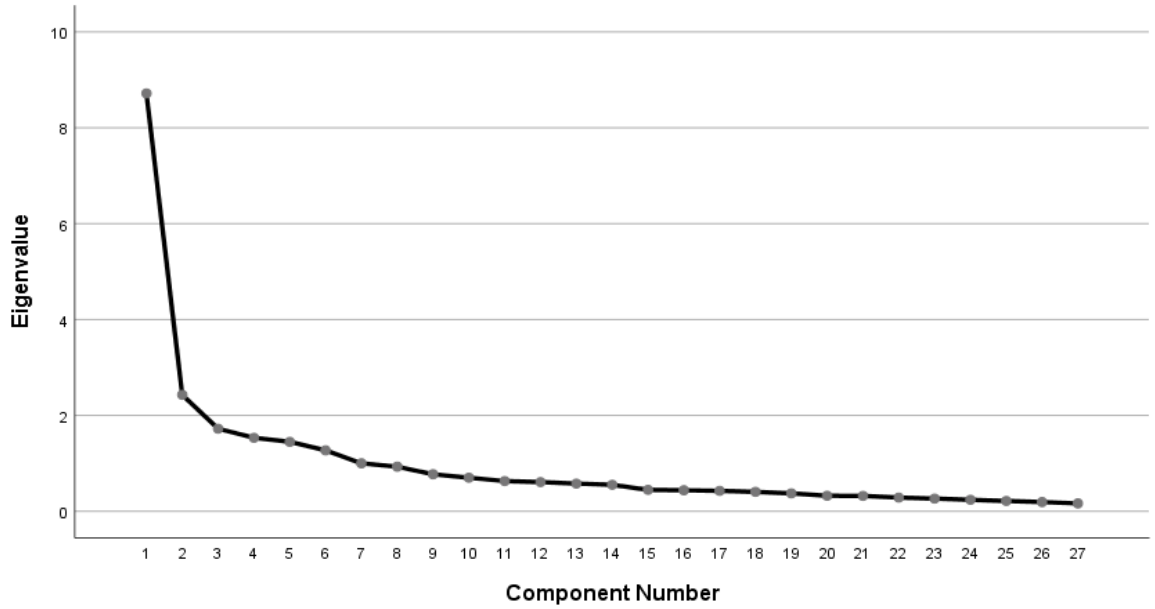

Figure 5.10: The scree plot

Table 5.14 shows the final output of the component analysis. Seven components with (eigenvalue > 1) were obtained and the table also shows the results of the total variance explained by each extracted component. The extracted components accounted for the cumulative variance of 63.114 %, which is above the 50% threshold (Meyers et al., 2006, p. 504).

Table 5.12: Total Variance Explained

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.447	30.476	30.476	9.447	30.476	30.476	3.910	12.613	12.613
2	2.523	8.138	38.614	2.523	8.138	38.614	2.954	9.528	22.141
3	1.846	5.955	44.569	1.846	5.955	44.569	2.741	8.840	30.981
4	1.610	5.195	49.764	1.610	5.195	49.764	2.690	8.677	39.658
5	1.578	5.090	54.854	1.578	5.090	54.854	2.676	8.634	48.292
6	1.399	4.513	59.367	1.399	4.513	59.367	2.314	7.463	55.755
7	1.161	3.746	63.114	1.161	3.746	63.114	2.281	7.359	63.114
8	0.958	3.090	66.204						
9	0.858	2.769	68.973						
10	0.806	2.599	71.571						
11	0.750	2.420	73.991						
12	0.691	2.228	76.220						
13	0.652	2.103	78.323						
14	0.616	1.988	80.310						
15	0.591	1.908	82.218						
16	0.552	1.779	83.997						
17	0.490	1.581	85.578						
18	0.477	1.539	87.117						
19	0.437	1.410	88.527						
20	0.416	1.343	89.870						
21	0.395	1.273	91.144						
22	0.376	1.212	92.356						
23	0.373	1.204	93.560						
24	0.330	1.065	94.625						
25	0.312	1.006	95.631						
26	0.289	0.931	96.562						
27	0.254	0.818	97.380						
28	0.237	0.764	98.144						
29	0.216	0.697	98.841						
30	0.190	0.613	99.454						
31	0.169	0.546	100.000						
Extraction Method: Principal Component Analysis.									

Table 5.15 shows that 6 iterations yielded a set of 7 components consisting of 31 variables. Thus, the factor loadings of the 31 items accounted for 63.114% of the total variance explained. Factor loadings represent the role that each variable plays in describing each component and a factor loading of ±.50 or greater is assumed to be practically significant (Hair, et al., 2014, p. 110, 115).

Table 5.13: Factor loadings (rotated component matrix)

Rotated Component Matrix[a]							
	1	2	3	4	5	6	7
PM4	0.578						
PM5	0.636						
PM10	0.621						
PM11	0.579						
PM12	0.705						
PM13	0.639						
PM14	0.656						
PM15	0.663						
SC1		0.800					
SC2		0.791					
SC4		0.776					
SC5		0.788					
OF1			0.701				
OF2			0.618				
OF3			0.783				
OF4			0.682				
HR1				0.765			
HR3				0.762			
HR4				0.792			
HR7					0.572		
HR9					0.651		
HR11					0.599		
HR12					0.741		
HR13					0.703		
SC10						0.650	
SC11						0.782	
SC12						0.790	
PR1							0.749
PR2							0.657
PR3							0.727
PR4							0.590
Eigenval	9.447	2.523	1.846	1.610	1.578	1.399	1.161
% of Variance	30.476	8.138	5.955	5.195	5.09	4.513	3.746
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.							
a. Rotation converged in 6 iterations.							

The components were interpreted through their factor loadings. To interpret the components, attempts are made to understand the underlying dimension that unifies the group of variables (Tabaschnick & Fidell, 2013, p. 655). However, this interpretation remains a

subjective and inductive process (Williams et al., 2010, p. 9). The following interpretations were extracted from the examination of the components.

Component 1 - Project Management Actions (PM)

The attributes under this component accounted for 30.746% of the total variance explained. The attributes described by this variable along with the factor loadings are: risk identification (0.705), lessons learned (0.663), effective monitoring (0.656), site and contractor management (0.639), risk-based inspection (0.636), safety management (0.621) and project integration (0.579).

Component 2 - Project Efficiency (SC_A)

This component accounted for 8.138% of the total variance and the variables under this component explain the efficient delivery of a shutdown project. This component highlights the importance of delivering the project within budget (0.800), on time (0.791), and according to safety, health and environmental requirements (0.788). The component also indicates that quality standards in shutdown projects are defined by the number of start-up or commissioning incidences (0.776).

Component 3 - Organisational Factors (OF)

The attributes under this component represents the organisational factors in a project and the component accounted for 5.955% of the total variances. The following factors were extracted along with the factor loading: organisational structure (0.783), top management support (0.701), the organisational culture (0.682) and the strategy (0.618).

Component 4 - Project Manager Competence (HR_A)

This component accounted for 5.195% of the total variance. This factor extracted the information about attributes of the project manager. The factors that were extracted under this component included leadership style (0.792), experience (0.765) and competence (0.762).

Component 5 - Project Team Competence (HR_B)

This component accounted for 5.090% of the total variance and the component extracted information about the attributes of the project team, and the following factors must be prioritized: training and development of the team (0.741), specialised skills (0.703), the team must be aligned with strategic goals (0.651), conflict resolution (0.599), and motivation within a team (0.572).

Component 6 - Organisational Success (SC_B)

This is another component of project success, and the attributes within this component are related to the benefits to the customers and the organisation. The component accounts for 4.513% of the total variance. This component is defined by profitability or business value (0.790), customer satisfaction (0.782), and strategic objectives (0.650).

Component 7 - Project Characteristics (PR)

The attributes in this component define the characteristics of the project. This component extracted 3.746% of the total variance. The factors under this component were found to be size and complexity of the project (0.749), project frequency (0.727), project duration (0.657), and lead time the project was initiated (0.590).

From the results of the PCA, seven components were identified. From the analysis, the uni-dimensionality of the following constructs were confirmed: project management actions (PM), organisational factors (OF) and project characteristics (PR). The analysis for success criteria (SC) indicates a multi-dimensional nature of project success by resulting in two constructs: project efficiency (SC_A) and organisational success (SC_B). Human-related factors (HR) resulted in two components: project manager competence (HR_A) and project team competence (HR_B). Thus, Figure 5.11 illustrates a revised conceptual model for this research study. The model seeks to explore the success of shutdown projects by analysing the relationship between organisational factors (OF), project management actions (PM), project manager's competence (HR_A), project team's competence (HR_B) and project

characteristics (PR) on the two-dimension of success, namely: project efficiency (SC_A) and organisational success (SC_B).

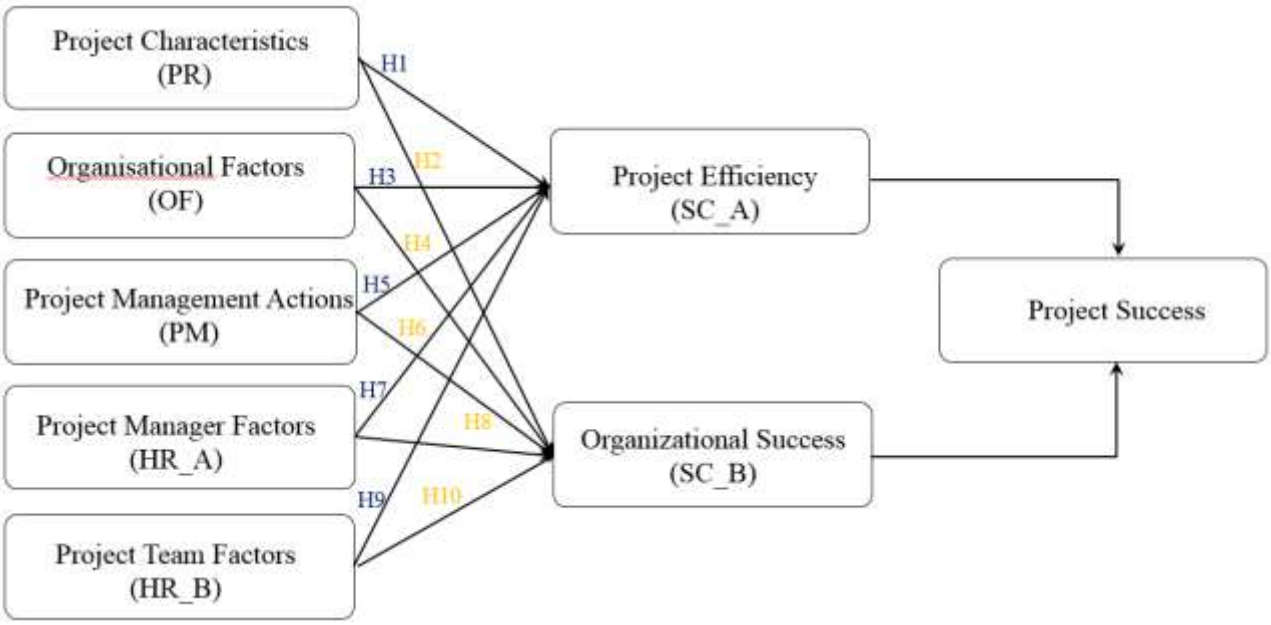

Figure 5.11: A revised theoretical model for shutdown project success

To evaluate the hypothesised relations between the constructs based on the revised model in Figure 5.11, an attempt was made to examine the following hypothetical relations:

