A MODEL FOR THE SUCCESSFUL COMPLETION OF PUBLIC SECTOR CONSTRUCTION AND ENGINEERING PROJECTS IN SOUTH AFRICA

A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy in Construction Management

College of Agriculture, Engineering and Science, School of Engineering,

Construction Studies, University of KwaZulu-Natal, Howard College.

UNIVERSITY OF KWAZULU-NATAL

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2020

DECLARATION OF ORIGINALITY

As the candidate's supervisor, I agree/disagree to the submission of this thesis;

Signed: [redacted]

____

Supervisor: ___Prof. Theodore. Conrad Haupt___ Date: ___December 10th, 2020________

I, **Zakheeya Armoed**…………, hereby state that this thesis was completed by myself, the candidate, and is submitted for the Degree of Doctor of Philosophy in Construction Management at the University of KwaZulu-Natal, Durban, South Africa. Where the works of other authors have been used, they have been duly acknowledged and referenced. This research has not been submitted before for any degree or examination to any other university.

Signed: [redacted]

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COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE

DECLARATION 1 - PLAGIARISM

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ACKNOWLEDGEMENTS

Without God, none of this could be possible.

I would like to recognize and acknowledge the following individuals and organisations for having contributed towards the successful completion of this research project.

My supervisor; Professor Theodore C. Haupt, from the School of Engineering: Construction Studies at the University of KwaZulu-Natal, for his ardent professional advice and supervision throughout the duration of the research project.

My husband, Mohamed Ziyaad Dhurghia for the endless love, support and encouragement.

Special thanks to my family; Zarina Armoed, Nazir Armoed, Mohamed Zaffer Armoed and Nazmeera Armoed; for encouraging me to pursue my dreams.

The respondents who took the time out of their schedules to complete all survey questionnaires and participate in interviews; who provided this research study with the relevant information and data as well as all those who responded to the various emails and telephone calls.

ABSTRACT

The construction and engineering industry has regularly been described as suffering from poor performance such as time and schedule overruns, quality defects, poor health and safety performance, fragmentation, poor communications, adversarial relationships and lack of co-ordination between the various project stakeholders. There has been little written in the South African public sector context regarding the key operational strategies of responding to these challenges that pervade the sector. Prior to the implementation of any meaningful interventions or strategies for improvement can be developed, it is essential to gain an in-depth understanding of the nature and extent of current practices at the operational level in the South African public sector. It is important to acknowledge the foundational issues, so that effective solutions may be implemented to assist in the improvement of project delivery. Due to the ever-present challenges with public sector infrastructure delivery, it is of national importance to understand critical theories behind current practices and the role of industry stakeholders, if the effective implementation of proposed strategies is to occur. The construction and engineering industry is extremely project-centric, operating in an environment of great complexity and uncertainty which is exacerbated by fragmentation in the supply chain processes; stakeholder influences; complex project characteristics and challenges such as the poor flow of information, conflicts and disputes; socio-economic factors and national and global dynamics. Consequently, delays and disruptions have become endemic to the industry. Inapt strategies have resulted in further delays, disruptions, disputes and increased costs, with rising levels of dissatisfaction among clients and end users. Several studies have found that clients are becoming dissatisfied with the outcome of construction and engineering projects as their expectations have not been met. Reasons posited have included apart from the issues raised above, includes, lagging behind in technological advancement, the overall development of operational processes and not keeping abreast of societal and industry trends. This research study highlighted the nature and extent of the challenges, systemic bottlenecks and factors that result in delays, disruptions and strategies through six constructs and 38 factors that influence successful construction and engineering project delivery in the South African public sector. The findings concluded with the development of a Strategic Infrastructure Delivery Management Model for implementation by public sector institutions and key industry stakeholders, through the integrated of advanced technological software programs that reflect the five essential constructs and associated factors identified through extensive structural equation modelling.

Keywords: Public sector, project delivery, project challenges, project performance, strategies.

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LIST OF TERMS

ANC:	African National Congress
BBBEE:	Broad Based Black Economic Empowerment
CAPEX:	Capital Expenditure Budget
CIDB:	Construction Industry Development Board
GDP:	Gross Domestic Product
GFCF:	Gross Fixed Capital Formation
GNI:	Gross National Income
GNP:	Gross National Product
HDI:	Historically Disadvantaged Individuals
IDMS:	Infrastructure Delivery Management System
IGS:	Infrastructure Gateway System
IPIP:	Infrastructure Programme / Project Implementation Plan
IPMP:	Infrastructure Programme / Project Management Plan
MFMA:	Municipal Finance Management Act
MTEF:	Medium Term Expenditure Framework
ND:	National Department
NPC:	National Planning Commission
NT:	National Treasury
PFMA:	Public Finance Management Act
PPPFA:	Preferential Procurement Policy Framework Act
PFMA:	Public Finance Management Act
SC:	Supply Chain
SCM:	Supply Chain Management
SEF:	Socio-Economic Factor
SEM:	Structural Equation Modelling
SPSS:	Statistical Package for the Social Sciences
SOE:	State-run Enterprises
SRF:	Statutory and Regulatory Factor

GLOSSARY

Accountability

Being ultimately held responsible for a specific decision or action, such that the accountable person may be required to justify why a specific action happened or not, why a specific decision was taken or not, as the case may be (The Public Service Commission, 2007).

Benchmarking

"Benchmarking is the search for the best industry practices which will lead to exceptional performance through implementation of these best practices" (Baccarini, 1996). A deployment project focuses on the rollout of a standardized approach to working or an existing solution to one or more operational companies or other entities. Key performance indicators (KPI) KPIs are a type of performance measures that evaluate the success of an organization or of an activity with which it engages.

Deliverables

The outcomes/outputs expected by an employer from its employees (The Public Service Commission, 2007).

Health

The protection of the bodies and minds of people from illness resulting from the materials, processes or procedures used in the workplace (Hughes and Ferrett, 2011:25).

Incapacity

The failure of an employee to perform satisfactorily due to reasons of either incompetence, ill-health, or injury as recognized by the Labor Relations Act (The Public Service Commission, 2007).

Monitoring and Evaluation

The process of observing and assessing the effectiveness of a particular intervention, with the view to achieve an improvement (The Public Service Commission, 2007).

Organizational Culture

Organizational culture can also be defined as the way things are done and operated within the internal environment of the workplace (Naoum, 2001: 162).

Performance Agreement

An agreement between the employer and employee1 that the employee will meet the specified performance standards set out for that particular job and how those standards can be met (The Public Service Commission, 2007).

Performance Management

A process that facilitates the management of performance of employees through planning, regular reviews and feedback as a way of motivating employees to attain their full potential in line with a department's objectives. This process enables the employer to deal effectively with inadequate performance and equally permits recognition of outstanding performance (The Public Service Commission, 2007).

Performance Measurement

The process of collecting, analyzing and reporting information regarding the performance of an organization, person or component. Project "A project is a temporary and unique endeavor undertaken to deliver a result. This result is always a change in the organization, whatever it is in its processes, performance, products or services. This transformation consists then in a gap between a start and a final state. Time and resources are consumed to produce results, which may be deliverables and/or performance improvement and/or resource improvement (skills, knowledge)" (Vidal and Marle, 2008).

Performance Standard

The acceptable standard of performance that the employees must attain. The standards for each job are derived from (internal) norms and (external) benchmarks of performing similar activities (The Public Service Commission, 2007).

Poor Performance

Consistent failure by an employee to meet the required performance standards set out by the employer in consultation with the employee (The Public Service Commission, 2007).

Procurement

Watermeyer and Jacquet (2004: 1.1) define procurement as the process which creates, manages, and fulfils contracts relating to the provision of supplies, services or engineering and construction works, the hiring of anything, disposals, and the acquisition of any rights and concessions (The Public Service Commission, 2007).

Project Categorization

"Project categorization is a procedure where all candidate projects are evaluated on a set of criteria and then classified into various groups." (Jung & Lim, 2007) Project characteristic A project characteristic is an element that characterizes a project.

Project Indicator

A project indicator measures the physical and visible outcomes of a project (Vleems,2018)

Safety

The protection of people from physical injury. The borderline between health and safety is ill defined and the two words are normally used together to indicate concern for the physical and mental wellbeing of the individual at the place of work (Hughes and Ferrett, 2011:25).

Structural Equation Modelling

Structural equation modeling is a multivariate statistical analysis technique that is used to analyze structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyze the structural relationship between measured variables and latent constructs (Statistics Solutions, 2019)

Supply Chain

Supply chain is a set of three or more entities (individual / firms) directly involved in the upstream and downstream flow of products, services, finances, and / or information flow from a source to a customer (Blanchard, 2004: 6).

Supply Chain Management

Supply chain management is the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular firm and across businesses with the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole (Blanchard, 2004: 6).

CHAPTER ONE

INTRODUCTION

1. Introduction

"Construction is the art of making a meaningful whole out of many parts. Buildings are witnesses to the human ability to construct concrete things. I believe that the real core of all architectural work lies in the act of construction. At the point in time concrete materials are assembled and erected, the architecture we have been looking for becomes part of the real world (Zumthor, 2006:48)".

An estimated 58,78 million individuals reside in South Africa, in a society that is rich in culture and diversity (Statistics SA, 2019). It is bound by a coastline that stretches 2,798 kilometres along both the Indian and South Atlantic Oceans. Its land area is 1,221,037 km², and it is made up of 9 multicultural provinces. Archbishop Desmond Tutu coined the term, "the rainbow nation" as a reflection of the diverse cultures, a nation with people of all shades, backgrounds, religious denominations, financial status and the many different languages of South Africa (Baines, 1998). South Africa plays a vital role within the African continent and the world at large, as it is only one of over 57 African countries, yet its economy contributes 19% to the total African economy. This equates to a third of the economy in Sub-Saharan Africa, with two-thirds of the Southern African Development Community's (SADC) gross domestic product. The country has a significant socioeconomic and political influences within the African continent and globally (Mooya, 2007).

South Africa had previously been described as a nation with a tempestuous and violent past. However, it is now considered as an exciting and progressive society with a highly informed constitution in keeping with the rest of the world. South Africans as a united nation made the peaceful transition to democracy in 1994 and is now seen as a leading first world country on a third world continent. Since 1994, South Africa has transitioned from a political system of apartheid to democracy and one of majority rule. The election resulted in a democratic government along with numerous promises within manufacturing, mining and services sectors including, but not exclusively, economic advancement, investment, infrastructure development, change in socioeconomic policies and equality amongst the nation (Seekings, 2014 and Mooya, 2007).

1.1. The South African Construction and Engineering Sector

1.1.1. The Historical Transformation in South Africa

1.1.1.1. <u>The South African Economy</u>

Over the last two decades, South Africa's construction and engineering sector has experienced immense transformation and development since the apartheid era. The apartheid era brought with it not only spatial and cultural segregation between the races, but majority of the historically disadvantaged population; namely individuals who were not White or from European descent; were not allowed to own freehold property, nor were they allowed to actively participate in the construction and property industry as entrepreneurs or professionals (Mooya, 2010). Due to the severe inequality faced by South Africans, sanctions and racial policies were implemented, which restricted the countries development. The economic crisis further increased the empowered of the class struggle, which in combination with the forte of the labour movement were an immense risk to the success and profitability of the construction and engineering sector and its related industries (Cottle, 2014).

The African National Congress (ANC) was the first democratically elected government in South Africa, which saw the dawn of a new era. As a means to redress historical inequalities the South African state has been engaged in a programme of socio-economic transformation. An array of legislative and policy interventions has been devised in an attempt to generate increased participation by historically disadvantaged individuals in various sectors of the construction and engineering sector. Attempts at broadening the participation of the construction and engineering sector were implemented by means of policies on Black Economic Empowerment (BEE) to assist black-owned businesses and through its policy on preferential procurement. The ANC established the Reconstruction and Development Programme (RDP), which was aimed at the redistribution of economic policies as its main objective. The intention of this policy was to direct the progress of transformation strategy. The key aspect of the transformation strategy was to develop a public sector infrastructure programme that provides access to modern, effective and efficient social and economic services such as health, water, electricity, education, transportation and telecommunications for society with the aim of securing economic growth (South Africa Republic, 2014). The transformative process sought to overcome the legacy of Apartheid and promulgate society into successfully addressing the rudimentary needs of its citizens. The process further sought to address a divided society that was founded on racial segregation and income inequality (Cottle, 2014).

The capital expenditure spent by the democratic government forms the pillar on which the economy functions. The capital expenditure and investment thereof, seeks to improve infrastructure, facilities, education, logistics and connectivity of the nation which facilitates trade and attracts investment. Through economic investment and societal infrastructure development, the government saw the construction and engineering sector as a noticeably essential sector of the economy. The extent of infrastructure development determines the magnitude to which investment efforts are transformed into lucrative investment outcomes. This investment enables communities to access a range of services such as electricity, water and sanitation (StatsSA, 2020).

The construction and engineering sector of an economy is an essential sector in the social, national and economic development (United Nations Industrial Development Organization, 2009). It is also an essential contributor to the development of the national economy through employment creation, the improvement and transfer of technology, opportunities for entrepreneurs and their initiatives, and it contributes directly to cultivating a quality of life for society, therefore any changes within the industry have profound effects on the economy. This ultimately affects the wealth of the country (Construction Industry Development Board, 2012; Ofori 2012, 1994 and 1990; Giang and Pheng, 2011; Mlinga and Wells 2002; StatsSA, 2010a, Hillebrandt 2000; Wells 1986 and Turin, 1973).

The South African construction and engineering sector has enjoyed sustained economic growth over the last two decades, due to the significant transformation policies; with an annual anticipated GDP contribution of 2.3% (Cottle, 2014). According to Rameezdeen (2007), Olanrewaju and Abdul-Aziz (2015), the construction and engineering sectors contribution to the South African economy may be divided into the following components that are directly related to the development process and its varied contribution.