H1: *The project characteristics have a strong and significant relationship with project efficiency.*

H2: *The project characteristics have a strong and significant relationship with organisational success.*

H3: *The organisational factors have a strong and significant relationship with project efficiency.*

H4: *The organisational factors have a strong and significant relationship with organisational success.*

H5: *The project management actions have a strong and significant relationship with project efficiency.*

H6: *The project management actions have a strong and significant relationship with organisational success.*

H7: *The project manager's competency has a strong and significant relationship with project efficiency*

H8: *The project manager's competency has a strong and significant relationship with organisational success.*

H9: *The project team competency has a strong and significant relationship with project efficiency.*

H10: *The project team competency has a strong and significant relationship with organisational success.*

5.7 Correlation Analysis

According to Williams et al. (2010, p. 5), a correlation matrix represents the degree of relationships between the constructs. Based on the results of extracted components, correlation analysis was performed to determine the strength and the interaction between the constructs. The results of the bivariate association between the latent constructs are in shown in Table 5.16. The correlation for the constructs was found to be within the statistically significant level ($p < 0.01$) and all constructs were positively correlated.

Table 5.14: Pearson's correlation of latent constructs

Correlations							
	SC_A	SC_B	PR	OF	HR_A	HR_B	PM
SC_A	1						
SC_B	.408**	1					
PR	.300**	.334**	1				
OF	.340**	.476**	.400**	1			
HR_A	.254**	.283**	.336**	.507**	1		
HR_B	.215**	.413**	.382**	.479**	.471**	1	
PM	.250**	.429**	.417**	.497**	.434**	.533**	1
**. Correlation is significant at the 0.01 level (2-tailed).							

According to Field (2009, p. 170), the correlation coefficient indicates a measure of an observed effect with correlation values of ± 0.1 representing a small impact, values of ± 0.3 indicating a moderate effect and values of ± 0.5 representing a large impact. The output presented in Table 5.16 indicates high correlation between project management actions (PM) and project team competency (HR_B) ($\gamma = 0.533$, $p < 0.01$). A strong correlation also exists between organisational factors (OF) and project manager competency (HR_A) at ($\gamma = 0.507$, $p < 0.01$), project team competency (HR_B) at ($\gamma = 0.479$, $p < 0.01$) and project

management actions (PM) at (γ = 0.497, p < 0.01). Another strong correlation exists between organisational success (SC_B) and organisational factors (OF) at (γ = 0.476, p < 0.01).

Moderate correlations were observed between project characteristics (PR) and project efficiency (SC_A) at (γ = 0.300, p < 0.01); organisational success (SC_B) at (γ = 0.334, p < 0.01). Another moderate correlation exists between organisational factors (OF) and (SC_A) at (γ = 0.340, p < 0.01). Project team's competence (HR_B) were found to be moderately correlated with organisational success (SC_B) at (γ = 0.413, p < 0.01). Moderate correlations also exist between project management actions (PM) and organisational success (SC_B) (γ = 0.429, p < 0.01).

Weak correlations were observed between project efficiency (SC_A) and project team's competence (HR_B) (γ = 0.215, p < 0.01), project manager's competence (HR_A) (γ = 0.254, p < 0.01) and project management actions (PM) (γ = 0.250, p < 0.01). Another weak correlation was observed between organisational success (SC_B) and project manager's competence (HR_A) at (γ = 0.283, p < 0.01).

5.8 Multiple Regression Analysis

Multiple regression assesses the constructs that have a significant impact on project success. To examine the relationship amongst the constructs, the output of the structure identified through PCA in Figure 5.11 was used. Thus, considering the theoretical model in Figure 5.11, two regression models were considered for the analyses of the direct effects from the hypothesised model. The first model seeks to determine the relations between the independent variables (project management actions (PM), project characteristics (PR), project manager competence (HR_A), project team competence (HR_B), and organisational factors (OF)) and the dependent variable project efficiency (SC_A). Thereafter, the regression analysis was conducted to determine the relations between the independent variables (project management actions (PM), project characteristics (PR), project manager competence (HR_A), project team competence (HR_B), and organisational factors (OF)) and the dependent variable organisational success (SC_B).

Regression analysis for dependent variable - Project Efficiency (SC_A)

Multiple regression analysis assumes that the residual errors are normally distributed and must be independent of one another (Field, 2009, p. 248). To check for normality of the residual terms, the histogram and normal probability plots were generated. Figure 5.12 indicates the histogram with normal curves for the regression model - project efficiency (SC_A). The output indicates normality of the residuals based on the symmetric bell curve shape that is not skewed and thus centred around the mean (Tabaschnick & Fidell, 2013, p.83). The graph indicates a normal distribution of the residuals and thus meets the assumptions of normality.

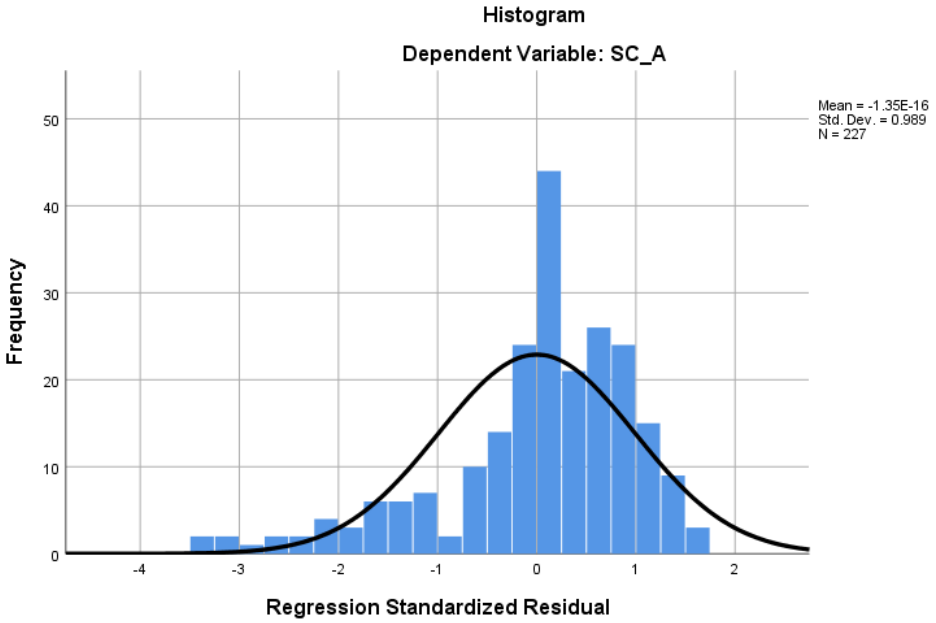

Figure 5.12: Histogram of standardised residuals for SC_A with the normal curve

The normal P-P plot of the residuals for the regression model - project efficiency (SC_A) is shown in Figure 5.13. The plotted residuals are contrasted with the straight diagonal line of the normal distribution. A distribution is considered normal if the residual line corresponds to the diagonal (Hair et al., 2014, p. 78). The residual values follow along the diagonal with minimal departure and the residuals are thus rendered to represent a normal distribution.

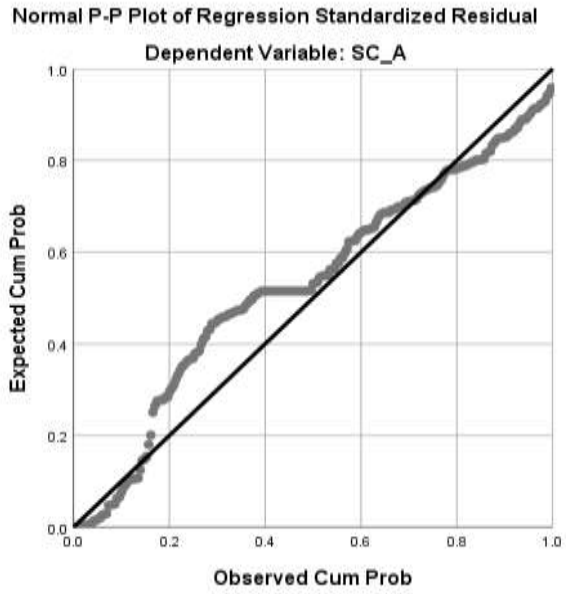

Figure 5.13: Normal P-P plot for the regression residual SC_A

The output of the first regression model assessment led to the model summary shown in Table 5.17. The model shows a multiple correlation coefficient R = 0.392, which implies a strong association between the dependent variables and the predictor of project efficiency (SC_A). The R^2 value of 0.153 implies that 15.3% of the variance of the dependent variable (SC_A) is collectively related to the independent variables (PM, PR, HR_A, HR_B, and OF). The adjusted R^2 value is 0.134, implying that 13.4% is a more conservative model fit for all populations, not just the one represented in the survey of this research study. Thus, there must be other variables that have an influence as well.

Table 5.15: Model summary for the regression model - SC_A

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.392[a]	0.153	0.134	0.75435	2.019
a. Predictors: (Constant), PM, PR, HR_A, HR_B, OF					
b. Dependent Variable: SC_A					

The analysis of variance in Table 5.18 indicates that the combination of constructs project management actions (PM), project characteristics (PR), project manager's competence

(HR_A), project team's competence (HR_B) and organisational factors (OF) were found to be statistically significant, F (5, 221) = 8.002, (p < 0.01).