These include:

1. Nationwide basic needs,
2. Fixed capital assets and infrastructure development of a country,
   (Reported a 9,6% average GDP between 2008 and 2016, with the GFCF and Employment rates between 2000 and 2016 illustrated in figure 1)
3. Contribution to the gross domestic product which promotes growth through the linkages with other industrial sectors,
4. Employment generation.
   (The construction industry has contributed an estimated 8% average between 2008 and 2017)

5. Income generation and re-distribution,
6. Sustainable development,
7. Significant contribution to the informal sector,
8. Construction output as growth-initiating and growth dependent and,
9. Provide outputs and utilises the outputs of many industries (CIDB, 2017).

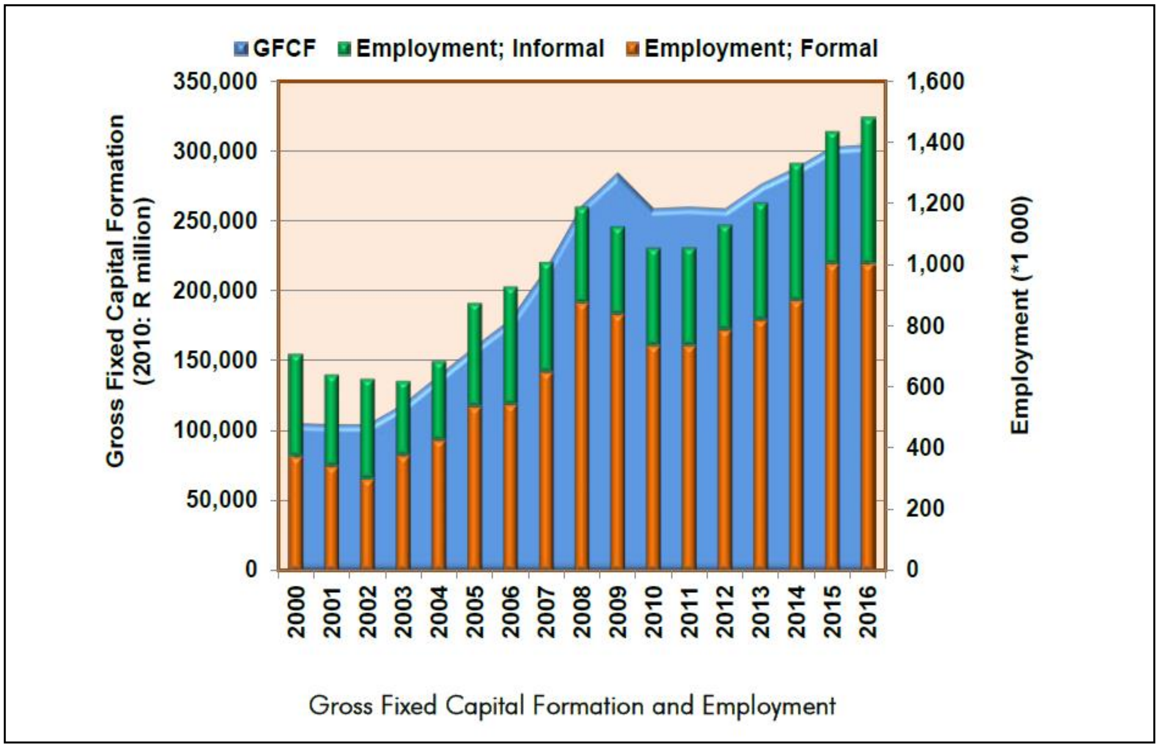

Figure 1: Gross Fixed Capital Formation and Employment (Cottle, 2014)

The state run by the African National Congress in the post-apartheid era had implemented strategic policies to encourage stability, enhance economic development and enable an environment for international competitiveness of the South African public sector construction and engineering industry. One of the vital components of the transformation policies was the conception of the Construction Industry Development Board (CIDB) to ensure the efficient scheduling of public sector spending and support programmes in order to develop the historically disadvantaged professionals which was denied under apartheid. The CIDB under the guidance of the ANC has successfully used the field of infrastructure delivery as a capital accrual strategy for developing historically disadvantaged black, medium and small level contractors (Cottle, 2014).

State-run enterprises have become the largest client in the construction and engineering sectors, with the delivery of economic and societal infrastructure development, highlighted in figure 2. The public sector is expected to render social and economic services efficiently and it is expected to frequently renew and improve its delivery modalities. In 1994 there was an instantaneous move from the RDP to neo-liberal macro-economic policies which secured an increase in the level of suppleness and improved productivity of the labour force. The post-apartheid period was distinct in their efforts of an increased level of investment in social infrastructure development (Shen, Platten, and Deng, 2006).

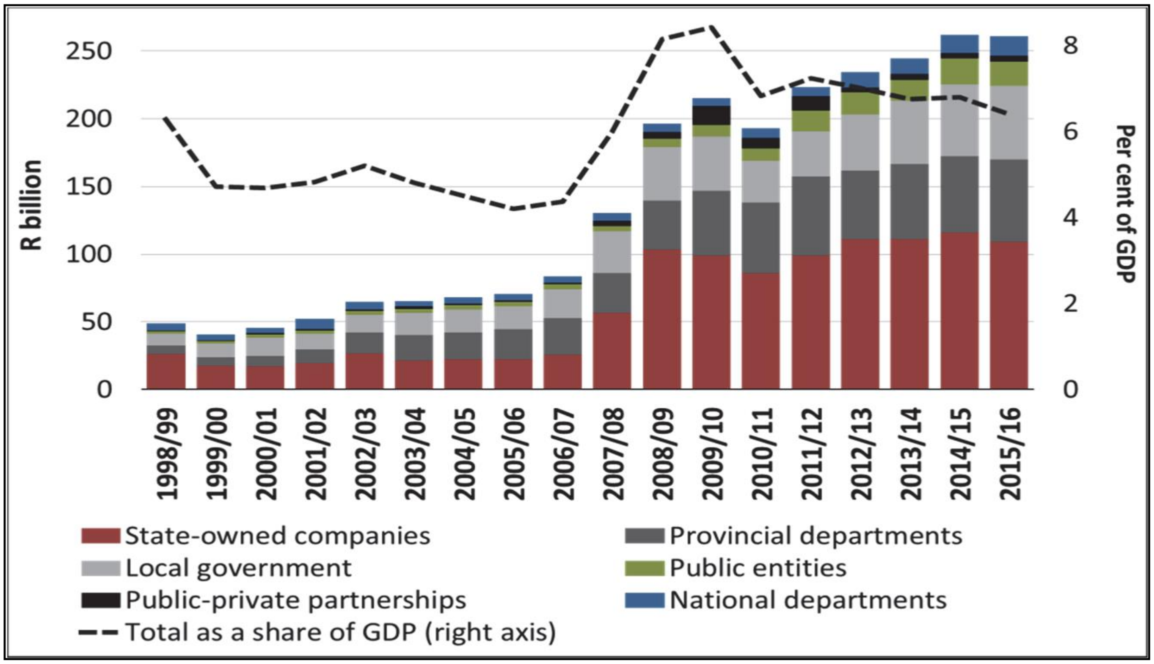

Figure 2: Capital Expenditure by South African State-run Enterprises (StatsSA, 2019)

As stated in the National Treasury Budget Review (2017), between 1998-1999 and 2015-2016, the South African public sector spent a further R2.5 trillion on infrastructure development. This expanse saw an increase in expenditure from R48 billion in 1998- 1999 to R261 billion in 2015-2016, reflected in figure 3, which resulted in an estimated annual increase of 6.8%. State-run enterprises such as municipalities and provincial departments have been the largest contributors to public sector expenditure having contributed R1.1 trillion, with provincial departments and municipalities having contributed R500 billion and R580 billion respectively for social infrastructure development. This included the development of hospitals, clinics, schools and other community-related infrastructure. However, public-sector infrastructure investment has been on a decline since 2016. The 757 public-sector institutions in South Africa have spent R250 billion on fixed investments in 2018, which was less than the amounts recorded in 2017 of R272 billion and R283 billion in 2016.

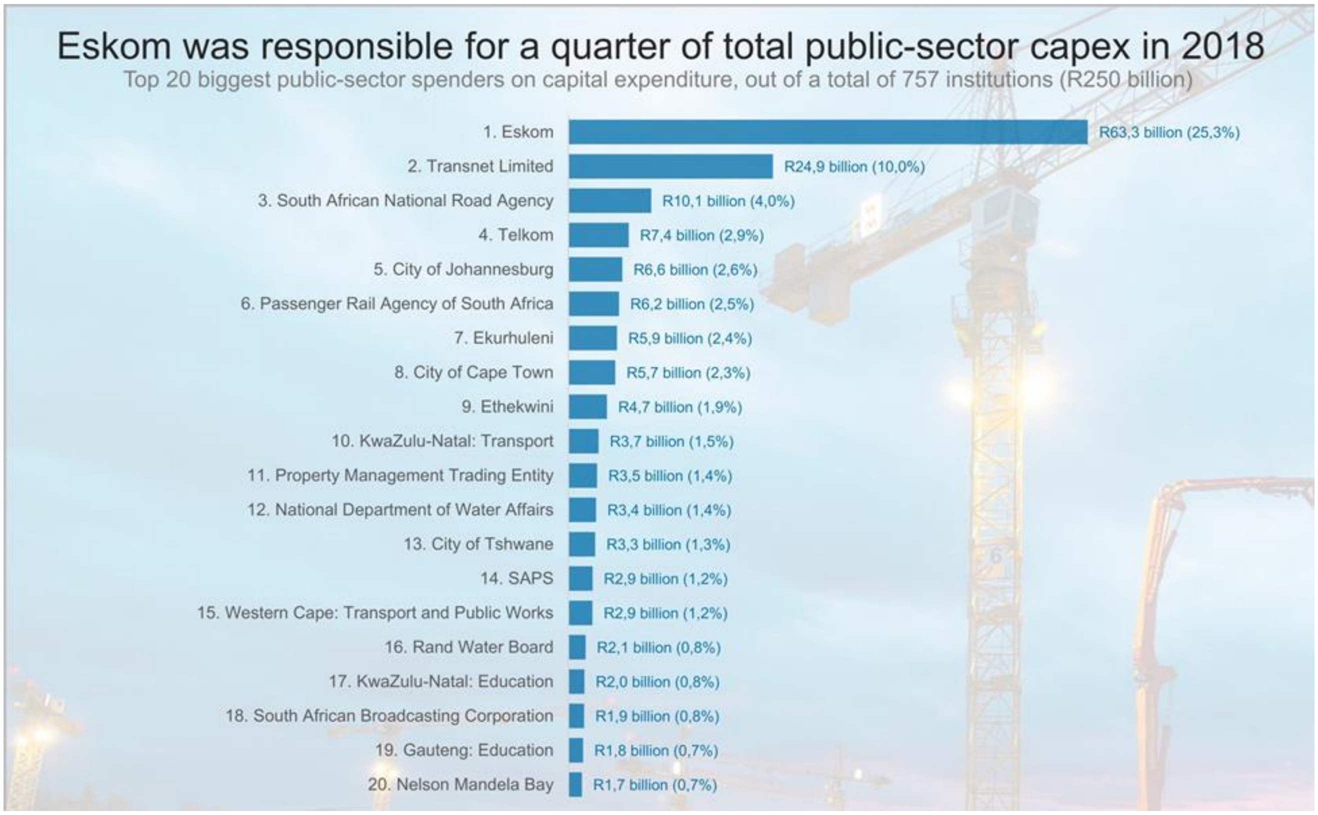

Figure 3: Public-Sector Infrastructure Plans Financed at National, Provincial and Local Government (National Treasury Budget Review, 2017)

The construction and engineering sector makes a substantial contribution to the national economy through public sector infrastructure development. However, infrastructure spending has evolved at a sluggish pace than economic infrastructure spending in current years (Windapo, A.O., and Cattell, K. 2013). Several challenges have emerged with the various strategies proposed by state-run enterprises which created mechanisms that inhibit construction processes. It has been recognized as conflicting and significantly influencing the development, growth and performance of the South African construction and engineering sector (Boshoff, 2010; Mbande, 2010; Milford, 2010; Tomlinson, 2010; CIDB, 2007 and 2004; Lewis, 2007; van Wyk, 2004 and 2003 and Luus, 2003). These challenges result in delays and disruptions to public sector construction project delivery (Cottle, 2014).

1.1.1.2. <u>The Construction and Engineering Sector</u>

The public sector construction and engineering sector is largely seen as project-centric, that functions in an environment of immense complexity and ambiguity. It is a sector driven by infrastructure delivery that is often described as suffering from poor performance, growth and development due to significant challenges experienced (Ying, Tookey and Roberti, 2015).

In a South African context, very little has been written addressing the key operational aspects that respond to these challenges which results in delays, disruptions and acceleration strategies within public sector construction and engineering projects. Delays, disruptions and acceleration strategies have had significant effects on construction projects. These effects include schedule and cost overruns, quality defects, health and safety defects, skills capacity and procurement issues, lack of project sustainability, reduced client satisfaction, disputes, arbitration and total abandonment of the project (Sambasivan and Soon, 2007 and Aibinu and Jagboro, 2002). As mentioned by Windapo and Cattell (2013), literature highlighted the following challenges as influencing factors in the construction and engineering sector that has affected its overall performance and development. This includes public-sector capacity and the disparities between available skills and required skills, industry fragmentation and adversarial relationships, procurement practices, competitive tendering and the capacity for sustainable empowerment, statutes and regulations; globalisation; technological advancements, suitable and sustainable land availability and project uniqueness have been cited as causing the industry to perform poorly (Kadangwe, 2013; Boshoff, 2010; Mbande, 2010; Milford, 2010; Black Economic Empowerment News, 2009; Lewis, 2007; Statistics South Africa, 2004; CIDB, 2007 and 2004; van Wyk, 2003;3 and Raftery et al., 1998).