Table 5.16: ANOVA for the regression model SC_A

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22.768	5	4.554	8.002	.000[b]
	Residual	125.759	221	0.569		
	Total	148.527	226			
a. Dependent Variable: SC_A						
b. Predictors: (Constant), PM, PR, HR_A, HR_B, OF						

The output in Table 5.19 shows the standardized coefficients for the predictor variables. The standardized β coefficient indicates the degree of each construct's contribution to the model. Project characteristics (PR) have a statistically significant effect on project efficiency (β = 0.175, t = 2.464, p-value < 0.05). The relationship between organisational factors (OF) and project efficiency (β = 0.218, t = 2.744, p-value < 0.05) was found to be statistically significant. The relationship between project manager (HR_A) and project efficiency was not statistically significant (β = 0.072, t = 0.943, p-value > 0.05). Furthermore, the relation between project team's competence (HR_B) and project efficiency (β = - 0.14, t = - 0.175, p-value > 0.05) was found to be negative and insignificant. Lastly, the effect of project management actions (PM) on project efficiency was found to be insignificant (β = 0.044, t= 0.555, p-value > 0.05).

Table 5.17: Coefficients of regression model - SC_A

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.325	0.519		2.552	0.011
	PR	0.223	0.090	0.175	2.464	0.015
	OF	0.286	0.104	0.218	2.744	0.007
	HR_A	0.094	0.100	0.072	0.943	0.347
	HR_B	-0.019	0.107	-0.014	-0.175	0.861
	PM	0.077	0.139	0.044	0.555	0.579
a. Dependent Variable: SC_A						

Regression analysis for dependent variable of Organisational Success (SC_B)

The histogram of the residuals in the regression model for dependent variable organisational success (SC_B) is presented in Figure 5.14. The histogram of the residuals was observed to be close to the normal curve and thus displaying acceptable normality.

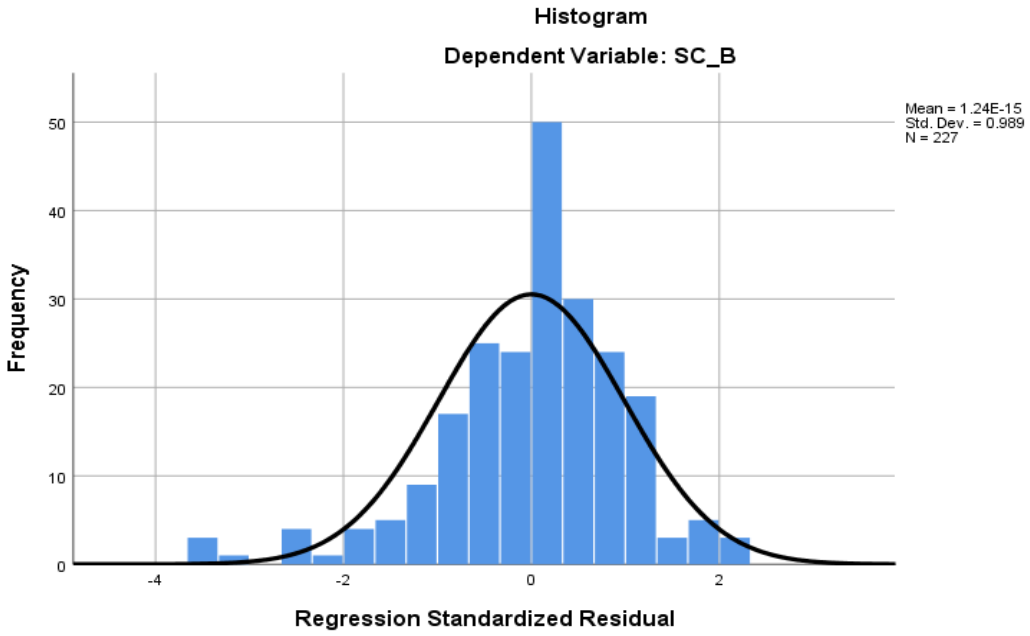

Figure 5.14: Histogram of standardised residuals for SC_B

The P-P plot of the residual for the regression model - SC_B is shown in Figure 5.15. The residuals were found to possess no drastic deviations from normality (Tabaschnick & Fidell, 2013, p.83) and thus satisfying the assumption of normality.

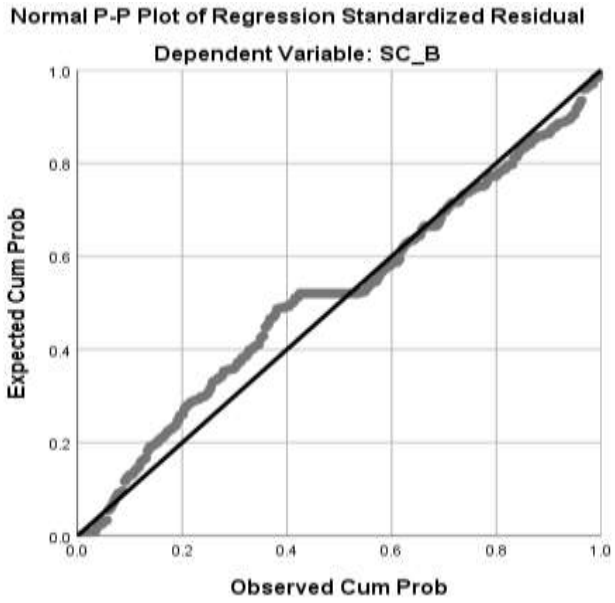

Figure 5.15: Normal P-P plot for the regression residual - SC_B

The output of multiple regression analysis indicated the findings of the model summary in Table 5.20. The model suggests that the predictors of organisational success explained a significant amount of variance with R^2 of 0.303 and adjusted R^2 of 0.287. These results suggest that 28.7% of the variances can be explained by the independent variables (PM, PR, HR_A, HR_B, and OF).

Table 5.18: Model summary for the regression model - SC_B

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.550[a]	0.303	0.287	0.55751	1.950
a. Predictors: (Constant), PM, PR, HR_A, HR_B, OF					
b. Dependent Variable: SC_B					

Table 5.21 shows a statistically significant finding of F (5, 221) = 19.194, ($p < 0.01$), implying that the joint combination of constructs project management actions (PM), project characteristics (PR), project manager (HR_A), project team (HR_B) and organisational factors (OF) was found to be statistically significant.

Table 5.19: ANOVA for the regression model - SC_B

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29.830	5	5.966	19.194	.000[b]
	Residual	68.692	221	0.311		
	Total	98.522	226			
a. Dependent Variable: SC_B						
b. Predictors: (Constant), PM, PR, HR_A, HR_B, OF						

Table 5.22 indicates the output of the regression coefficients. The standardized β indicates how much each construct contributes to the model. The results indicate that the relation between project characteristics (PR) and organisational success (β = 0.097, t = 1.496, p-value > 0.05) is statistically insignificant. The predictor variables suggest that the association between organisational factors (OF) and organisational success (β = 0.299, t = 4.146, p-value < 0.05) is positive and statistically significant. The association between the project manager's competence (HR_A) and organisational success was negative and statistically insignificant (β = - 0.055, t = -0.791, p-value > 0.05).

Table 5.20: Coefficients of the regression model - SC_B

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	0.806	0.384		2.099	0.037
	PR	0.100	0.067	0.097	1.496	0.136
	OF	0.320	0.077	0.299	4.146	0.000
	HR_A	-0.059	0.074	-0.055	-0.791	0.430
	HR_B	0.182	0.079	0.165	2.298	0.022
	PM	0.248	0.102	0.175	2.425	0.016
a. Dependent Variable: SC_B						

The predictor variables indicate a significant connection between the project team's competence (HR_B) and organisational success (β = 0.165, t = 2.298, p-value < 0.05). Lastly, the output reveals a statistically significant correlation between project management actions (PM) and organisational success (β = 0.175, t= 2.425, p-value < 0.05). Organisational factors

have the largest β-value implying that these factors have the highest impact on organisational success.

5.9 Structural Equation Modelling

In this section, an investigation was carried out on whether the conceptual model hypothesised in this research is supported by the data of the study sample (Kline, 2016, p. 9). Attempts were also made to explore relations between the drivers of success and the dimensions of project success. A full SEM model was used using the maximum likelihood estimation method to evaluate the goodness of fit of the conceptual model to the observed data. Thus, considering the conceptual model in Figure 5.11, two SEM models were analysed. The first model tests the association between project efficiency and the critical success factors (project characteristics PR, project management actions PM, project manager's competency HR_A, project team's competency HR_B and organisational factors OF). Conversely, the second model assesses the causal association between organisational success and the critical success factors (project characteristics PR, project management actions PM, project manager's competency HR_A, project team's competency HR_B and organisational factors OF). AMOS version 25 was used to build and analyse the models.

SEM Model 1: Project Efficiency

Figure 5.16 shows a path diagram illustrating the relationship between the latent variables. This model hypothesizes that the dependent variable, project efficiency (SC_A) is influenced by the independent variables project-related factors (PR), project management factors (PM), project team's competence (HR_B), project manager's competence (HR_A) and organisational factors (OF). The single-headed arrows are the causal relations between constructs and the dependent variable (SC_A), while double-headed arrows reflect covariances between the variables (Byrne, 2012, p. 9).