The South African public sector construction and engineering industry is deemed to be high risk in comparison to other industries due to its intricacy in managing an array of contrasting and interconnected set of activities and skillsets. This level of intricacy is enhanced in the execution of construction projects, where several project objectives are anticipated by a range of industry stakeholders (Shen, Platten, and Deng, 2006). The intricacies and challenges experienced by the industry, influences the growth, development and performance of the construction and engineering sector. Mbande (2010) and CIDB (2004) highlight that there is a lack of skills within state-run enterprises. The Construction Industry Development Board (CIDB, 2004) along with Al-Kharashi and Skitmore (2008) further highlight the level of capacity in the public-sector as it is a significant limitation on infrastructure delivery and in the sustainable growth of its construction and engineering sector. In a 2004 report, the CIDB highlighted that, policies implemented by state-run enterprises such as preferential procurement processes; are a challenge to the sector, as it encourages historically disadvantaged individuals to found start-up enterprises rather than join established organisations. This fragmentation within the industry has diminished the extent of expertise on specialised and diverse construction projects.

According to CIDB (2012), Black Economic Empowerment News (2009) and Williams (2007), the preferential procurement process employed by state-run enterprises in South Africa causes an unnatural degree of competition and hinders the growth of small enterprises and the sustainability thereof. The successful execution of construction and engineering projects within the public sector, relies on a sound engineering judgement in an attempt to ensure successful project completion within the allotted time and schedule limitations, estimated costs, quality control processes, health and safety requirements, procurement framework and to ensure its sustainability. However, most construction projects irrespective of their complexity experience extensive challenges which often result in delays and disruptions. Delays and disruptions are a worldwide phenomenon which affects the construction and engineering sector as well as the economy of a country (Bowen et al., 2007; Sambasivan and Soon, 2007 and Faradi and El-Sayegh, 2006).

Public sector construction and engineering projects that are plagued by challenges often result in client hardships, expenses that hinder project revenue, if the project is delayed beyond the projected time (Odeh and Battaineh, 2002). Delays and disruptions are also great sources of potential risks such as technical, social, economic, legal and financial risks (Kikwasi, 2012). Al-Momani (2000) and Kaming et al. (1997), found that the causative factors related to project delays and disruptions were often related to architectural or client changes, weather, site conditions, poor labour productivity, inadequate planning, late deliveries, economic conditions, inflation, inaccurate estimations and a degree of project complexity. This issue is seen to be more prevalent in frameworks that are constructed around the basis of traditional or argumentative contracts in which the contract is often presented to the lowest bidder. This type of framework and awarding strategy seems to be favoured in South Africa, as it is a developing country. Most clients are dissatisfied with the outcome of construction projects because their expectations are not being met (Mafimidiwo and Iyagba, 2015 and Odeh and Battaineh, 2002). Despite significant contributions to the economy and of societal infrastructure development, the construction and engineering sector's performance, growth, development, reputation and image suffers. The sector has developed an image associated with infrastructure delivery backlogs, unsustainable, chaotic working practices, high costs, poor levels of quality and health and safety records (Ball, 2014). According to Rameezdeen (2007), the sector is seen as hazardous, non-technical, tedious, unprofessional, recurring and is associated with arduous working conditions.

Due to the numerous challenges associated with the deficiencies and poor accessibility to social services, there has been an amplified and constant level of discontent within communities across South African. After an increased movement of societal discontent, the government has acknowledged public sector delivery inadequacies and social marginalization are prevalent and have led to high levels of tension in the country (National Treasury Budget Review, 2013). The negative image has an indirect outcome being that the sector is no longer the career choice by potential new entrants (Haupt and Harinarain, 2016).

It is against this framework that this research study seeks responses to the overall poor performance in the construction and engineering sector. These include: cost overruns, quality defects, time overruns, schedule overruns and poor health and safety performance. This may be achieved through trying to comprehend the nature of the construction and engineering industry, the degree of challenges faced, the causes of delays, disruptions and acceleration on construction projects in the public sector, systemic bottlenecks, level and nature of uncertainties, legal consequences and the relationships between various project performance indicators in order to understand them with the objective of developing models of intervention that will optimize the performance of construction projects and the various stakeholders. This optimization will lead to reduced costs and improved overall customer/client satisfaction. This study is intended to investigate the nature of the construction and engineering sector in order to ensure successful strategy and policy formulation and its implementation within the public sector. The study further seeks to obtain views from clients, industry stakeholders, construction and engineering organisations and regulatory boards with respect to the factors that influence delays, disruptions and acceleration strategies in construction projects. According to Ofori (2015), it is important to

1.2. The South African Public Sector

Post-apartheid South Africa has seen significant economic and social transformation as it has been a fundamental goal for the newly elected democratic government. Small, Medium and Micro Enterprises (SMMEs) have been identified as a vital point for key economic development and transformation within the construction and engineering sector. This ethos has been developed through strategic transformation policies and under an economic framework that has been influenced by the state, in particular, Broad-Based Black Economic Empowerment (BBBEE). Legislation states that BBBEE is to be guided by moral governance and associated to a strategy which ensures sustainable growth and development (Deutsche Bank, 2006).

It is perceived that through positive collaboration between the SMME and BBBEE frameworks, it can successfully contribute to the empowerment of historically disadvantaged South Africans and therefore contribute to meaningful socio-economic transformation. The democratic government aims to achieve the BBBEE strategy through the use of legislations, frameworks, regulations, reorganization of state-run enterprises, associations, financial assistance, preferential procurement processes and skills development programmes that addresses public sector capacity (Sanchez, 2006). More than 25 laws, regulations, legislations and policies are in existence that promote the empowerment of HDI's. These laws span over 10 sectors with 10 government tender boards, tender boards of state-run enterprises and labour relations institutions to name a few (Businessmap, 2006).

These provisions include, but are not partial to the following:

a. The Employment Equity Act (1998) – The implementation of affirmative action laws that favours HDI's at the workplace,
b. The Preferential Procurement Policy Framework Act (2000) – The provision of a framework that encourages active procurement processes and,
c. The Skills Development Act (1998) – The provision of an institutional framework for the improvement of the skillset of the nation (Bezuidenhout et al., 2005).

Even though, laws, regulations, legislations and policies have been implemented, criticisms about the South African public sector construction and engineering industry and client dissatisfaction have been constantly raised and included within governmental reports. Existing regulations, legislations, frameworks and policies within the public sector construction and engineering industry seem to be lacking in their effectiveness. Therefore, a new prospective solution for improvement is required, through the identification of critical success factors that influence successful project delivery and through the formation of a framework agreement between contractors and their clients. Medium to long term relationships between stakeholders should focus on project performance, growth, development and successful project delivery models (Lam and Gale, 2013).

1.3. Critical Project Success Factors for Public Sector Project Delivery

Project success factors are considered as an effective measure for the enhancement of the efficiency of construction and engineering projects. The term critical project success factors were first used by Rockart, which simply refers to those factors that are responsible for forecasting the success of projects (Baccarini, 2009 and Saqib, et al 2008).

It is often used amongst project stakeholders within the construction and engineering sector to ascertain the success or failure of public sector construction projects, which contributes significantly to socio-economic development and employment of the nation (Jha and Chockalingam 2009 and Love et al., 1997). Adnan, et al (2014), highlights that that CSFs are a vital few factor that project stakeholders should pay attention to in order to achieve project goals and successful project delivery. These key factors may be used during the strategic planning of a construction project and of an organization's daily activities. According to Mashwama et al., (2016) and Amade et al., (2015) there are many CSF's that impact a construction project.

These include:

a. Strategic planning,
b. Effective procurement processes,
c. Effective communication management,
d. Effective coordination of project activities,
e. Quality measurement,
f. Weather conditions,
g. Leadership skills of the project manager,
h. Adequate monitoring and feedback,
i. Owner/client involvement,
j. Teamwork,
k. Training and development, and
l. Continuous improvement.

Public sector construction projects are undertaken with a fundamental goal of achieving the key objectives of maintaining project costs and schedule, while ensuring that the quality and standards initially set out are met. A construction and engineering project is seemed to be unsuccessful if it does not meet the above-mentioned objectives (Oyedele, 2013). The life cycle of construction and engineering projects in South Africa is volatile as there are numerous public sector construction projects abandoned due to poor strategic planning, poor communication, lack of skills and stakeholder involvement. (Oyedele, 2013; Ubani and Ononuju, 2013; Amade, 2014 and Mbachu and Nkado, 2007).

Construction projects delivered for public use such as hospitals, clinics, schools and other community-related infrastructure illustrates poor and unsuccessful execution. This could be due to contractors' lack of experience and building knowledge, poor design, complexity of projects and corruption amongst stakeholders. Aibinu and Jagboro (2002), stated that the main criticism of the public sector construction and engineering industry is the developing trend in delays and disruptions that are associated with construction project delivery.

1.4.The Problem Statement

The South African public sector construction and engineering industry is required to continuously improve the optimum utilisation of the resources at hand, through the expansion of services, while instantaneously maintaining satisfactory standards within reasonable parameters (The Public Service Commission, 2007). As a successful industry, it is expected to regularly provide efficient and effective services, through a constant renewal and improvement of its service delivery modalities, in order to make them more accessible to historically disadvantaged individuals and the nation at large. However, the public sector construction and engineering industry in South Africa suffers from a negative image that is plagued by poor service delivery (Rameezdeen, 2007; Baldry, 1997 and Griffith, 1988). The government institutions in South Africa utilises construction projects as vehicles to operationalise policy programmes and strategic objectives for project delivery. However, due to the labour-intensive nature of the public sector construction and engineering industry, it is critical that the optimum performance of its stakeholders is maintained for successful project delivery. Although great effort has been made by government institutions such as, state-run enterprises, to enhance the overall performance levels within the public sector, disparagement continues to grow due to poor service delivery and the absence of a responsiveness system that satisfies the needs of the nation (The Public Service Commission, 2007).

Curristine, Lonti and Joumard (2007:1-41) mention that the concept of providing a higher level of public sector services with less public sector expenditure, is an ongoing challenge. It may be argued that limited research has gone into the impact and influence of challenges, delays, disruptions, acceleration strategies and that of the relationships between various project performance indicators that impact public sector construction projects. As a result, the construction and engineering sector needs to develop methodologies, techniques and a client-centred model of intervention that promotes quality engineering, minimize losses and optimize the performance of both stakeholders and construction projects within the public sector (Jin, Tan, Zuo and Feng, 2012).

Therefore, the problem addressed in this study may be stated as follows:

The South African public sector construction and engineering industry plays an essential role in the socio-economic development of the country, and is a noteworthy contributor to the economic growth of the country. However, numerous challenges, delays and disruptions have been recognized as influencing factors that oppose the performance and development of the South African construction and engineering sector. As a result, the public sector construction and engineering industry is perceived to be unsuccessful in producing projects that are within the conventional measures of project time, cost and quality. In recent years it also fails to comply with measures such as customer and stakeholder satisfaction, health and safety parameters, quality control and overall project sustainability. Therefore, the public sector construction and engineering industry should aim to investigate challenges presumed to influence overall project performance and development of the South African construction and engineering sector. The study will investigate how to improve overall construction and engineering project poor performance through understanding the nature and degree of challenges, systemic bottlenecks, uncertainties, legal frameworks, policies, and other factors that result in delays, disruptions and acceleration strategies. The study will seek to develop modalities and interventions for improvement in construction project delivery within an industry that has been declared a national asset with great potential to create employment while contributing heavily to economic growth and development.

1.5.Research Questions

1.5.1. Main Research Question

a. How to enhance the successful delivery of public sector construction and engineering projects in Kwazulu-Natal?

1.5.2. Sub - Research Questions

a. What are the key factors, roles and influence of public sector project stakeholders and project characteristics that influence successful construction and engineering project delivery in Kwazulu-Natal?
b. What are the key challenges; such as delays and disruptions that influence successful public sector construction and engineering project delivery in Kwazulu-Natal?
c. What are the key socio-economic factors that influence successful public sector construction and engineering project delivery in Kwazulu-Natal?

d. What are the frameworks and legislations that are related to the management of construction and engineering project performance in the public sector construction and engineering industry in Kwazulu-Natal?
e. What are the national and global dynamic factors that influence project performance and development in the public sector construction and engineering industry in Kwazulu-Natal?
f. What are the infrastructure delivery modalities that contribute to poor project delivery in the South African public sector construction and engineering industry?

1.6.General Research Objectives

1.6.1. Theoretical Objectives

a. To identify and examine the factors, roles and influence of project stakeholders and the project characteristics that influence poor public sector project delivery in the Kwazulu-Natal construction and engineering industry;
b. To identify the key challenges such as project delays and disruptions that influence successful construction and engineering project delivery in Kwazulu-Natal;
c. To identify the key socio-economic factors that influence successful construction and engineering project delivery in Kwazulu-Natal;
d. To identify the statutory frameworks and legislations that are related to the management of poor project performance in the public sector construction and engineering industry in Kwazulu-Natal;
e. To identify the national and global dynamic factors that influence the development of public sector construction and engineering projects in Kwazulu-Natal;
f. To examine the public sector infrastructure development management system impacts successful construction and engineering project delivery in Kwazulu-Natal.

1.6.2. Empirical Objectives (Aim)

a. To develop a *proposed strategic infrastructure delivery management model* for the successful delivery of public sector construction and engineering projects in South Africa which integrates construction project knowledge and public sector processes, that are aimed at assisting managers and supervisors; so that optimum performance of construction projects and of the various stakeholders involved are achieved.

1.7. Research Methodology

1.7.1. Conceptual Framework

The conceptual framework of the research study assists in the illustration of the relationships between the independent and dependent variables. Based on an extensive literature review, the independent variables for this study include the construction project stakeholders, project characteristics, key project challenges, socio-economic factors, efficient and effective statutory frameworks and legislations, national and global dynamic trends, and the effective coordination and management of the above project activities. While the dependent variable, is success of public sector construction project delivery.

1.7.2. Theoretical Framework

A comprehensive review will be conducted of the relevant literature and of previous studies. The research will focus on the public sector construction and engineering industry, the current trends and practices for successful public sector construction project delivery, challenges that impact successful construction, critical success factors and advancements in successful public sector construction project delivery.

1.7.3. Quantitative Methodology

A quantitative methodological approach will be adopted. The study will employ methodological quantitative research strategies, data collection methods and statistical analysis will be employed. The quantitative research method will include an exploratory pilot survey and a scaled survey questionnaire accompanied by structural equation modelling (SEM).

a. An exploratory pilot survey will be administered to industry stakeholders to ascertain their views, experiences and opinions on successful construction project delivery and to ascertain their views and opinions on the factors that impact successful construction and engineering project delivery in the South African public sector environment. Findings will be used to develop the main research instrument.
b. A survey questionnaire will be issued to industry stakeholders to further ascertain their views, experiences and opinions regarding the factors that influence successful project delivery in the South African public sector environment.
c. The data will be statistically analysed using relevant techniques and appropriate statistical software, such as SPSS version 26 and AMOS version 27 to develop and validate the *proposed strategic infrastructure delivery management model* for successful construction project delivery.

d. Conclusions will be drawn from the findings of the study and the recurring themes from the survey questionnaire and proposed strategic infrastructure delivery management structural model. Recommendations for implementation and strategies will be formulated, based on the findings of the study.

A detailed research methodology map illustrating the alignment of the research objectives with data collection and analysis techniques is reflected in table 1.

Table 1: Research Methodology Map – The alignment of objectives with data collection and analysis techniques

	Methods						
Objectives	***Literature Review***	***Quantitative Methodology***	***Descriptive Statistics***	***Thematic Analysis***	***Parametric and Non-Parametric Statistics***	***Critical Factor Analysis***	***Structural Equation Modelling***
1	✔	✔	✔	✔	✔	✔	✔
2	✔	✔	✔	✔	✔	✔	✔
3	✔	✔	✔	✔	✔	✔	✔
4	✔	✔	✔	✔	✔	✔	✔
5	✔	✔	✔	✔	✔	✔	✔
6	✔	✔	✔	✔	✔	✔	✔
7	✔	✔	✔	✔	✔	✔	✔
8	✔	✔	✔	✔	✔	✔	✔
9	✔				✔	✔	✔

1.8. Research Limitations and Delimitations

The study is subject to the following limitations and delimitations:

a. Region: This study will be limited to Kwazulu-Natal due to the Covid-19 pandemic.

b. Study: A quantitative research study will be conducted with 750 construction and engineering sector stakeholders that represent the views and opinions of their organisations. The selected organisations are registered with the Construction Industry Development Board and are actively involved in public sector construction and engineering projects, procurement processes and project delivery. A quantitative research methodology will be administered which seeks to arrive at a consensus on the complex issues that influence project delays and disruptions of the South African public sector construction and engineering projects. The study will include anonymity as an important part of the research study.

e. Time: The time available for this research is from February 2017 to November 2020.

1.9. Research Assumptions

The study is subject to the following assumptions:

a. That public sector infrastructure projects are undertaken for developmental purposes to meet societal needs and demands;
b. That the participants of the study will co-operate and provide accurate responses and meaningful information with respect to the research topic;
c. That participants are capable of responding to the research instruments as they are considered to be knowledgeable individuals and experts in their respective fields of study;
d. That the selected participants will be honest and respond accurately to the questionnaires;
e. That the participants are be notified of their anonymity and confidentiality which will be preserved in order to enhance and reinforce the accuracy of the information provided.

1.10. Ethical Considerations

In an attempt to ensure ethical considerations of international standards are preserved, the names of all individuals and organizations participating in the study will be withheld. The underlying principle of voluntary participation will be maintained. All through the duration of the research study, the aim of the research will be explained thoroughly, anonymity will be ensured and all responses will be held confidential. The participants will be able to withdraw from the study, with no consequences being held and no compensation being issued. The research does not aim to harm or advertise an individual, company or associate organization that has participated in the study. The University of Kwa-Zulu Natal will approve all research instruments that will be used via the Ethical Clearance Committee. See Appendix A: Ethical Clearance Letter. The quality will be assured through the correctness and completeness of instruments issued i.e. The structured interviews, the accuracy in its statistical calculation and efficiency of data analysis and its capturing. The study is also open to an independent review to assist in protecting all participants and the researcher against any proposed legal implications.

1.11. Significance of the Study

An empirical gap exists in South African literature on the key factors that influence successful project delivery of public sector construction and engineering projects. Prior research has focused primarily on select aspects of project delivery such as time and cost overruns; and project delays and disruptions within a limited South African context (Rafat and Ahmed, 2017; Mukuka, et. al., 2015 and Aziz, 2013). The study provides an outline for gaining a deeper understanding of unexplored influences such as legislature, framework and the political environment that governs the public sector construction and engineering industry in South Africa. It further highlights the key project characteristics, challenges, economic and socio-economic factors, national and global dynamics that are found within the public sector; which impacts infrastructure development. An empirical investigation of these issues is important as it assists in refining the key influencing factors and in developing a proposed strategic infrastructure delivery management structural model for the successful delivery of public sector construction and engineering projects in South Africa; which integrates construction project knowledge and public sector processes. This is aimed at assisting key industry professionals; so that optimum performance of construction projects and of the various stakeholders involved are achieved. This model may be used to improve or be adopted into existing infrastructure delivery models. Furthermore, previous research has focused primarily on quantitative research concerning critical success factors of projects based on global project characteristics (Amade, et. al., 2015; Hanid, 2013; Oloruntobi, 2013; Ogunlana, 2008 and Chan et. al., 2004). No study to date has directly attempted to empirically evaluate the unique factors that influences public sector construction and engineering project delivery in South Africa. The research study explores a causal relationship model between poor construction project delivery within the public sector and its contributing factors. The literature and findings should provide a basis for state owned enterprises to mitigate the current dependability and industry consistency issues, challenges, political environment and risks that surrounds successful construction project completion (Miles, 2017).

The research study contributes to the existing body of knowledge in numerous ways. First and foremost, it deepens the understanding pertaining to the range of influencing factors beyond those within existing literature in the South African context (Asiedu, Frempong and Alfen, 2017; Raisbeck and Aibinu, 2010). The findings further serve as a basis for further research into infrastructure delivery and management systems in the context of developing countries, more specifically, it provides the basis for research into the efficacy and appropriateness of infrastructure delivery management systems as a successful tool for infrastructure delivery management in the South African public sector environment.

Secondly, the research study explores the causal relationships between the influencing factors and successful construction project delivery. This aims at establishing their level of influence on project delivery. The model will be tested for both internal reliability and validity through statistical analysis validation testing. The external reliability and validity tests will be conducted through a two-stage model validation process, through the implementation of a survey questionnaire among select industry professionals. The research study provides a current body of knowledge and a guide for the implementation of the findings from industry experts, professionals and stakeholders. The findings could provide an informed platform for public sector industry stakeholders in understanding the current status of the construction and engineering sector and to take into consideration industry trends. The findings founded on empirically tested evidence will also aim at assisting stakeholders in identifying the key influencing factors with regards to successful construction project delivery. The research findings could also assist state owned enterprises and investor clients to make informed decisions pertaining to infrastructure delivery.

1.12. Chapter Summaries

Chapter 1: Introduction

The introductory chapter introduces the research topic and discusses the background study, problem statement, the theoretical and empirical research objectives, the rationale of the study, research methodology, all limitations, delimitation, assumptions, ethical considerations and the overall significance of the study.

Chapter 2 and Chapter 3: Literature Review

Chapters 2 and Chapter 3 highlights the theoretical framework of the study. It further provides an in-depth review of literature that directs and informs the study. It presents the significant concepts for the research study, in the framework of existing bodies of knowledge. It also provides insight into the public sector construction and engineering industry, project delivery, project performance and the challenges faced; including the public sector environment it finds itself in and its governance through legislature, framework and the acceleration strategies implemented.

Chapter 4: Research Model

Chapter 4 provides a detailed illustration of the components of the research model, proposed hypotheses and proposed conceptual model based on the findings from the extensive literature review.

Chapter 5: Research Methodology

Chapter 5 presents the mixed research methodology including the tools and techniques used to collect and analyze the theoretical and empirical objectives of the study. The research methodology will be explained making sure to highlight key definitions of the study and the research methods to be followed. It introduces quantitative research methods for collection of data. The research methodology processes will further be explained, in relation to the sampling processes and will illustrate the manner in which data will be analyzed and presented. Information on the reliability and validity of the data collected and research model will be included. The chapter further presents the key hypotheses to be tested based on empirical data.

Chapter 6: Data Analysis

Chapter 6 presents the findings from the quantitative research analysis of the data collected and captured. It demonstrates the planning and implementation of the survey questionnaires and semi-structured interview, presentation of data, data analysis and the structural equation model development. The chapter further presents the findings based on the analyzed data. The analysis will be conducted using the Statistical Package for Social Sciences version 26 and AMOS. The coded data will be analyzed to identify the general views of the respondents, with the findings being discussed in the context of the reviewed literature of previous studies. Thereafter an overview of the conceptual model theory, model components, model design, variables of the model, the inter-relationships of the variables and a final proposed conceptual model for successful construction project delivery will be illustrated.

Chapter 7: Model Development and Validation

Chapter 7 evaluates the final structural research model with descriptive statistics and reliability and validity testing. Exploratory and confirmatory factor analyses processes were further conducted with the refinement and measurement of the structural model. Normal distribution, multicollinearity, standard factor loadings and their statistical significance were employed to assess and test the research hypotheses. The chapter highlights the profile of the industry survey respondents; including the factors that influence successful construction and engineering project delivery in the South African public sector. It further discusses the findings of the exploratory factor analysis, principal component analysis and structural equation modelling, with the refinement of the final structural model being validated. Research findings were highlighted based on the positive results from the data analysis; with the final structural model illustrating the main constructs and sub factors that influence successful construction and engineering project delivery in the South African public sector.

Chapter 8: Discussion and Findings

Chapter 8 highlights and emphasizes the tests and validation of the SEM model, which includes the internal and external reliability and validity checks. This process is conducted via an analysis of the feedback collected from the exploratory pilot survey and survey questionnaires of industry professionals during the various stages of empirical data gathering. The results are further discussed in respect to the objectives and hypotheses of the research study.

Chapter 9: Conclusion and Recommendations

The final chapter presents a summary of the research findings, the research contributions to the existing body of knowledge and a finalized model for the successful completion of public sector construction and engineering projects in South Africa including a proposed progression for industry acceptance and implementation of the research findings. Recommendations to the public sector industry shall be articulated for implementation and for further research recommendations.

The study is structured and presented in eight chapters. The Chronological Flow of the Research Study, provides a brief introduction into the chapters to outline the chronological flow of the diverse parts of the research study.

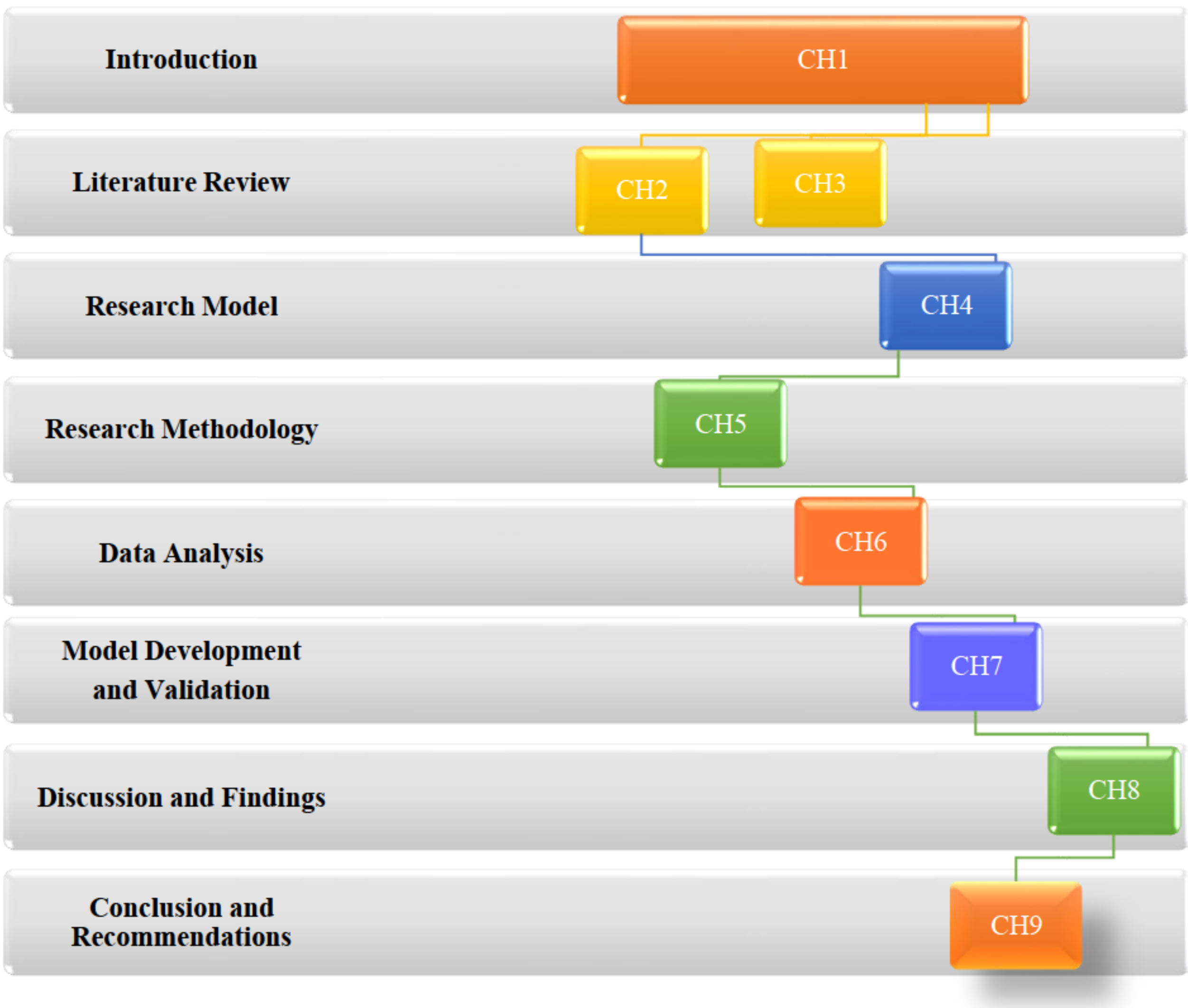

Figure 4: The Chronological Flow of the Research Study

CHAPTER TWO

THE PUBLIC SECTOR CONSTRUCTION AND ENGINEERING SECTOR

2. Introduction

This chapter provides an international and south African perspective on the nature, challenges and overall performance of the construction and engineering industry. The literature review chapter is used to establish and express the nature of the construction and engineering industry, the south African public sector in which it functions, challenges experienced by the industry and sector at large, the disruptions and delays that exist within, including the various causes and associated being outlined and the overall performance of the construction and engineering industry. The literature review responds to the questions; *"What are the key factors, roles and influence of public sector project stakeholders and project characteristics that influence successful construction and engineering project delivery in the Kwazulu-Natal region?"; "What are the key challenges; such as delays and disruptions that influence successful public sector construction and engineering project delivery?" and "What are the key socio-economic factors that influence successful public sector construction and engineering project delivery?".*

2.1. An International Perspective

Perkins, Fedderke and Luiz (2005), highlight the significant impact that economic and socio-economic infrastructure development has on the economy of a country. Economic and socio-economic infrastructure may be compared to the foundation of a building as it plays a supportive role in facilitating the productive economic activities that generates the majority of the economy, or GDP. It is referred to as investments and related services that increase the productivity of other types of physical capital. These include transportation networks, water systems, electricity and communication, whereas; social infrastructure is referred to investments and public services that increase the productivity of human capital. This includes the health and education services.