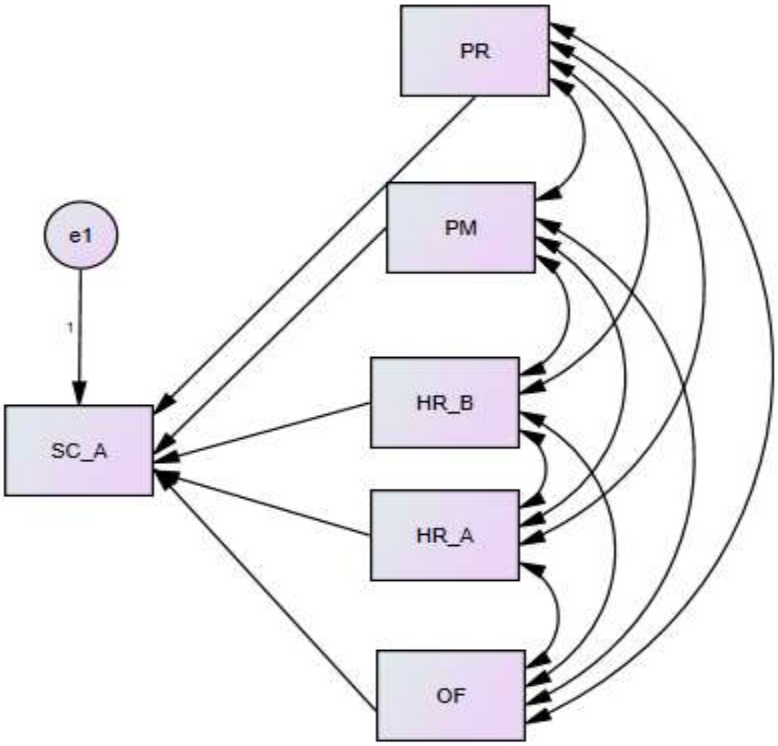

Figure 5.16: Path diagram for project efficiency (SC_A) and the critical success factors

Examining the structural model, the exogenous latent variables in terms of project characteristics (PR), project management actions (PM), project manager's competency (HR_A), the project team's competency (HR_B) and organisational factors (OF) are assumed to be correlated with each other, as indicated by the curved two-headed arrows joining them. These exogenous latent variables are linked to the endogenous latent variable represented by Project Efficiency (SC_A). The unidirectional arrows point to the endogenous variables and shows the direct effects in the model.

Model Fit Indices

The overall model fit was assessed using several fit indices as indicated in Table 5.23. The suitability for the model fit was adopted from Byrne (2011, p. 82), Schumacker and Lomax (2010, p. 76). The fit indices considered in this analysis included the chi-square (CMIN), root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), Comparative Fit Index (CFI), normed fit index (NFI) and the p- of close fit (PCLOSE) and Tucker Lewis Index (TLI). These measures indicate how close the predicted data are with the actual data.

Table 5.21: Model fit indices - model SC_A

Name of Index	Acceptance level	Model Output	Interpretation
Chi square	< 0.05	0.000	acceptable
RMSEA	0.5 - 0.8	0.443	poor model fit
GFI	0 (no fit) - 1 (perfect fit)	1.000	very good
CFI	0 (no fit) - 1 (perfect fit)	1.000	very good
TLI	0 (no fit) - 1 (perfect fit)	0.000	acceptable
NFI	0 (no fit) - 1 (perfect fit)	1.000	very good
PCLOSE	< 0.05	0.000	acceptable

Table 5.23 shows that the sample data fit the model. The results from the chi-square index did not indicate that the model is consistent with the data. It has been noted that the probability level has to be significant ($p < 0.05$). However, the chi-square alone cannot be used to validate the model as it is dependent on the sample size. It has been recognised that the chi-square depends on the degrees of freedom correlated with sample size (Wang & Wang, 2012, p. 18). Additionally, more tests were considered to confirm this outcome using goodness-of-fit indices (Schreiber et al., 2006, p. 326). The RMSEA = 0.443 showed a poor fit model; however, the other fitness indices for the model seem to indicate good fit of between the model and the data.

Parameter Estimates

The SEM diagram with the corresponding parameter estimates is shown in Figure 5.17.

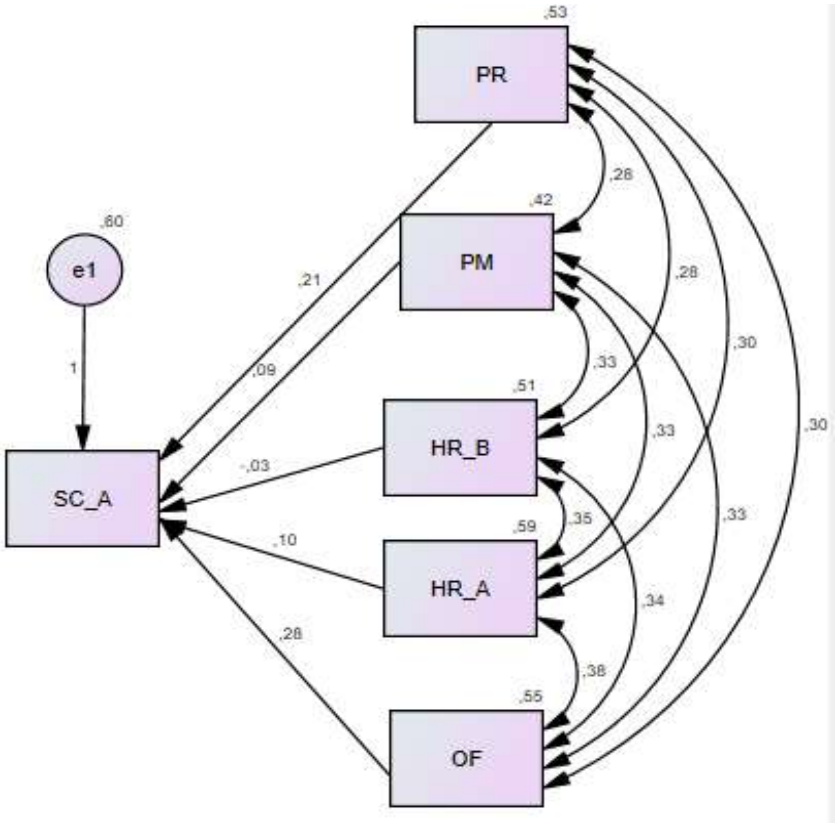

Figure 5.17: SEM model for SC_A with regression coefficients

Hypotheses Testing

To assess whether the hypotheses are supported, the parameter estimates and the p-values were considered. The ($p < 0.05$) was used as the criterion to determine the degree of significance. The results of standardized regression weights for model SC_A are presented in Table 5.24.

Table 5.22: Standardised regression estimates for project efficiency (SC_A)

Hypothesis				Estimate	S.E.	C.R.	*p*	Conclusion
H1	SC_A	<---	PR	0.205	0.093	2.203	0.028	Supported
H3	SC_A	<---	OF	0.281	0.106	2.643	0.008	Supported
H5	SC_A	<---	PM	0.09	0.13	0.69	0.49	Rejected
H7	SC_A	<---	HR_A	0.097	0.101	0.961	0.336	Rejected
H9	SC_A	<---	HR_B	-0.029	0.11	-0.265	0.791	Rejected

These results indicates that H1 is supported (β = 0.205, p-value < 0.05). The results imply that project characteristics (PR) positively influence project efficiency. H3 is also supported (β = 0.281, p-value < 0.05), and this implies that organisational factor (OF) positively influences project efficiency. H5 is not supported (β = 0.09, p -value > 0.05). H7 is also not supported (β = 0.097, p-value > 0.05). The results also indicate that H9 (β = - 0.029, p-value > 0.05) is not supported.

Table 5.25 shows the bi-directional correlations between constructs. The causal relationships of all the constructs were found to be significant with (p-value < 0.05). None of the correlations were above 0.8, indicating that all constructs were well correlated.

Table 5.23: Covariances (group number 1 - default model)

			Estimate	S.E.	C.R.	P
PR	<-->	HR_A	0.297	0.042	7.064	***
HR_A	<-->	OF	0.385	0.046	8.391	***
PM	<-->	HR_A	0.332	0.04	8.31	***
HR_B	<-->	HR_A	0.354	0.043	8.141	***
PR	<-->	OF	0.304	0.041	7.374	***
PM	<-->	PR	0.282	0.037	7.724	***
PR	<-->	HR_B	0.281	0.039	7.174	***
PM	<-->	OF	0.327	0.039	8.424	***
HR_B	<-->	OF	0.339	0.042	8.083	***
PM	<-->	HR_B	0.327	0.038	8.657	***

SEM Model 2: Organisational Success

The path diagram describes the hypothesized relationships among the latent constructs. The path model depicted in Figure 5.18 assesses the causal effects of the independent variables (project-related factors (PR), project management factors (PM), project team's competence (HR_B), project manager's competence (HR_A) and organisational factors (OF)) on organisational success (SC_B).

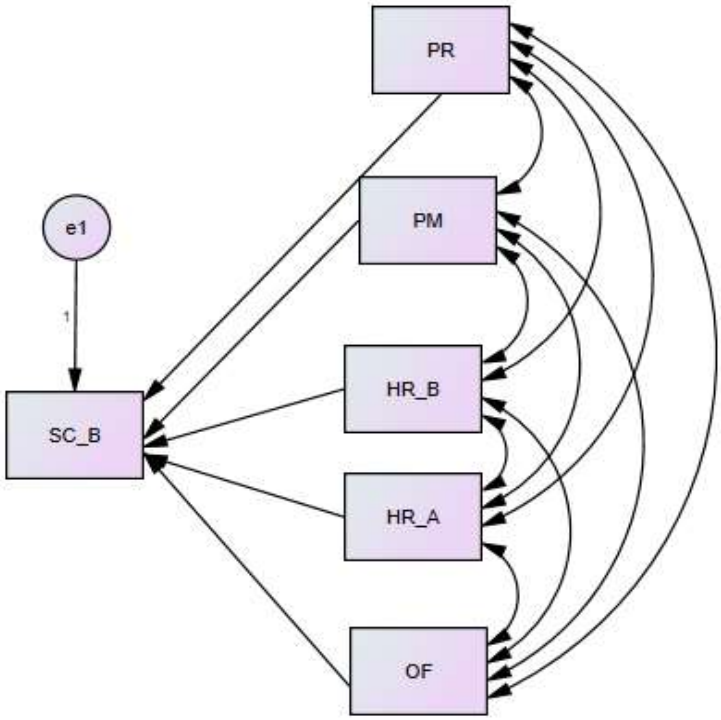

Figure 5.18: Path diagram for organisational success (SC_B) and the critical success factors

Figure 5.18 indicates that the exogenous variables (project characteristics (PR), project management actions (PM), project manager (HR_A), the project team (HR_B) and organisational factors (OF)) are assumed to have a direct influence on the endogenous variable organisational success (SC_B).

Model Fit Indices

The chi-square test results shown in Table 5.26 has rejected the null-hypothesis of a model fit. According to Schreiber et al. (2006, p. 326), further tests should be applied to the model using goodness-of-fit indices. The value of the RMSEA = 0.468 showed a poor model fit; however, the values of the other model fit measures seem to have achieved the desired level of fit.