The construction and engineering sector and its involvement in societal development has been in existence since the beginning of time. Societies have utilised the natural materials within their environments for a wide range of construction projects. These projects have been planned and successfully implemented through the adaptation of concepts, active use of resources, and creating processes that are in accordance with societies cultures, circumstances and technical knowledge of the time. As a result, these structures have been effectively integrated into its natural environment (Adebayo and Adebayo, 2000). Rudofsky (1964) highlighted, that as societal needs change, the demands brought forward to the construction and engineering sector has adapted and evolved over the centuries. The dawn of colonialization brought about the introduction of both materials and techniques that were not indigenous to developing countries. The nature of the present-day construction and engineering sector is one which is a unique, complex and dynamic system that is surrounded by variables regardless of whether the country is developed, developing or underdeveloped.

According to Ofori (2015 and 1980); Dlamini (2011) and Egbeonu and McCutcheon (2007), in present-day construction, countries experience a gradual change and sense of complexity as the construction and engineering sector develops with the economy, in size, intricacy and sophistication. The construction and engineering sector continues to evolve, enhance and effectively overcome challenges posed by economic expansion. The industry is fundamentally a service industry, which acquires its resources from countless other sectors of the economy, which are interconnected.

Olanrewaju and Abdul-Aziz (2015) mentions that the construction and engineering sector is essential to the economic and societal development of a country both nationally and internationally, and appears in its national accounts: GDP, GNP, GNI and GFCF. The construction and engineering sector is diverse and is responsible for the demolition and development of infrastructure. Its activity has been classified based on the range of goods it produces, the magnitude of technical construction required and nature of building or engineering works; which contributes to the production of specific national basic needs, repair and maintenance of infrastructure, the size of construction projects and the type of client either public or private sector. Goldsmith (2014) highlights the various infrastructure development sectors and services expressed in table 2. Ofori (2015); Cottle (2014); Goldsmith (2014) and Turin (2003 and 1973) further highlight that the physical and economic characteristics of infrastructure includes; immobility; longevity; expense and public service. However, an essential characteristic of infrastructure is that it is intended to meet a specific need within a geographical context. Infrastructure developmental processes includes the planning, design and maintenance of infrastructure.

Table 2: Infrastructure Development Sectors and Services

Sector	***Typical Physical Works***
Urban	Streets; Public buildings; Lighting; Recreational facilities
Social	Social Housing; Schools; Universities; Hospitals; Prisons
Water	Irrigation; Water supply; Dams; Drainage; Flood defenses
Transport	Railways; Roads; Airports Canals; Bridges; Tunnels; Ports; Tramways
Communications	Telephone; Television; Internet
Energy	Electricity; Oil; Gas; Nuclear; Renewables
Environmental	Waste disposal; Waste treatment; Sustainable infrastructure

(Source: Goldsmith, 2014)

The contribution of infrastructure delivery to both economic growth and employment creation is widely established (Aliber, 2001; Hassen, 2000; Wells and Hawkins, 2010 and Vukeya, 2015). The contributions include:

a. Infrastructure lowers transaction costs by facilitating interactions between markets and the flow of information and goods;
b. Infrastructure creates economic investment which creates the potential for economic relations;
c. The provision of infrastructure concentrates economic activity which supports economic relationships;
d. Economic growth and employment are dependent on the quality of infrastructure delivered and the ability for an economy to respond to unexpected challenges, competitive pressures and value-added production;
e. Improving productivity capacities through the access to infrastructure services for producing quality services in communities;
f. Infrastructure development creates wealth through transport routes, agricultural systems, and other infrastructure outcomes;
g. Infrastructure expansion creates employment during the construction process and repair/maintenance phase; and
h. Infrastructure expansion enhances the demand within the economy, therefore supporting forward relationships between various stakeholders.

The construction and engineering sector plays an essential role in the contribution of infrastructure delivery, and produces valued fixed capital assets and infrastructure of a country which directly contributes to the Gross Domestic Product by enabling economic and social development which effectively creates employment (Dlamini, 2011 and Rameezdeen, 2007). More than 50% of Gross Fixed Capital Formation consists of construction and engineering sector outputs such as housing, hospitals, homes, roads, shopping malls and factories, to name a few. Capital or investment goods are also contributing factors. Therefore, it is imperative for a country to tailor its construction and engineering sector in order to ensure continuous sustained development, that enhances the level of productivity and quality of life for society, as it plays an imperative role to a countries economic growth (Myers, 2013; Hillebrandt, 2000; Ofori, 1990; 2012; Lopes, 2011; Turin, 1973).

Field and Ofori (1988) regard the construction and engineering sector as a notably indispensable contributor to the growth and sustainability of an economy. Ramazdeen, (2007) further highlights that the sectors can be used as a gauge of the economic welfare of a country due to its contribution. This could be found in the employment and capital formation of a country. The construction and engineering sector accounts for 6-10% of total employment in developed countries and 2-6% in developing countries. Capital formation amounted to 7-13% of the GDP in developing countries while developed countries ranged between 10-16%. It is notable that the significant contributions of infrastructure delivery to a countries economy and its construction and engineering sector, has an immense impact on the diverse nature, image and complexity of the industry.

The nature of present-day construction and engineering sector is largely based on British standards which is separated into three sub-sectors; the building, civil engineering and materials manufacturing sectors which interrelates with nearly all areas of societal endeavours. The responsibilities of the construction and engineering sector includes design, planning, construction, preservation and destruction of development, which enable economic and societal activities to be attained. However, the nature of the South African construction and engineering sector is often poorly understood. A greater understanding is therefore required as it is essential in order to formulate effective policies and strategies (Ramazdeen, 2007).

"… some of the problems with which the building industry in Africa is faced are of a similar nature to those encountered in more industrialised countries. Discontinuous programmes, frequent stoppages of work, conflicts arising from the interpretation of inadequate or incomplete specifications and drawings, delays in the settlement of accounts or in the refund of guarantee funds …
(Economic Commission for Africa, Housing in Africa, United Nations, New York, 1965:99)."

It is largely recognised that the construction and engineering sector plays an essential role in the South African economy and is a noteworthy contributor to the national and socio-economic development of the country (Construction Industry Development Board 2012; Statistics South Africa, 2010). The United Nations Industrial Development Organisation (2009) and Kelly (1984), state that the construction and engineering sector is a complex collection of industries, which includes plant and equipment manufacturers, banking services, material manufacturers, contracting organisations and so forth. Despite these significant economic and social contributions to the country, the construction and engineering sector suffers from a negative image. The industries poor image is attributed to various factors which include poor site conditions and environmental considerations; high accidental rates; poor work practice and productivity; adversarial relationships; rework; delays and cost over-runs. As a result, a positive image is a representation of the overall performance, which affects the reputations of industry stakeholders involved in the project development process. Project image and reputation are therefore inter-related (Smallwood, 2010 and Wells, 2001). A positive image is therefore important, as it defines the manner in which industry stakeholders and society at large, therefore there is a need for the re-evaluation of the public sector image and of the construction and engineering sector which is respected by the society at large.

Ofori (1980) refers to the construction and engineering sector as being liable for the design, planning, development, maintenance and subsequent destruction of the building. This enables social and economic activities to be conducted. As a result, the construction and engineering sector is a service industry, which obtains its resources from numerous areas of the economy, with which it is interconnected and interdependent. Therefore, it may be argued that the construction and engineering sector and its projects should be understood as a complex and dynamic system. Construction processes encompass the interpretation of the clients' needs into construction works which supports the performance of recognized activities, are in accordance with agreed standards and merges with the built environment. However, the nature of the South African construction and engineering sector is not well understood and the extent of its contribution is not always clear. A deeper understanding is therefore required as it is essential in order to formulate policies.

The intrinsic features of this construction and engineering sector include:

a. Size,
b. Cost,
c. Time
d. Demands,

e. Location,
f. Organisation,
g. Technology, and
h. Construction information.

As a result of its features, the construction and engineering sector plays a vital role in every country and is therefore not seen as efficient and nor are they free from challenges (Ofori, 1980).

The intrinsic nature of the construction and engineering sector includes:

a. Size

The construction and engineering sector is a critical component of the economy of a country, as it contributes a substantial percentage of its annual national product, creating employment for the working population, responsible for capital formation, and relating to other complex economic activities. According to Ofori (2000; 1980) and Hillebrandt, (2000), the industries role in infrastructure development such as hospitals, schools, houses, factories and schools accounts for a fraction of the sector. It is also responsible for the construction of ports, bridges, roads and sewers which obtains its vital resources from several sectors of the economy. In addition, the construction and engineering sector maintains and repairs the various types of infrastructure. The main significance of the sector is that it is a sizeable sector that delivers infrastructure of which other sectors depends on. It is essential to note that the construction and engineering sector is however affected, favourably or adversely, by policies, regulations, credit restrictions, taxation, import controls, education policy and research support (Organisation for Economic Co-operation and Development, 2008).

b. Cost

Infrastructure development is a very arduous and expensive process. As a result, accumulated savings are generally used to meet societal demands. These demands create employment opportunities where the general income of the labour force may be inflationary. Government's role in construction costs relates to its fiscal policies which have a significant impact on the movement of capital resources to the private and public sector. The government and other state-run enterprises are the most important client of the construction and engineering sector. As clients, they relate directly to the construction and engineering sector as clients, and indirectly as policy makers (Ofori, 2000; 1980).

Due to unforeseen construction risks and the industry’s high mortality rates, clients make a concerted effort to safeguard their investments and minimise costs. The role of governments transcends their role as clients to their direct and indirect control of construction aspects such as building regulations, practices, taxation and wage policies. Government therefore plays a vital and dominant role within the construction and engineering sector and infrastructure development (Windapo and Catetll, 2013).

c. Time

Construction projects have complex and time-consuming designs which tend to have lengthy contract periods which require a mix of vital resources at various stages. The construction processes and methods are also prone to unseen events and circumstances (Acharya, et al., 2006). This results in challenges and effects the management of risks which has become a major problem that challenges the construction and engineering sector. As a result, articulating policies for the construction and engineering sector is a daunting task which requires the expertise of numerous role players, foresight and a sense of stability when faced with adverse geographical and economic conditions (Gardezia, et al., 2013, 2014; Ogunlana, et al., 1996; and Ofori, 1980).

d. Demands

The undeniable demand for infrastructure development is determined by urban growth which is a result of a shift for various role players within the construction and engineering sector. Infrastructure is essential to the economic and socio-economic development, that is significant for even the poorest countries. It differs from province to province, and even from one district to another. According to Amrop and Landelahni (2012), the Medium-Term Expenditure Framework (MTEF) in South Africa has set aside R850b for public sector infrastructure projects and highlighted a further R3,2 trillion to be spent on infrastructure development over the next two decades. The construction and engineering sector is varied and subject to deviations in the environment within which it operates to produce investment goods and services. It is essentially a service industry which responds to societal demands and as a result, cannot stock its products or investments (Weddikkara and Devapriya, 2001).

Infrastructure is produced in response to demands, at a fixed cost, in a defined timeframe, in accordance to the documented design plans and making sure that it is of highest quality. The factor of demand within the sector in combination with the duration it takes to provide resources, is a determinant of the major challenges experienced which often has harmful effects. The entrepreneurial independence of proprietors may be limited; the contractor may find construction operations out of his control; the materials and techniques are specified, and both suppliers and subcontractors are nominated (Ofori, 2000; 1980).

e. Location

Infrastructure is generally fixed and therefore it is vital to consider the geographical location and the structures area of reach. This affects the type of construction and engineering sector and development strategy that a country adopts. The fragmented nature of the industry has produced a myriad of professional practices/organisations with flexible employment policies who have very little capital investment, a sensible number of projects and are located country wide for ease of infrastructure development (Ofori, 2000 and 1980).

f. Organisation

The construction and engineering sector through infrastructure development draw a variety of individuals together with an array of skills and expertise. Larger projects bring together a great number of individuals. The roles of individuals also differ between construction projects and from one stage to another. Turin (2003 and 1973), categorized the constantly changing roles of the various individuals under four main groups: a traditional approach, component approach, notional building and package deal. It is a sector that is composed of an interactive process between numerous professional organisations, all actively participating in the construction process at various stages, at varying time periods and to achieve specific objectives. The various role players are interdependent and are accomplished in an uncertain environment. However, in many countries, the sector is classified by a set of rules, regulations, policies, associations and establishments that hinder the cooperation amongst the various role players. Therefore, contractual frameworks have an impact on the efficacy of the construction and engineering sector (Ofori, 2000; 1980).

g. Technology

Technology has always had a place within the construction and engineering sector, with an extensive array of technologies employed in the construction and engineering sector of each country. As technology progresses in society, our expectations and demand for infrastructural services has changed, however the need has always been there. Figure 5 illustrates a time line of infrastructure innovations and economic growth (Goldsmith, 2014).

First world countries have sought to improve upon existing technologies and techniques. Higgin and Jessop, (2013), mention that when conducting research in the building industry, different methods and procedures are at its core, traced back to the Noah and the building of the Ark. The construction and engineering sector utilises an array of materials, techniques and equipment, ranging in complexity. This is of great importance as countries require a range of technical programmes recently developed to sustain their development in a highly competitive market. The policies of a country often determine the magnitude of imported technological techniques, materials and equipment to be used. It also provides regulations and bye-laws specific to the construction and engineering sector that governs the distribution and use of space, including the standards of workmanship in order to ensure proper health and safety standards are maintained. These policies, regulations and bye-laws are influential in regulating the choice of materials and techniques employed. As infrastructure developments of the construction and engineering sector interrelate with societies way of life over a life time; as reflected in figure 6, appropriate technologies should consider the relationship between the economy, technology, man and the equipment he/she uses; including a set of social, psychophysiological and culturally appeasing requirements. This forms the fundamental dynamic nature of the construction and engineering sector (Ofori, 1980).

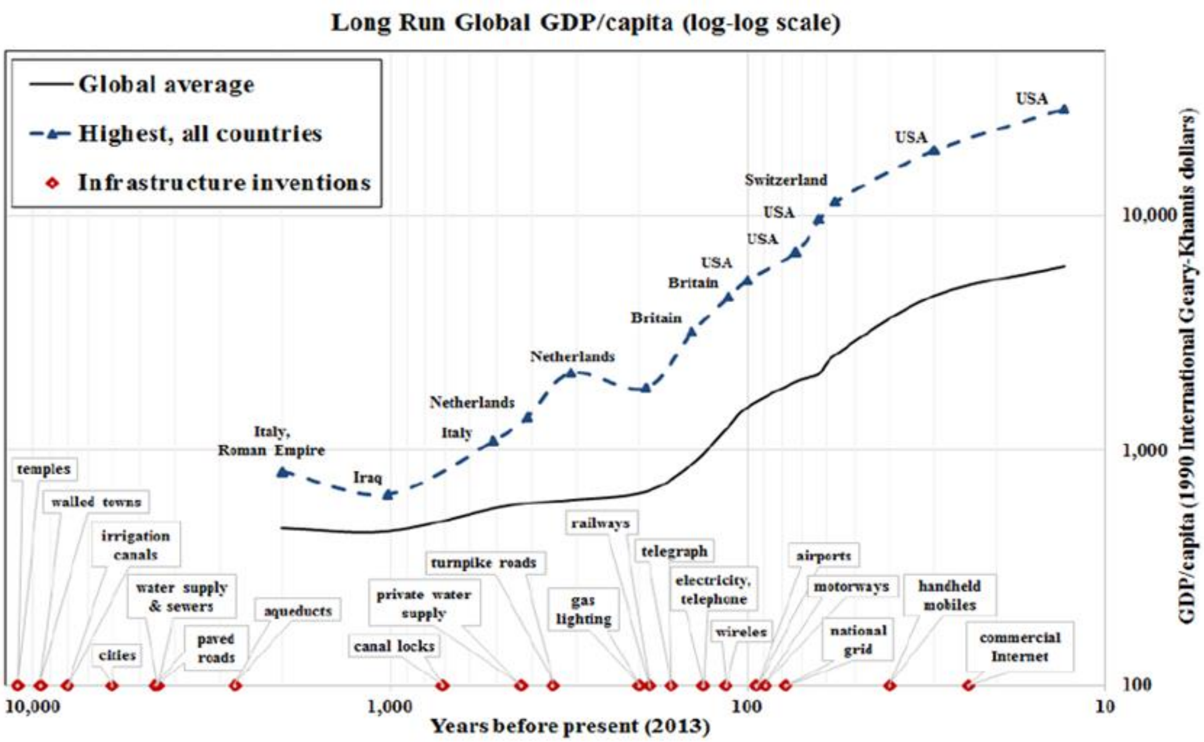

Figure 5: Time line of infrastructure innovations and economic growth (Goldsmith, 2014)

h. Construction Information

According to Ofori (2015, 2000 and 1980) and Ramazdeen (2007), the nature of the construction and engineering sector, as mentioned previously, is one of complexity and unpredictability. It is essentially a service industry that is interconnected by several role players and other sectors of the economy. Construction activities between various role players also occur in a host of production units in quite a few isolated areas, with the risk of omission or duplicating of information. As a result, information becomes outdated due to fluctuating regulatory frameworks and government policies. It is therefore trying to acquire a foundation for policy development or to provide extensive planning for the construction and engineering sector. These factors negatively influence the collection of construction information.

2.2. A South African Perspective

The development of economic and socio-economic infrastructure in South Africa has a long and troubled history. During the 19th and 20th centuries, the development of infrastructure in South Africa was controlled by the state. The state owned and operated infrastructures such as harbours, roads, airports, power stations, railway lines, water systems, and all communication networks. However, access to economic and social infrastructural services was pre-determined along racial lines, with favour being granted to the minority white population and away from the majority black population (Perkins, et al., 2005).

Under apartheid rule, not only was there cultural and spatial separation between the various race groups, but the black population were also not allowed to own freehold property, nor were they allowed access to government contracts (Mooya, 2007 and Bolton, 2006). In the late 20th century, South Africa had experienced an economic crisis and an increased movement with the racial class struggle. This resulted in a grave threat to the level of success of construction and engineering sector companies. In 1994, South Africa had experienced a further change with the dawn of a new era under the new political rule of the ANC. In an effort to address the discriminatory and unfair practices, the Constitution of the Republic of South Africa, (RSA, 1996) laid the foundation for the public procurement system. A host of policies and legislative interventions was enacted such as the Preferential Procurement Policy Framework Act, 5 of 2000 (PPPFA) (RSA, 2000). The Public Finance Management Act, 1 of 1999 (PFMA) (RSA, 1999) and the Broad-Based Black Economic Act, 53 of 2003 (B-BBEE) had been devised and implemented in order to generate increased participation by the black population in all aspects of the construction and related property industry.

Affirmative action and employment equity policies have also sought to alter the demographic profile of the construction and engineering sector. The broad based black economic empowerment (B-BBEE) policy, preferential procurement policy and the promotion of a property charter are all attempts to intensify the level of black proprietorship within the industry and to facilitate the spending power to assist black-owned businesses to develop (Cottle, 2014 and Mooya, 2007). The post-apartheid economic period in South Africa has been characterised as one of the most extensive periods of positive economic growth, with the average GDP growth rate of 3,2% between 1993 and 2013, through its provision of infrastructure development. In 2013 the formal and informal sector of the construction and engineering industry noted an employment rate of 1,204,000 million. The annual contribution of the sector to GDP in 1994 was 2,9% and 3,1% in 2013. This level of contribution averaged at 2,3% of GDP over a period of two decades (Statistics South Africa, 2014).

The South African construction and engineering sector has shown to be a dynamic, multifaceted industry which is complex and risky due to its political transformation and emergence as an inclusive nation, in a post-apartheid era. The end of a period which was plagued by sanctions and racial policies which restrained its growth. The country has made a resolute commitment to infrastructure development and transformation amongst the historically disadvantaged communities; where significant achievements have been made in terms of capital investment with a decrease in service backlogs that were inherited from apartheid (Palmer, et al., 2016). However, recent years have seen an emergence of challenges such as infrastructure service delays and disruptions. These are a common sight in present day construction. The management and successful completion of construction projects have faced many difficulties due to the intrinsic complexity, dynamics and uncertainty of construction projects regardless of the numerous interventions that have been employed (CIDB, 2011, 2004 and Wells, 2001).

The World Bank expressed:

"That the emphasis of the first fifteen years on expanding access to services in previously disadvantaged communities has been appropriate and necessary – much progress has been made, particularly in extending access to electricity. Frustratingly, some service delivery "backlogs" remain (World Bank, 2009:6)*".*

With the implementation of a new political rule in South Africa, an influx of policies, legislations and frameworks explicit to the construction and engineering sector was approved; with governmental organisations, state owned enterprises and municipalities becoming the public sector's single biggest client. This initiative promoted transformation of the sector and its capacity to deliver economic and societal infrastructure. Transformation brought about an important endeavour in the construction sector, with an improved degree of centralisation and concentration of capital including the stability it provides (Ofori, 2015 and Ofori et. al., 1996).

2.2.1. The South African Public Sector Construction and Engineering Industry

The public sector construction and engineering industry in South Africa, is an industry that is highly project driven with projects that are immensely diverse, complex and capital in nature. It is an industry that is highly sophisticated and unique, as it inhabits both first and third world characteristics. It is regarded as being on the same level with the rest and the best in the world. However, a large portion of the construction and engineering sector still maintains characteristics that are more in common with third world developing countries, such as its status as an emerging economy and the lack of social transformation (Cottle, 2014 and Mooya, 2007). The Construction Industry Development Board (2012), Statistics South Africa (2010), The United Nations Industrial Development Organisation (2009) and Ofori (2007), view the South African public sector construction and engineering sector as an essential component of the economy, which seeks to provide infrastructure, as the contribution provided by sector determines the degree of investment. This later translates into investment outcomes which benefits the country (Windapo and Cattell, 2013).

South Africa's progression towards democracy finds itself in the pursuit of nation and economic building due to sanctions and racial policies which had previously restrained its development. The government aims to adopt a sense of multiculturalism within the construction and engineering sector through a range of policies, frameworks and resulting legislations. As a result, the government has become the public sector’s singular greatest client in contributing extensively to infrastructure development within the construction and engineering sector; infrastructure development funded by the countries taxpayers (Mooya, 2007 and Baines, 1998). Extensive construction processes are managed through policies and procedures that have been implemented by the government within the public sector. The immediate influence of these policies and procedure has a considerable effect on the performance of construction and engineering projects. The government had identified policies and procedures in the public sector construction and engineering industry though the Public Finance Management Act, 1 of 1999, Preferential Procurement Policy Framework Act, 5 of 2000 and the Broad-Based Black Economic Empowerment Act, 53 of 2003. These policies were and continue to be essential in bridging the gap within the economy and in lack of infrastructure development created through the apartheid dispensation. (Cottle, 2014).

The South African public sector construction and engineering industry has evolved to become internationally competitive through its ability to adapt and innovate itself. However, the sector experiences significant challenges in its efforts to ensure suitable capital infrastructure development, along with adequate skills development, technological innovation, partnerships between various stakeholders, efficient regulations and effective government contributions. The successful development of capital projects contributes to the development processes of provinces, regions and communities in countries throughout the world. It is therefore imperative that construction projects successfully achieve the goals for which they were conceived and essentially meet societal demands. It is important to note that public sector infrastructure development seeks to address the crisis of the country in order to ensure the success of any sustainable infrastructure development (Windapo and Cattell, 2013).

Government has created vital mechanisms such as state-run enterprises to assist the public sector in achieving effective economic development and service delivery; locally, regionally and internationally, as they source a large amount of public resources, capital equipment, partnerships and finances. The Public Finance Management Act, 1999 (Act 1 of 1999), highlights 300 public organisations that consists of nine constitutional institutions, 21 major public entities, 153 national public entities, 26 national government business enterprises, 72 provincial public entities and 18 provincial government business enterprises. Larger departments such as the Department of Energy, the Department of Transport, the Department of Communications and the Department of Minerals and Energy have been involved in infrastructure development programmes and have been placed under the Department of Public Enterprises (Department of Public Enterprises, 2012).

Mbande (2010) also states that the role of state-run enterprises is to assist government in achieving economic growth and service delivery. Public sector infrastructure expenditure over the medium-term expenditure framework (MTEF) period is valued at a total of R947.2 billion, highlighted in table 3. State-run enterprises account for the majority of capital investment in South Africa, having spent an estimated R432.8 billion over a period of three years. The nine provinces are anticipated to spend a total of R198.2 billion on infrastructure development, while municipalities have projected an expenditure of R179.6 billion for infrastructure development over a three-year period. The development promotes the growth of the economy and the socio-economic development of the country's capital infrastructure development by 77 per cent of total public sector infrastructure expenditure through the energy, transport, manufacturing and telecommunications sectors. The funds are used to elevate and expand the transport network, develop electricity capacity and advance water and sanitation services (National Treasury Budget Review, 2017).

The development of socioeconomic infrastructure for the provision of services amounts for 20 per cent of public-sector infrastructure expenditure, while education amounts for 5 per cent and health services amounts to 4 per cent respectively. In order to ensure successful economic and socio-economic development, capital infrastructural projects are required to be delivered timeously, within budget, in accordance with quality standards and specifications and to the stakeholder's satisfaction. (Fourie, 2014 and Mooya, 2007).