Table 5.24: Model fit indices - model SC_B

Name of Index	Acceptance level	Model Output	Interpretation
Chi square	< 0.05	0.000	acceptable
RMSEA	0.5 - 0.8	0.468	poor model fit
GFI	0 (no fit) - 1 (perfect fit)	1.000	very good
CFI	0 (no fit) - 1 (perfect fit)	1.000	very good
TLI	0 (no fit) - 1 (perfect fit)	0.000	acceptable
NFI	0 (no fit) - 1 (perfect fit)	1.000	very good
PCLOSE	< 0.05	0.000	acceptable

Parameter Estimates

The parameter estimates for the model are presented in Figure 5.19.

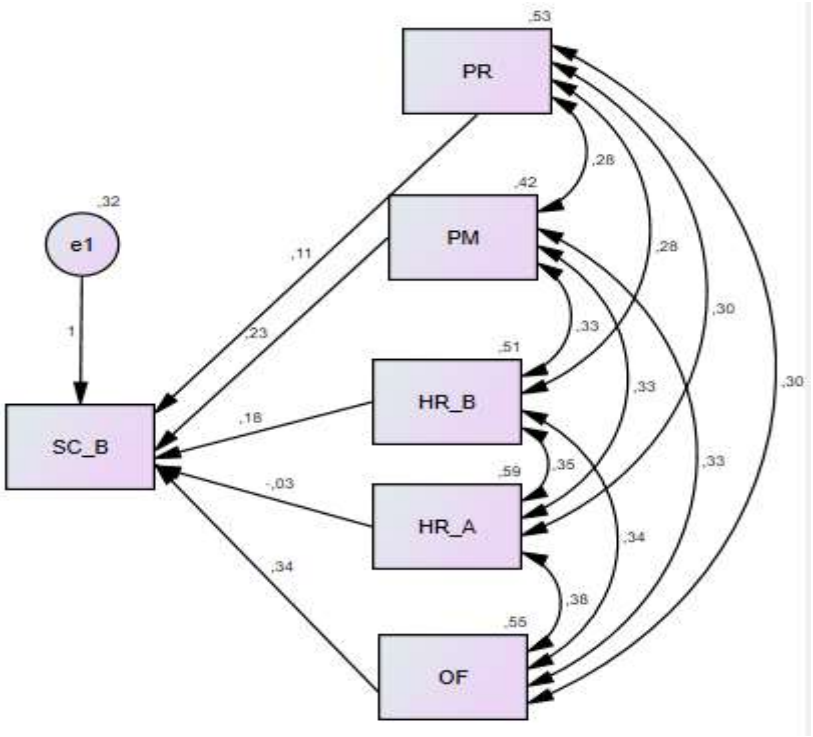

Figure 5.19: SEM model for SC_B with regression coefficients

Hypothesis Testing

The output of the parameter estimates were considered for the analysis of the hypotheses. To determine the degree of significance, the p-values were also used as a criteria to establish how the parameters were statistically significant with ($p < 0.05$). The results of the standardized regression weights for model SC_B are presented in Table 5.27.

Table 5.25: Standardised regression estimates for organisational success (SC_B)

Hypothesis				Estimate	S.E.	C.R.	*p*	Conclusion
H2	SC_B	<---	PR	0.107	0.068	1.567	0.117	Rejected
H4	SC_B	<---	OF	0.338	0.078	4.349	***	Supported
H6	SC_B	<---	PM	0.226	0.095	2.38	0.017	Supported
H8	SC_B	<---	HR_A	-0.035	0.074	-0.473	0.636	Rejected
H10	SC_B	<---	HR_B	0.181	0.081	2.25	0.024	Supported

The results indicate that H2 is rejected ($\beta = 0.107$, p-value > 0.05). This implies that project characteristics (PR) does not show a significant impact on organisational success. The results indicate that H4 is supported ($\beta = 0.338$, p-value < 0.05), which suggests that organisational factors (OF) have a significant influence on organisational success. H6 is also supported ($\beta = 0.226$, p-value > 0.05). The results indicate that project management actions (PM) positively influences organisational success. The results also indicate that H8 is not supported ($\beta = - 0.035$, p-value > 0.05). H10 is also supported ($\beta = 0.181$, p-value < 0.05). Thus, the following factors do not affect organisational success: project characteristics (PR) and project manager's competence (HR_A).

The bi-directional correlations between constructs are shown in Table 5.28. The causal relationships of all the constructs were found to be significant with (p-value < 0.05) and positive. None of the correlations are above 0.8, indicating that all constructs were well correlated. The correlations fit the model.

Table 5.26: Covariances (group number 1 - default model)

			Estimate	S.E.	C.R.	P
PR	<-->	HR_A	0.297	0.042	7.064	***
HR_A	<-->	OF	0.385	0.046	8.391	***
PM	<-->	HR_A	0.332	0.04	8.31	***
HR_B	<-->	HR_A	0.354	0.043	8.141	***
PR	<-->	OF	0.304	0.041	7.374	***
PM	<-->	PR	0.282	0.037	7.724	***
PR	<-->	HR_B	0.281	0.039	7.174	***
PM	<-->	OF	0.327	0.039	8.424	***
HR_B	<-->	OF	0.339	0.042	8.083	***
PM	<-->	HR_B	0.327	0.038	8.657	***

5.10 Summary

The results of the data analysis were presented in this chapter. The results showed the profiles of the respondents of the survey and the characteristics of their projects. Cases with missed values, outliers, normality and multi-collinearity were handled through the screening of data and the cleaning processes. The data was also assessed for the suitability of multivariate analysis. Descriptive statistics were used to understand the responses from the survey using measures of standard deviation and mean scores. The Cronbach's alpha index was considered for the measurement instrument's internal consistency. Principal components using varimax rotation was employed to analyse the structure of the underlying variables and to reduce the variables into meaningful components. Bivariate correlation was used to indicate how the constructs correlated with one another and to confirm issues of multicollinearity. Multiple regressions and SEM were used to understand the hypothesised relationships of the factors in the conceptual model. The next chapter is a discussion of the results.

CHAPTER 6

DISCUSSION OF FINDINGS AND CONCLUSIONS

6.1 Introduction

In this chapter, the main findings from the data analysis are discussed. Firstly, the objectives that this study sought to achieve are discussed. Thereafter, the results from the data analysis are summarised and recommendations are made on how the success of shutdown projects can be improved based on the research findings. The chapter concludes by highlighting the limitations encountered in this research and suggests areas for further research.

6.2 Overview of the Research Objectives

The focus of this research was to analyse the relation between the drivers of success and the dimensions of success in shutdown projects. The following objectives were formulated for this research study:

- Determine how a successful shutdown project is viewed by defining the criteria used to evaluate the project outcome;
- Define the critical factors which have an impact on shutdown project success;
- Develop a conceptual model analysing the interaction between the project outcome and project success factors.

To meet these study objectives, an analysis of literature was undertaken. The analysis resulted in the identification of a set of success indicators and critical success variables for shutdown projects. Based on the findings of the literature review, a conceptual model was proposed, which hypothesized the connection between project success and the critical success factors of shutdown projects.

6.3 Discussions of the Findings

Research Objective 1: The Success Criteria for Shutdown Projects

The motivation behind this research was that shutdown projects are often delayed or delivered with cost overrun. To improve poor performance in shutdown projects, this study argued that the criteria used to measure a successful shutdown project must be clarified. The review of literature revealed that the traditional criterion of cost, time and performance requirements was limited and that the criterion provides a limited view of project success. It was also noted that the characterisation of project success varies according to different perspectives of the stakeholders, the different objectives for initiating projects, the type and context of the project. It was also discovered that a comprehensive measure of project success in shutdown projects has not been thoroughly discussed. Hence, this study attempted to determine a comprehensive set of indicators used to define shutdown project success based on the perceptions of those involved in these projects in South Africa.

A conceptual model was presented for measuring shutdown projects based on the three dimensions of success: *project efficiency, impact to the customer, business and organisational benefits* proposed by Shenhar et al. (2001, p. 701). Using the constructs and the variables in the conceptual model, a questionnaire survey was conducted to understand the importance of the indicators used to measure success from the views of the respondents.

To address RSQ1 of this research: *How is the concept of project success in shutdown projects defined and measured?* The results of this research indicated that success in shutdown projects is a multi-dimensional construct based on the dimensions of project efficiency and organisational success. These findings are consistent with prior research (Obiajunwa, 2012, p. 380; Alashwal et al., 2017, p. 73; Ahadzie et al., 2008, p. 684) and confirm that the maintenance efficiency and effectiveness are essential to the organisation (Parida et al., 2015, p. 6). Project efficiency accounted for 8.128% of the total variance while organisational success for 4.415 % of the variance. Thus, project efficiency was found to be the more significant criteria when compared with organisational success. The results also confirm the findings by Shenhar et al. (1999, p. 917), Ahadzie et al. (2008, p. 684), and Al-Tmeemy et al. (2011, p. 346), which advance that project efficiency is a critical construct in project success. The efficient delivery of a shutdown project is always the primary objective

of the project team. However, the main purpose of initiating a shutdown maintenance project is to improve the long-term benefits of reliability and availability of the plant. Thus, delivering the project according to the measures of time, cost, quality and safety incidences is not a sufficient measure of shutdown performance. The results generated from this research study also suggest that, not only are project teams concerned about delivering the project according to the conventional measures of project success, they are also concerned about whether the project adds value and that the stakeholders are also satisfied with the project outcome. Using principal component analysis, the success dimensions were defined by the following components: project efficiency and organisational success.

Component: Project Efficiency

This component consists of four variables, which have the following factor loadings: budget (80%), time (79.1%), safety, health and environmental incidences (77.6%), commissioning incidences (78.8%). The variables in this component explain the efficiency of project execution and ensures that the project is implemented according to specifications. The results are consistent with the previous findings reported by Obiajunwa (2012, p. 380), which advanced that the efficient delivery of a shutdown is measured by the cost, time, safety, health and environmental incidences and commissioning incidences. However, due to the uncertainties surrounding the loosely defined scope, it is often a problem for the project teams to achieve these objectives. Yet the scope is not considered as a measure of shutdown performance. The factor loadings indicate the cost and time as the most significant within the measure of project efficiency. Shutdown projects are costly events and concluding the project within budget and time is essential. Thus, to overcome the challenge of cost overruns and delays, efforts must be directed towards the strict monitoring of the progress of the project so that it meets these performance objectives.