Table 3: Public-Sector Infrastructure Expenditure and Estimates

R billion	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	MTEF
		Outcomes			Estimates			Total
Energy	69.6	67.8	65.9	75.0	78.3	81.9	74.3	**234.5**
Water and sanitation	25.8	29.5	31.5	37.2	39.3	41.2	44.9	**125.4**
Transport and logistics	77.8	92.4	81.3	91.4	104.6	105.7	117.4	**327.7**
Other economic services	13.0	13.0	13.2	16.0	12.6	12.9	13.0	**38.5**
Health	10.0	8.7	10.3	11.0	11.2	11.9	12.5	**35.6**
Education	13.7	15.4	18.0	17.3	17.6	15.8	16.7	**50.1**
Human settlements[1]	17.0	17.1	18.3	18.3	20.0	21.1	22.3	**63.4**
Other social services	12.9	13.1	16.3	15.6	16.1	16.6	17.5	**50.2**
Administration services[2]	5.0	5.2	6.5	7.9	7.1	7.2	7.5	**21.7**
Total	**244.8**	**262.2**	**261.2**	**289.8**	**306.7**	**314.3**	**326.1**	**947.2**
National departments	11.9	13.5	14.5	16.6	16.7	16.0	15.0	**47.7**
Provincial departments	55.2	56.4	60.6	62.3	64.1	65.1	68.9	**198.2**
Local government	47.1	53.2	54.7	58.2	56.7	59.1	63.9	**179.6**
Public entities[3]	15.4	19.2	17.8	22.0	23.9	23.6	24.9	**72.3**
Public-private partnerships	3.9	4.0	4.3	4.8	5.1	5.5	5.9	**16.5**
State-owned companies[3]	111.2	115.8	109.3	125.8	140.3	145.0	147.5	**432.8**
Total	**244.8**	**262.2**	**261.2**	**289.8**	**306.7**	**314.3**	**326.1**	**947.2**

(National Treasury Budget Review, 2017)

However, within state-run enterprises, there exists a shortage of efficient skills that are essential for a diverse range of infrastructural developments. The South African Construction Industry Development Board (CIDB, 2004) mentions that public-sector capacity has become the main constraint in successful infrastructure delivery and the sustainable growth of the public sector construction and engineering industry. Milford (2010) and van Wyk (2003) note that the lack of capacity within the public-sector construction and engineering sector has led to a tedious and an inefficient process of financing capital projects by the government. This had created project delivery backlogs and payment backlogs to contractors of up to six months. They also highlight the inability of government and state-run enterprises to effectively spend budgetary allocations received for infrastructure development. The fundamental role of the public sector is to continuously meet societal needs within an evolving environment. This is due to rapid globalisation and an increase in consumer expectations. However, despite South Africa’s new economic policies and framework, unemployment still remains high and productivity growth remains low, which is reflected through the GDP per capita growth (Fourie, 2014). Figure 6 reflects the GDP contributions in South Africa within the engineering and construction sectors, while figure 7 reflects the GCFC contributions for 2019 and figure 8 representing the overall growth rates in industry value added and GDP in South Africa.

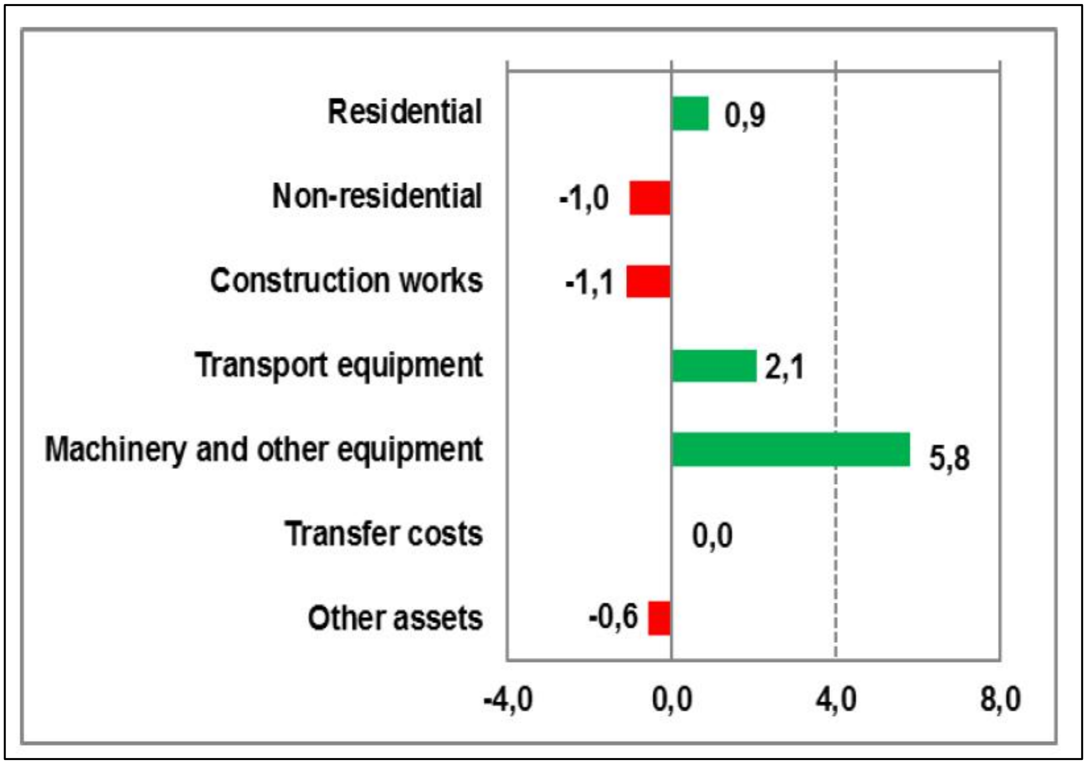

Figure 6: GDP Contributions in South Africa (Stats SA, 2019)

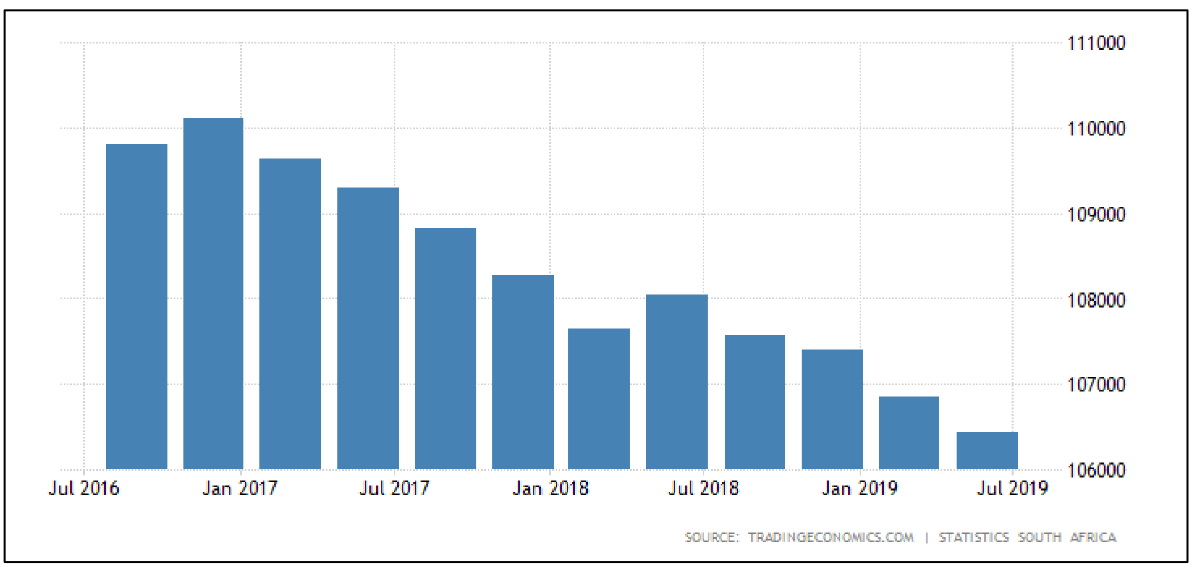

Figure 7: GCFC Contributions for 2019 in South Africa (Stats SA, 2019)

	Agriculture, forestry and fishing	Mining	Manufac-turing	Electricity, gas and water	Construc-tion	Trade, catering and accommo-dation	Transport, storage and communi-cation	Finance, real estate and business services	General govern-ment services	Personal services	Total value added at basic prices	Taxes less subsidies	GDP at market prices
	% change year-on-year												
2013	4,5	4,0	1,0	-0,6	4,6	2,0	2,9	2,6	3,2	2,6	2,6	1,8	**2,5**
2014	6,8	-1,7	0,3	-1,0	3,5	1,4	3,5	2,7	3,2	1,8	1,9	0,9	**1,8**
2015	-5,9	3,3	-0,4	-1,9	1,8	2,1	1,4	2,1	0,8	0,9	1,1	1,6	**1,2**
2016	-10,1	-3,9	0,8	-2,1	1,2	1,7	1,1	1,9	0,6	1,8	0,5	-0,5	**0,4**
2017	21,1	4,2	-0,2	0,6	-0,6	-0,3	1,4	2,1	0,3	1,3	1,5	1,0	**1,4**
2018	-4,8	-1,7	1,0	0,9	-1,2	0,6	1,6	1,8	1,3	1,0	0,7	1,2	**0,8**
	% change year-on-year												
2015 Q4	-6,3	-0,8	-1,3	-3,7	1,4	2,4	0,4	1,6	0,4	0,5	0,5	0,2	**0,4**
2016 Q1	-5,4	-10,4	-0,7	-4,2	2,0	1,7	-0,2	2,2	0,4	1,4	-0,3	-2,2	**-0,4**
2016 Q2	-16,1	-3,8	4,1	-1,8	0,5	2,1	1,0	2,0	0,3	1,5	0,6	-0,4	**0,5**
2016 Q3	-12,9	0,7	0,6	-0,8	1,4	1,2	1,1	1,7	0,3	2,2	0,7	0,3	**0,7**
2016 Q4	0,0	-2,2	-0,6	-1,8	0,8	1,6	2,4	1,8	1,4	1,9	0,9	0,2	**0,9**
2017 Q1	4,4	7,0	-0,8	-1,0	-0,4	-0,5	1,6	1,8	0,9	1,2	1,2	0,6	**1,1**
2017 Q2	36,7	1,9	-2,0	1,1	0,1	-0,7	1,3	2,2	0,1	1,4	1,6	1,4	**1,6**
2017 Q3	36,6	4,0	-0,3	-0,2	-0,4	-0,5	1,0	2,1	0,1	1,7	1,6	0,9	**1,6**
2017 Q4	-2,9	4,2	2,3	2,3	-1,5	0,5	1,5	2,2	0,1	0,9	1,4	1,1	**1,4**
2018 Q1	-3,1	-0,9	0,3	1,0	-1,8	0,6	2,0	1,3	1,2	1,3	0,7	1,2	**0,7**
2018 Q2	-16,9	1,4	1,0	0,1	-1,3	0,4	-0,1	0,9	1,5	1,0	0,1	0,5	**0,1**
2018 Q3	9,4	-3,8	1,2	1,4	-0,8	1,1	1,9	1,9	1,6	0,7	1,2	2,2	**1,3**
2018 Q4	-0,6	-3,4	1,3	1,1	-1,1	0,3	2,4	3,1	1,0	1,1	1,1	0,9	**1,1**
2019 Q1	-12,7	-4,6	0,6	-1,4	-2,3	-0,6	1,1	2,4	1,0	1,3	0,1	-0,4	**0,0**
2019 Q2	-6,7	-2,1	0,5	-0,5	-2,5	0,6	2,5	3,1	1,8	0,8	0,9	0,5	**0,9**
2019 Jan-Jun	-9,2	-3,3	0,5	-0,9	-2,4	0,0	1,8	2,7	1,4	1,0	0,5	0,1	**0,4**

Figure 8: Growth rates in industry value added and GDP (Stats SA, 2019)

Omran, et al., (2012) states that by constantly improving the efficiency of construction projects and through successfully achieving construction project objectives, it becomes the foundation for determining success factors that are critical to construction and engineering projects. However, in the twenty-first century a high rate of failure of public sector projects in SA has led to unsuccessful infrastructure project delivery. As a result, very few individuals would dispute that the South African public sector construction and engineering sector maintains a negative image.

2.3. Public Sector Challenges in the Construction and Engineering Industry

The construction and engineering sector is well known globally to be faced with a constant array of challenges. However, developing countries have been faced with these difficulties and challenges at increased levels, which are present alongside the countries socio-economic stresses, long-lasting resource shortages, institutional and operational weaknesses and the overall inability to handle key issues. Ofori, (2000), has highlighted that over the last two decades, these challenges have become greater in scope and severity. Challenges such as capacity inefficiencies within the public sector construction and engineering industry, lack of accurate data for decision making processes, uncertain economic environments; high levels of unemployment, poverty, reduced urban investment, the overall lack of interest by industry stakeholders, lack of interest with regards to sustainable development, technological inactivity and the overall dependence on engrained colonial codes of conduct and standards. Once these challenges are identified the improvement of environmental health and safety standards may be achieved and the development of new procurement approaches can be implemented for the successful implementation and completion of construction projects (Du Plessis, 2002 and Construction 21 Steering Committee, 1999).

2.3.1. Government Policies, Legislatures and Frameworks

The construction and engineering industry is a complex industry that experiences ongoing difficulties, due to the lack of governmental policies, legislatures and frameworks or; due to ineffective policies, legislatures and frameworks that aim to support the construction and engineering sector. Governmental organisations and state-run enterprises have implemented tender processes based on a low price-base system which have been identified as highly inefficient at times (Latham, 1994). The political transformation experienced in South Africa has seen rapid changes of policies such as the Public Finance Management Act, Preferential Procurement Policy Framework Act and the Broad-Based Black Economic Empowerment Act in an attempt to foster rapid transformation in the public sector construction and engineering industry (Fourie, 2014 and Du Plessis, 2002).

These policies were developed through the identification of national construction priorities and with the fundamental aim of providing guidance for industry stakeholders in the mobilization of investment. Policies and legislatures are established with the aim to provide a framework that assists in the development of infrastructure through personal professional enhancements and business productivity enhancement. However, transformation in the South African public sector has witnessed significantly high levels of corruption and favouritism that has been created with the open economic policies (Fourie, 2014, Emuze, 2011 and The Public Service Commission, 2007). The transformation of policies and legislature over the past few decades have seen the South African public sector restructure inherited policies, which previously disadvantaged historically disadvantaged individuals. These policies seek to determine the relevant procedures and practices including the associated documentation used in the construction and engineering sector. It specifies the roles of all stakeholders involved and the associated relationships amongst them. It highlights the levels and powers of authority, as well as the channels of communication. The traditional procurement approach used in South Africa is also predominant in other Commonwealth countries. However, as stated by Rwelamila et al (2000), the failure to integrate cultural behaviours in procurement policies and processes in the construction and engineering sector is a significant contributor to the poor performance of projects.