Safety, health and environmental incidences are also an essential measure of project efficiency. According to Parida and Kumar (2006, p. 242), it is essential to understand the contribution of maintenance towards health, safety and environmental issues so that a safe working environment can be provided. Safety, health and environmental incidences must be adhered to due to the catastrophic consequences that might occur during the shutdown project. Whilst quality was part of the questionnaire item, the

results indicated that quality in a shutdown project is defined by the number of incidences during plant commissioning. This supports the views of Obiajunwa (2012, p. 381). The amount of additional, unplanned or emergent work was also found to be an insignificant measure of shutdown project success.

Component: Organisational Success

This component is associated with the following attributes: customer satisfaction (79%), strategic objectives of the project (78.2%), profitability (65%). These findings also strengthen the views presented in earlier works (Duffuaa & Ben-Daya, 2004, p. 184) asserting that corporate performance may be measured by customer satisfaction and profitability. In contrast, Sahoo (2014, p. 28) states that the criteria for customer satisfaction in shutdown projects are cost, schedule and quality. In this research study, customer satisfaction emerged as the most critical factor in this cluster. The customers in shutdown projects are the plant operators who are concerned with the functional aspects of the plant such as improved availability, reliability and safe operation of the plant (Obiajunwa, 2012, p. 382). However, the reliability and the availability of equipment can be realised over time, making this a long-term measure of success. It is also worth noting that after the plant is handed over to the plant operators, new measures to monitor the daily plant performance take effect; however, it is unclear if the outcome of these daily performance measures are linked to the shutdown project outcome. Profitability is also an essential criterion in organisational success. According to Lenahan (1999, p. 3), Duffua and Ben-Daya (2004, p. 184), the efficient conclusion of the project contributes to the profitability of the organisation and to its competitive advantage.

Thus, this research defines a successful shutdown project as one that been completed on time, within budget, within the health safety and environmental specification, with no commissioning incidences, that meets the needs of all stakeholders and contributes to the profitability of the organisation.

Research Objective 2: The Critical Success Factors for Shutdown Projects

This research also resolved that the critical success factors must be identified to improve the likelihood of success in shutdown projects. Thus, the second objective in this study was to evaluate the variables that have a significant impact on shutdown project success. It is argued in this research study that although sets of success factors have been identified in previous research, these factors have not been categorised according to their underlying dimensions. Thus, a comprehensive set of variables were identified from literature and incorporated in the conceptual model of this research study. The conceptual model hypothesised that shutdown project success is influenced by the following groups of factors: *organisational, project-related, human-related and project management factors*. In the questionnaire survey, the respondents were requested to indicate their level of agreement that the success variables were essential for the success of their projects.

To address the RSQ2: *Which success factors influence the success of shutdown projects?* The mean item scores were used to prioritise the importance of the success variables based on the responses received from the survey. The scoring of the success factors ranged between (M = 3.493) and (M = 4.625). This implies that the success variables were viewed as essential for shutdown projects. All items having a mean score of 4 and above were considered critical success factors. Out of the identified critical success factors, the results revealed that top management support (M = 4.525) was the highest-scoring factor under organisational factors, the project size and complexity (M = 4.192) was the top-scoring factor under project-related factors, roles and responsibilities (M = 4.584) and project manager competence (M = 4.520) were the highest scoring items under human-related factors, the shutdown report and lessons learned (M = 4.625) was the top-scoring items under project management factors.

The underlying dimensions of critical success factors

The critical success factors were further prioritised using principal component analysis. The analysis identified five components of critical success factors with their factor loadings: *project management actions* (30.746%), *organisational factors* (5.955%), *project manager's competence* (5.195%), *project team's competence* (5.090%) and lastly *project characteristics* (3.746%).

Component: Project Management Actions

The most critical success variables related to shutdown project success are those related to project management actions. This construct has been identified by Alias et al. (2014, p. 65) and Chan et al. (2004, p. 154) as being necessary for project success. However, given the unique features of the respective shutdown projects, the project management methods are not common and thus the variables explaining this component are not the same as those contained in these studies. Project management actions were defined by risk identification (70.5%), lessons learned (66.3%), effective monitoring (65.6%), site and contractor management (0.639), risk-based inspection (63.6%), safety management (62.1%) and project integration (57.9%).

The importance of risk management was highlighted by Hlophe and Visser (2018, p. 82) as one of the critical factors in shutdown project success. In that study, it was recommended that a supportive organisational culture, top management support, lessons learned from experience and risk management training could improve the success of shutdown projects. This observation corroborates the findings of this research study. For a shutdown project to be a success, the assessment of risk in shutdown projects is necessary so that any uncertainties that will prevent the project manager from attaining the project goals are anticipated and minimised by the project participants (Sahoo, 2014, p. 181). The lessons learned must be documented so that the history of the performance of shutdown projects are recorded, that the same errors are not duplicated, knowledge is gained across projects and the document is used as a tool to improve the next shutdown event (Oliver, 2001, p. 5). The overall perfomance of the project team and contractors relies on proper site management and supervision. Thus, monitoring of every minor detail against the actual progress is essential. A project monitoring mechanism must be used for managing the development of the project against the objectives of safety, quality, schedule, risk, budget and resources so that they are better controlled (Ghanbaripour et al., 2018, p. 9). Thus, project managers need to focus their attention on having a comprehensive safety programme, the efficient management of contractors and ensuring that a review of readiness is done prior to project execution.

Component: Organisational Factors

The second component of critical success factors that are essential for shutdown project success are those that are related to the characteristics of the organisation. The factors under this component were found to be organisational structure (78.3%), top management support (70.1%), organisational culture (68.2%) and maintenance strategy (61.8%). These results are consistent with those of Maqbool (2018, p. 952) and Sudhakar (2013, p. 294).

Top management support has been dentified as a critical success factor in many other studies (Belout & Gauvreau, 2004, p. 9; Gunduz & Yahya, 2015, p. 74; Iyer & Jha, 2006, p. 877; Sudhakar, 2013, p. 294). The support from top management is crucial in shutdown projects because they are responsible for appointing a competent project manager, formulating a shutdown strategy, providing direction and guidance during project implementation, providing funding for the project and ensuring that the project is in line with the strategic objectives (Oliver 2001, p. 3; Lenahan, 2011, p. 56). Thus, for a shutdown project to be a success, top management support is crucial in making all strategic decisions and ensuring the project participants are able to achieve all dimensions of success in a project. Top management must ensure that people behave and make decisions based on what needs to be achieved to make the project successful, and this culture is achieved through constant training and improving of staff morale. The shutdown maintenance structure must be formulated in such a way that it enables clear lines of communication, clear roles and responsibilities, provides support to all maintenance activities and the project team.

Component: Project Manager's Competence

The third component of critical success factors involves the competency of the project manager. A competent project manager is defined by the following attributes: leadership style (79.2%), experience (76.5%) and competence (76.2%). These findings are in agreement with those of Yong and Mustaffa (2013, p. 966) and Sinesilassie et al. (2018, p. 112). The project manager's competency and the leadership style are essential for driving the project to success and for supporting, empowering and motivating the project team. Thus, top management must ensure that a project manager with strong

leadership skills, experience in managing large shutdown projects and who is competent in both managerial and technical aspects of the project is appointed.

Component: Project Team's Competence

The project team's competence was the fourth component of the critical success factors in shutdown projects. These findings are consistent with other previously reported research findings (Belout & Gauvreau, 2004, p. 9; Hwang & Lim, 2013, p. 212; Iyer & Jha, 2006, p. 291). The attributes under this component are: training and development (74.1%), skills (70.3%), team alignment with strategic goals (65.1%), conflict resolution (59.9%), and motivation within a team (57.2%). The project team consists of individuals from different disciplines. The top management must evaluate the skills needed to achieve a successful shutdown project and must provide resources for the training of the shutdown team in order to close the skills shortage gap. Team motivation is essential especially since the shutdown event involves working long hours and requires hard labour. According to Hwang and Lim (2013, p. 212), incentives enhance motivation within the team and motivation promotes the commitment of the project team. In Iyer and Jha (2006, p. 291), the dispute among project participants was highlighted as one of the reasons for project failure and it was thus suggested that top management must decide avenues to avoid conflict.

Component: Project Characteristics

The last component of critical success factors was attributed to the variables that define the characteristics of the project. The factors under this component were found to be the size and complexity of the project (74.9%), project frequency (72.7%), project duration (65.7%), and lead time the project was initiated (59.0%). Shutdown projects are known to be complex, and larger projects pose a higher risk of uncertainty. Thus, project managers need to be experienced to manage large shutdown projects. An unrealistic duration affects the outcome of the project, especially when there is a higher workload. Thus, the success of a shutdown project requires careful project definition and management of the work scope.

Research Objective 3: Examine the relationship between project success and the success factors

The literature review has indicated that although sets of success factors have been identified in shutdown projects, the extent to which these factors influence success has not been addressed. A conceptual model was developed and from that model, the hypotheses were formulated to evaluate the effect of the five components of critical success factors (i.e. *project management actions (PM), organisational factors (OF), project characteristic (PR), project team's competency (HR_B),* and *project manager's competency (HR_A)*) on shutdown project success.

To answer the MRQ: *To what extent do the critical success factors influence shutdown project success?* This research used SEM analysis to examine the relationship that was hypothesised to exist between the critical success factors and project success. The results of the SEM indicated the following relationships:

Project Characteristics and Project Success

Hypothesis 1 *tested the relationship between project characteristics and project efficiency:* The results suggested a moderate correlation between the project characteristics and project efficiency. The hypothesis H1 (p-value = 0.028) was also found to be significant, implying an existence of a relationship between project characteristics and project efficiency. These results were also confirmed through multiple regression analysis. The beta value between these two constructs was found to be (0.205), illustrating that one-unit change in project characteristics factors can bring 20.5% change in project success.

Hypothesis 2 *tested the relationship between project characteristics and organisational success:* The correlation analysis also indicated a moderate correlation between the two constructs. The hypothesis H2 (p-value = 0.117) was not supported, implying that project characteristics have an insignificant effect on organisational success. The results from the multiple regression analysis confirmed an insignificant relation between organisational success and project characteristics.

Organisational Factors and Project Success

Hypothesis 3 *tested the relationship between organisational factors and project efficiency:* A moderate correlation was observed between organisational factors and project efficiency. The hypothesis H3 (p-value = 0.008) was significant, which confirms a positive and significant relationship between organisational factors and project efficiency. The multiple regression analysis confirmed a significant impact of organisational factors on project efficiency. The beta value between these two constructs (0.281) confirms the significance of organisational factors and also implies that one-unit change in organisational factors can bring 28.1% change in overall project success.

Hypothesis 4 *tested the relationship between organisational factors and organisational success:* A moderate correlation was found between organisational factors and organisational success. The hypothesis H4 (p-value = 0.000) was also supported. The multiple regression analysis confirmed a significant relationship between organisational success and organisational factors. The significant relation between organisational factors and organisational success was also confirmed by the beta value (0.338). This implies that one-unit change in organisational factors can bring 33.8% change in overall project success. These results are in agreement with those of Maqbool and Sudong (2018, p. 997).

Project Management Actions and Project Success

Hypothesis 5 *tested the relationship between project management actions and project efficiency:* A weak correlation was observed between project management actions and project efficiency. The results of the path analysis showed that the hypothesis H5 (p-value = 0.49) was rejected, which implied that there was no significant relationship found between project management actions and project efficiency.

Hypothesis 6 *tested the relationship between project management actions and organisational success:* A moderate correlation was observed between project management actions and organisational success. The regression analysis indicated a

significant relationship between project management actions and organisational success. The hypothesis H6 (p-value = 0.017) was found to be significant, which confirms a strong relation between project management actions and project efficiency. At 0.226, the beta value between these two variables demonstrates that one-unit change in project management actions can bring 22.6% change in organisational success. These results imply that the project management characteristics have a significant impact on organisational success.

Project Manager's Competence and Project Success

Hypothesis 7 *tested the relationship between project manager's competency and project efficiency:* The correlation analysis indicated a weak correlation between the project manager's competency and project efficiency. The hypothesis H7 (p-value = 0.336) failed to show any significant relationship between project manager's competence and project efficiency. This was also confirmed by the results of the regression analysis.

Hypothesis 8 *tested the relationship between project manager's competency and organisational success:* The correlation analysis suggested a weak correlation between the project manager's competence and organisational success. The hypothesis H8 (p-value = 0.636) was found to be insignificant, which implied that there existed no relation between project manager's competence and organisational success. The results of the regression analysis indicated that the relation between the two constructs was insignificant.

Project Team's Competence and Project Success

Hypothesis 9 *tested the relationship between project team's competency and project efficiency:* Project team's competency and project efficiency were weakly correlated to one another. The hypothesis H9 (p-value = 0.791) was rejected, which implies an insignificant association between project team's competence and project efficiency. The same findings were drawn from the multiple regression analysis.

Hypothesis 10 *tested the relationship between project team's competency and organisational success:* A moderate correlation was observed between project management actions and organisational success. The hypothesis H10 (p-value = 0.024) was significant, which confirms a strong relationship between project team's competence and organisational success. The regression analysis indicates a significant relationship between the two constructs. The beta value between these two variables of 0.181 demonstrates that one-unit change in technical factors can bring 18.1% change in organisational success. These results also imply that the competence of the project team has a significant impact on organisational success.

The analysis of the hypotheses indicated that organisational factors have a significant correlation with the overall success of shutdown project. Project managers' competency was found to be statistically insignificant for the overall success of the shutdown projects. Whereas, the project characteristics were found to be significant to the project efficiency dimension, project management actions and project team competency was significant to the organisational success dimension.

6.4 Implications of the Study

The contribution of this research study is as follows:

6.4.1 Theoretical Implications

This is one of the few empirical studies that focuses on the success of shutdown projects. It addresses the need for more empirically based evidence in shutdown project management research (Ghazali et al., 2009). Structural equation modelling has been widely used in project management research and this approach has been used to address topics related to the success in construction and software projects. However, the current study is the first to address the use of the structural equation modelling approach to study shutdown projects.

The success criteria of shutdown projects reported in previous studies suggests that most of the authors tend to focus on the project objectives when evaluating the outcome of their projects. The findings of this research study are of significance in that they contribute to the

current understanding of the performance of shutdown projects and further supports the views of Obiajunwa (2012, p. 368) that no single dimension of success can provide a true reflection of the project outcome. Thus, a more holistic multi-dimensional approach was taken to evaluate the success of shutdown projects.

The literature review also indicated the need for considering the key variables of success to improve on project success. However, the research on shutdown projects is not exhaustive beyond the identification of the factors that influence shutdown projects and fails to consider the dimensions of the success factors in improving project success. Thus, this research study identified the following categories of critical success factors: *project management actions, project team's competence, project manager's competence, project characteristics* and *organisational factors*. These results corroborates with the current understanding of the critical success factors whereby the underlying structure of the critical success factors was examined for enhanced project performance.

This study is the first to explore the association between the critical success factors and project success in shutdown projects. The study developed a conceptual model that hypothesised how the critical success factors influenced the different dimensions of shutdown project success. In addition, the study indicated the significance of organisational factors in the success of shutdown projects. These findings contribute to the current understanding of shutdown project management.

6.4.2 Practical Implications

It has become an acceptable norm that shutdown projects are delivered with cost overruns and/or delays. Drawing from existing literature, this study has highlighted that some of the challenges in implementing shutdown projects include ineffective communication, shortage of critical skills, unavailability of spares, poor management of the work scope and an increase in health, safety and environmental incidences. These findings can assist project managers to focus on the factors that will help overcome these challenges and thus improve the probability of success of shutdown projects.

This study has highlighted that to measure the performance of shutdown projects, project efficiency and organisational success dimensions must be equally considered as indicators for the evaluation of shutdown project success. The project managers can use this as a guideline for evaluating the outcome of their projects and to ensure that all project participant have a clear understanding of the objectives that must be met for achieving project success. This measure of shutdown project success suggests that project managers must not only focus on achieving the project objectives but must also ensure that the project adds value and contributes to the profitability of the organisation. To this end, all project participants are expected to be in alignment with these strategic objectives.

The variables that contribute to the outcome of shutdown projects were examined. By identifying the essential factors in shutdown projects, an in-depth understanding of the factors that organisations can use in order to increase the probability of success in their projects was provided. The findings of this research suggest that the support from top management, the organisational culture, the organisational structure and maintenance strategy are key factors that have a significant influence on the success of shutdown projects. These results can serve as a guide for top management to make strategic decisions that will further improve the outcome of their shutdown projects. It is envisaged that the results generated in this research would assist project managers to implement and improve their processes to enhance shutdown project success and would also be incorporated as part of best practices in the implementation of shutdown projects.

6.5 Research Limitations

This research study has several limitations. The focus of this enquiry was limited to a sample population in South Africa, the results of which can be generalised as a reflection of the success of shutdown projects in South Africa. The study may therefore serve as a reference for research in shutdown project success in other countries.

The study sample had a good representation of the project team members and project managers, it was not possible obtain an adequate sample of executive members and contractors. Furthermore, the plant operators were not included in this study. A comparative study should be undertaken to understand the different views of the stakeholders of shutdown

projects, particularly that of contractors and plant operators as they form an important component of shutdown projects.

Not enough literature was found on the success of shutdown projects. The success factors identified in this research were derived from studies that were not empirically based. However, the effect of this limitation was reduced by incorporating previous literature from studies of other disciplines to develop the conceptual model.

The respondents were requested to consider one previous shutdown project when answering the questions of the questionnaire. The survey did not consider historical data of the performance of shutdown projects that resulted in the loss of production. Further work is needed to increase the variables or indicators of shutdown project success by considering the performance of shutdown projects over the previous years.

The open-ended questions of the survey were designed to identify new critical success factors that were not included on the questionnaire, and that the respondent thought were essential to the success of their shutdown projects. The respondents of the survey did not indicate any other critical success factors other than those that were identified in this research study.

The results of the multiple regression models indicated the R^2 values of 0.153 for model A (explaining project efficiency) and 0.303 for model B (organisational success). These results suggest that the total variance explained by the success factors was 15.3% and 30.3% of project success. Implying that there are many other critical success factors for shutdown project success that were not considered in this study. Thus, further research is needed to identify an exhaustive set of success variables in shutdown projects that are focussed on other dimensions of success factors such as external and environmental factors.

6.6 Future Research

The findings of this study are based on the collective view of respondents that are involved in shutdown projects across different industries. The industries have different stakeholders, processes and project characteristics. There is a need for further research work to be undertaken with the view to compare and differentiate the success factors according to the

different industries. A comparison or analysis of the views of different stakeholders on the success criteria and success factors in shutdown projects is also required. Efficacy must also be established while implementing findings based on an organizational character in order to isolate the factors which influence a particular industry.

Some of the success factors were not considered in this research based on the limitation of the literature review. It would be of benefit to conduct a longitudinal study that will first consider the views of specific individuals through an interview, and thereafter explore the importance of the success factors using the survey questionnaire.

This research has only evaluated direct effects of the success factors on shutdown projects. Opportunities abound for the investigation of the effect of moderating and mediating factors on shutdown project success. This study used structural equation modelling to understand the significance of the critical success factors to shutdown project success; further research can also be carried out using machine learning methods.

6.7 Conclusion

In this research study, it was demonstrated that shutdown project success is a multi-dimensional construct that is based on the achievement of project efficiency and organisational success. Furthermore, it was revealed that the success of shutdown project is influenced by project characteristics, project management actions, project manager's competency, project team's competency and organisational factors. The study developed a conceptual model that examines the extent to which these factors have an impact on project success. The structural equation modelling analysis indicated that the project success is significantly influenced by organisational factors. This implies that the strategic role and responsibilities of top management is crucial for the success of shutdown projects. The characteristics of a shutdown project has significant influence on achieving the project efficiency dimension of success. This study has demonstrated the importance of project management actions and the competency of the team as essential elements for improving the long-term goal of organisational success.

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APPENDICES

Appendix A: Cover Letter

Dear Participant,

You are invited to participate in a survey conducted by Ms F Masubelele under the supervision of Prof E Mnkandla, a Professor in the Department of Computer Science towards a Doctor of Philosophy qualification at the University of South Africa.

The survey you have received has been designed to examine the criteria with which the outcome of shutdown turnaround and outage projects are evaluated and further identify the most critical factors that influence the success of these projects. You were selected to participate in this survey because of your knowledge and your involvement in shutdown, turnaround and outage projects. By completing this survey, you agree that the information you provide may be used for research purposes, including dissemination through peer-reviewed publications and conference proceedings.

It is anticipated that the information gained from this survey will help determine the criteria used to define and assess the success of shutdown, turnaround and outage projects; and will provide insights on those factors that project managers should focus on to ensure a successful outcome of their project. You are, however, under no obligation to complete the survey and you can withdraw from the study prior to submitting the survey. The survey is developed to be anonymous, meaning that we will have no way of connecting the information that you provide to you personally. Consequently, you will not be able to withdraw from the study once you have clicked the send button based on the anonymous nature of the survey. Any identifying information that is obtained in connection with this survey will remain confidential and will be disclosed only with your permission.

If you choose to participate in this survey it will take up to 10 minutes of your time. You will not directly benefit from your participation as an individual, however, it is envisioned that the findings of this study will contribute to a better understanding of how the success in shutdown, turnaround and outage projects can be improved and how cost overruns and schedule delays can be minimised in these projects. We do not foresee that you will experience any negative consequences by completing the survey. The researcher undertakes to keep any information provided herein confidential, not to let it out of our possession and to report on the findings from the perspective of the participating group and not from the perspective of an individual.

The records will be kept for five years for audit purposes where after it will be permanently destroyed and electronic versions will be permanently deleted from the hard drive of the computer. You will not be reimbursed or receive any incentives for your participation in the survey.

The research was reviewed and approved by the School of Computing Ethics Review Committee and ethical clearance is attached. The primary researcher, Ms Flavia Masubelele, can be contacted during office hours at 011 670 9324 or 071 244 7249. The study leader, Prof E Mnkandla can be contacted during office hours at 011 670 9059. Should you have any questions regarding the ethical aspects of the study, you can contact the chairperson of the School of Computing Ethics Review Committee, Dr. Bester Chimbo on 0116709105 or email the committee on socethics@unisa.ac.za. Alternatively, you can report any serious unethical behaviour at the University's Toll Free Hotline 0800 86 96 93. You are making a decision whether or not to participate by following the link to the survey. You are free to withdraw from the study at any time prior to clicking the send button.

You can access the questionnaire by clicking on this link: http://survey.unisa.ac.za/index.php/692723?lang=en

*Please note that the online survey platform LimeSurvey works best in Google Chrome or Firefox. If you are unable to complete the survey in one sitting you may return to it later by clicking on the 'upload unfinished survey' option.

Thank you for participating in the study

Kind regards
Ms F Masubelele
PhD Student

Appendix B: Ethical Clearance Certificate

UNISA

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) RESEARCH AND ETHICS COMMITTEE

18 October 2018

Ref #: 058/FTM/2018/CSET_SOC
Name: Ms Flavia Thembelihle Masubelele
Student #: 44680082

Dear Ms Flavia Thembelihle Masubelele

Decision: Ethics Approval for 5 years
(Humans involved)

Researchers: Ms Flavia Thembelihle Masubelele, P. O. Box 53921, Wierda Park, 0149, masubft@unisa.ac.za, +27 11 670 9246, +27 71 244 7249

Project Leader(s): Prof E Mnkandla, mnkane@unisa.ac.za, +27 11 670 9059

Working title of Research

Improving the Success of Shutdown, Turnaround and Outage (STO) Projects in South Africa: A Structural Equation Analysis

Qualification: PhD in Computer Science

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee for the above-mentioned research. Ethics approval is granted for a period of five years, from 18 October 2018 to 18 October 2023.

1. The researcher will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.

3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date (18 October 2023). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.
8. Field work activities may only commence from the date on this ethics certificate.

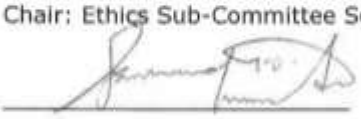
Note:

The reference number 058/FTM/2018/CSET_SOC *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee.*

Yours sincerely

Dr. B Chimbo

Chair: Ethics Sub-Committee SoC, College of Science, Engineering and Technology (CSET)



Prof I. Osunmakinde

Director: School of Computing, CSET

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Executive Dean: CSET

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Appendix C: Questionnaire

IMPROVING THE SUCCESS IN SHUTDOWN, TURNAROUND AND OUTAGE PROJECTS

SECTION A: DEMOGRAPHIC INFORMATION

The purpose of this section is to gather the demographic information of this survey. Kindly select the answer that is most relevant to you.

Which industry is your organization?

Electricity	1
Oil, Gas and Petrochemicals	2
Mining	3
Engineering	4
Automotive	5
Metal	6
Other, please specify: _____	7

How long have you been involved in Shutdown, Turnaround and Outage Projects?

Less than 3 years	1
3 – 6 years	2
7 – 10 years	3
years and more	4

Do you have a formal qualification in Project Management?

Yes	1
No	2

SECTION B: CHARACTERISTICS OF THE PROJECT

Consider a shutdown, turnaround and outage project that you recently completed and answer the following questions relating to the characteristics of the project.

What was your functional role in the project?

Executive Manager	1
Project Manager	2
Project Team Member	3
Contractor/Consultant	4
Other, please specify: _____	5

What was the value of the project in ZAR?

Less than R1 mil	1
Between R1 mil – R5 mil	2
Between R5 mil – R10 mil	3
Between R10 mil – R50 mil	4
More than R50 mil	5

What was the duration of the project?

Less than 3 weeks	1
3 – 6 weeks	2
7 – 10 weeks	3
9 – 12 weeks	4
More than 12 weeks	5

When was the project initiated?

Less than 6 months	1
7 – 12 months	2
13 – 18 months	3
More than 18 months	4

What percentage work was subcontracted?

Less than 25%	1
26% - 50 %	2
51 – 75%	3
More than 76%	4

What percentage work was additional, unplanned/discovery work?

Less than 25%	1
26% - 50 %	2
51 – 75%	3
More than 76%	4

SECTION C: SUCCESS CRITERIA

A list of performance measures or performance indicators that measure the outcome of a shutdown turnaround and outage project is provided. Kindly indicate the extent to which you agree or disagree that the following variables of success are used by your organization when evaluating the outcome of your project.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SC1	Completion of the project within budget or cost	1	2	3	4	5
SC2	Completion of the project on time	1	2	3	4	5
SC3	Completion of the project according to quality requirements	1	2	3	4	5
SC4	Start-up or commissioning incidences	1	2	3	4	5
SC5	Safety, health and environmental incidences	1	2	3	4	5
SC6	Amount of additional/unplanned/discovery work	1	2	3	4	5

Kindly indicate the extent to which you agree or disagree that the following criterion are considered by your organization when evaluating the benefits of your shutdown, turnaround and outage project. If the criterion is not applicable to your organization, kindly select neutral. Do you assess:

		Strongly Disagree	Disagree	Neutral	Agree	Strongly
SC10	If the project contributes to the strategic objectives of the organization	1	2	3	4	5
SC11	If the project meets the needs of the customers or end-users of the project	1	2	3	4	5
SC12	The project benefits in commercial value and market share	1	2	3	4	5
Kindly specify any other performance measures or performance indicators that are not mentioned in this survey that your organization uses to measure the outcome of your project.						

SECTION D: SUCCESS FACTORS

This section provides a list of critical factors or attributes believed to impact on the success of shutdown, turnaround and outage projects.

PROJECT RELATED FACTORS: Kindly indicate the extent to which you agree or disagree that the following project related factors have the most influence on the success of your project.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly
PR1	The size and complexity of the project	1	2	3	4	5
PR2	Project duration	1	2	3	4	5
PR3	Project frequency	1	2	3	4	5
PR4	The lead time when the project was initiated	1	2	3	4	5

ORGANISATIONAL FACTORS: Kindly indicate the extent to which you agree or disagree that the following organisational factors have the most influence on the success of your project.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
OF1	Support from top management	1	2	3	4	5
OF2	A realistic strategy	1	2	3	4	5
OF3	Organizational structure of the project	1	2	3	4	5
OF4	Organizational culture	1	2	3	4	5

HUMAN RELATED FACTORS: Kindly indicate the extent to which you agree or disagree that the following human-related factors have the most influence on the success of your project.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
HR1	Project Manager's competence	1	2	3	4	5
HR2	Project Manager's formal qualification	1	2	3	4	5
HR3	Project Manager's experience	1	2	3	4	5
HR4	Project Manager's leadership style	1	2	3	4	5

Kindly indicate the extent to which you agree or disagree that the following human-related factors have the most influence on the success of your project.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
HR5	A competent Project Team	1	2	3	4	5
HR6	Project Team's commitment	1	2	3	4	5
HR7	A motivated or incentivized team	1	2	3	4	5
HR8	Clearly defined roles and responsibilities for all team members	1	2	3	4	5
HR9	The team's alignment with organizational goals and strategy	1	2	3	4	5
HR10	A well-integrated and cohesive team	1	2	3	4	5
HR11	Effective conflict resolution	1	2	3	4	5
HR12	Adequate training and education of the project team	1	2	3	4	5

HR13	Availability of specialized skills within the team	1	2	3	4	5

PROJECT MANAGEMENT FACTORS: Kindly indicate the extent to which you agree or disagree that the following project management related factors have the most influence on the success of your project.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
PM1	Clear and realistic project objectives	1	2	3	4	5
PM2	Realistic time and cost estimates	1	2	3	4	5
PM3	Efficient and detailed planning	1	2	3	4	5
PM4	Review of readiness prior the project execution	1	2	3	4	5
PM5	Risk-based inspection	1	2	3	4	5
PM6	Freezing of the scope	1	2	3	4	5
PM7	Strict scope control and management	1	2	3	4	5
PM8	The ability to recognize the amount of additional/ discovery during project execution	1	2	3	4	5
PM9	Clear communication channels for all team members	1	2	3	4	5
PM10	Safety awareness and training	1	2	3	4	5
PM11	Integration of STO projects with other projects	1	2	3	4	5
PM12	Identification, assessment and addressing risks	1	2	3	4	5
PM13	Effective site management	1	2	3	4	5
PM14	Effective monitoring and feedback	1	2	3	4	5
PM15	The importance of the shutdown report and lessons learned for the success of the next project	1	2	3	4	5

Kindly specify any other performance measures or performance indicators that are not mentioned in this survey that your organization uses to measure the outcome of your project.

Appendix D: Turnitin Similarity Score