2.3.2. Financial Contributions

The transformation of policies and legislature in the South African public sector construction and engineering industry has seen the private sector play an essential role in the funding and delivery of services that were traditionally the responsibility of the public sector. This is based on numerous reasons, with the key reason being that government and state-run enterprises are incapable to manage with the constant growing demands on the capital budgets. Most infrastructure are funded by fiscal budgets, however factors such as investment requirements and macroeconomic volatility, have shown that public sector financing in the South African economy is volatile and seldom meet essential infrastructure expenditure in a suitable and sufficient manner (Cheng, 2014 and Ferreira and Khatami, 1996). The private sector offers efficacy arising through innovation management and marketing skills. As well as the control of operating costs of construction, maintenance costs; and additional finance for infrastructure development projects. This enables economical infrastructural projects to be unrestrained from public-expenditure constraints. As a result, it generates economic benefits for the country including the effects of foreign investment (Chege and Rwelamila, 2001 and Haley, 1996).

Numerous researchers have debated the importance of selecting the most appropriate procurement system, including the selection criteria used in determining the most appropriate procurement method (Rwelamila, 2000; Love et al., 1998 and Latham, 1994). Therefore, with the transformation of policies and legislature frameworks in the South African public sector, several procurement arrangements have been developed involving private sector participation. The selected procurement systems have as a result played an essential role in influencing privately funded projects that have been secured through public private partnerships (PPP). Arndt, (1999) and Confoy et al. (1998) mention that in an effort to reduce excess expenditure, deficit reduction programs have been employed in an attempt to efficiently control government debt and has encouraged the use of innovative procurement and financing methods (Chege and Rwelamila, 2001).

2.3.3. Skills Capacity

Globally, the construction and engineering sector suffers from an inadequate supply of industry professionals, skilled labour force and the inexperience of graduates. The South African construction and engineering sector is an industry that suffers from these inefficiencies. The construction and engineering sector experiences an increased demand for construction and engineering sector professionals, while offering low levels of salary structures. This ultimately reduces the number of skilled professionals retained in the local construction and engineering sector. The inexperience of new graduates may be a direct result of the inadequacy of industry-oriented training obtained during the degree programme offered by higher education institutes. There are several reasons as to why lower skilled workers exist in an organisation. This is due to lack of training opportunities offered by the government, private or state-run organisations and the lack of skill development short courses, comprehensive training courses and poor interest shown by workers/individuals for such courses (Hapuarachchi and Senaratne, 2008). Kaliba et al. (2009) mentioned that industry stakeholders such as clients, contractors, consultants and the common workforce should ensure that adequately skilled employees with suitable qualifications to effectively manage construction and engineering projects within an organisation are employed. However, in recent years this has become a significant issue experienced in the South African public sector construction and engineering industry (Haupt and Armoed, 2017).

2.3.4. Socio-Economic Culture

The socio-economic culture of the South African construction sector continues to develop and evolve throughout decades of social transformation, however in spite of all its achievements, the country still experiences a high rate of poverty; with new levels of inequality that are changing racial manifestations associated to the various levels of wealth and income inequality. This has led to increased levels of unemployment that is accompanied by negative formal sector employment as well as increasing levels of crime in society, especially within the formal sector industries. This has led to an environment that has become un-attractive to foreign and direct investment that often enables economic growth (Coetzee, 2014, Cottle, 2004 and Pillay et al., 2002).

Pillay (2000), states that South Africa in the 21st century face six essential socio-economic challenges. These include; macroeconomic policies; the labour force; high levels of inequality; a deficient social sector; globalisation and the economy. However, the resolution of these challenges lay in the effective development and implementation of policies, that include economic policy reforms. The programmes and strategies that have been implemented since the end of the apartheid era have sought to bring about transformation, but however, has not addressed the policy constraints. As a result, more policy thinking should be exercised for both social and economic transformations. According to Barthorpe et al., (1999) and Hofstede (1980), the organisational culture of organisations also plays a pivotal role in the effective coordination and management processes, whether private or public. This has become a vital area for research. This is often determined by an organisations history, size, objectives, industry, technology and its operating environment. The organisational culture found in the construction sector, consists of a consortium of organisations interacting with each other on a construction project, where cultural issues are prevalent.

However, the capacity of construction and engineering projects to effectively manage cultural issues within multi-cultural organisations, is a project determinant of organisational and project success. Individual conservatism and an organisations inheritance of processes, procedures and mixed professions including the essential operations of a national system of law are all vital to an organisations culture (Bröchner, et al., 2002).

Previous research relating to culture have been conducted by Rwelamila et al, (2000), Liu and Fellows, (1999) and Rowlinson and Root, (1997), highlight the impact of a nation's culture on infrastructure development, the culture of construction and engineering projects, the culture of an organisation and the overall culture of a construction site. The South African construction and engineering sector is quite unique with regards to its diversity and culture, including its inescapable influence on organisations and societies. Therefore, it is essential that the required effort is used to formulate practices, processes and associations that are suitable to the ethos of the country as universal solutions. Public sector organisations and their cultures are required to formulate specialised procurement methods that facilitates the amalgamation of development processes (Bröchner, et al., 2002).

2.3.5. Stakeholder Management

The concept of stakeholder management has become increasingly significant in recent years and it is especially pertinent to the construction and engineering sector as projects are often directed by a select few stakeholders. The effective co-ordination and management of cost planning, documentation, time, communication, progress monitoring and administration of construction projects are often illustrated as complex processes in the construction and engineering sector. Effective cost planning ensures that the objectives of the organisation and associated stakeholders are compatible with its resources. However, poor cost planning and incorrect documentation of processes by an organisation and its stakeholders results in poor quality of work and in convoluted process. Improper progress and time management strategies by stakeholders, result in schedule and cost overruns. Therefore, in order achieve effective stakeholder management, it is important to categorise construction and engineering sector stakeholders as primary and secondary stakeholders (Chege and Rwelamila, 2001 and Malkat and Byung-Gyoo, 2012).

Primary stakeholders are directly connected to the project and deem to include the client, consultant, and project manager. Secondary stakeholders have an indirect connection to the project and include employees, sub-contractors, investors, suppliers, third party individuals or organisations, financial institutes, pressure groups, governmental authorities, trade associations, and societies. These stakeholders have a substantial influence on the outcomes of construction and engineering projects. As a result, effective project stakeholder management is expected to provide project managers with the necessary support to assist with appropriate decision making that maximizes the value of the project, to project stakeholders (Oppong et al., 2017 and Cleland, 2002).

2.3.6. Information Technology

Information technology (IT) plays a vital role on all construction projects as it specifies the end product and controls all activities required for developing an infrastructural asset. IT has become an essential component of the construction and engineering sector and is often involved in all activities on a project, throughout the project lifecycle as reflected in figure 9. The evolution IT has had a profound impact on how organizations, whether private or public sector construction and engineering industry operate (Ofori, 2000).

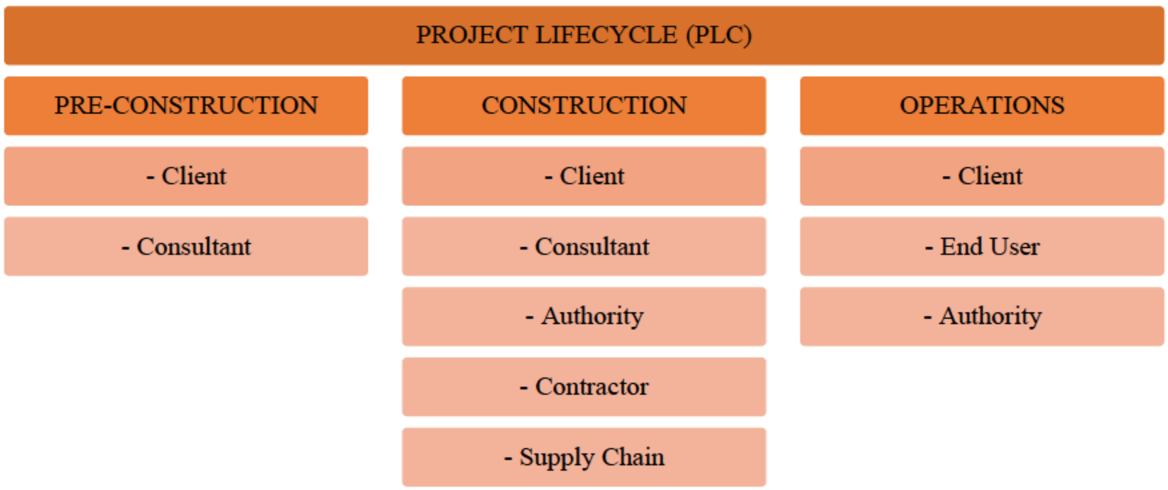

Figure 9: Stakeholder Involvement – Project Life Cycle (Malkat and Byung-Gyoo, 2012)

The South African public sector construction and engineering industry is often categorized by a level of disintegration amongst industry stakeholders that is incomparable to any other economic sector. The fragmentation has given rise to fundamental issues in communication and an overall coordination breakdown across a project lifecycle, across various construction related disciplines, and existing subsystems. These challenges negatively influence the productivity, performance and overall competitiveness throughout the construction and engineering sector (Rivard et al., 2004).

However, the effective and efficient use of IT can assist in facilitating the exchange and management of information across various platforms amongst industry stakeholders and organisations. This process may be possible due to the immense reduction in computer prices and the usefulness and popularity of computers over the last few decades. Computers have also become a vital asset in assisting organisations with the connection of other computers through the internet, and as a result enabling organisations located in different cities, provinces, countries, or even continents to easily and readily exchange information regarding the successful management and ultimate completion of construction projects (Azmy, 2012; Coetzee, 2014; Rivard, 2000 and Rivard et al., 2004).

2.3.7. Sustainability

The sustainability of the environment has been an internationally notable issue since the 1980's. Sustainability is a term which is credited to the various activities that have a common goal of achieving eco-friendliness (De Schrijver, 2009). According to Sachs (2008), the concept of sustainability is to seek out and identify solutions to the negative human actions that affect the environment. These negative human activities may be credited to population growth and economic activities. Globally, the construction and engineering sector is known to be the main consumer of non-renewable resources, a water and air polluter, source of waste and a key contributor to landfills. These harmful effects from construction related activities can only be rectified by developing sustainable building methods for construction projects (Dixon, 2010).

A sustainable means of construction has therefore been found to be of great importance for the effective management and protection of the environment (Ding, 2008). The resultant harmful impact of construction related activities and its effects on the environment, has placed the construction and engineering sector under immense focus; as clients, investors, legislators and occupants have become more mindful about the environment (Dixon,2010). Construction firms have since developed strategies that incorporate sustainable construction practices in their operations. However, there is widespread understanding that countries and respective organisations only pay attention to the environment and its sustainability when a significant degree of socio-economic development is achieved. The subject of conserving the environment ought to be identified as of great interest to developing countries, as it faces extensive environment-related problems. South Africa, like most developing countries have delicate environments that face high levels of land degradation and rapid urbanisation (Holton et al., 2010 and Yates, 2003).

This places immense pressure on existing infrastructure. Another significant issue faced by developing countries are the volume of physical resources needed to address the backlog of societies infrastructural needs, in an effort to raise the standard of living of individuals. Fulfilling the above requirements of the country's economy and the basic needs of society ultimately places immense pressure on the resources of the country. These societal movements highlight the seriousness of sustainable management of resources in developing countries (Ofori, 1998 and UNCHS, 1996).

The challenges of sustainability faced in South Africa and its effects on the environment co-exist with a deficiency of the economies financial resources, natural resources, managerial experience, including legal and administrative systems, the formulation and enforcement of regulations and legislations, as well as developing and implementing economic tools such as grants, subsidies and taxes. In recent decades' numerous countries and organisations made a concerted effort to ensure that the construction and engineering sector adopts practices, materials and relevant techniques that have a reduced environmental impact. The practices, materials and relevant techniques that may be employed to assist sustainability processes include government actions, market forces, institutional initiatives and enhancing the operational environment (Hill and Bowen, 1997 and Ofori, 2000).

2.3.8. Industry Development

The nature of the construction and engineering sector, has numerous challenges that are complex and unique to the industry. As a result, the importance of improving construction and engineering sector performance through the successful completion of infrastructure development projects, has been identified in South Africa at several levels of socio-economic development (Fourie, 2014 and Hillebrandt, 2000). Dedicated agencies and organisations have been formulated to administer efforts that ensure the continuous development of the construction and engineering sector. The formation of the Construction Industry Development Board (CIDB) and other respective agencies in South Africa has been led by regional initiatives that effectively co-ordinate efforts and group resources. It also actively encourages industry's active participation. These initiatives have an increased chance of sustainability and success due to greater involvement and participation by the main stakeholder and beneficiaries during the planning and implementation processes of construction and engineering projects. However, it is essential to note that due to the industry challenges, the formation of the CIDB and other agencies does not assure the success of continuous construction and engineering sector development (Construction Industry Development Board, 2018).

Numerous countries have formulated long-term plans and trends for the constant improvement of their construction industries. These countries include; South Africa, Hong Kong, Singapore, Australia and the United Kingdom (Egan, 1998 and Latham, 1994). These long-term plans and trends for the constant improvement of their construction industries include client demands, the needs of a sophisticated economy, globalisation, social and technological change including competitive pressures (Ofori, 2000).

2.3.9. Force Majeure Events - The 2019 Novel Coronavirus Pandemic

The 2019 Novel Coronaviruses belongs to a comprehensive family of viruses that are capable of causing illness in animals and humans, therefore affecting a host of living species. The 2019 novel coronavirus, also referred to as Covid-19 is a virus strain, which was first recognized in Wuhan, Hubei Province, China in December 2019. The virus has since managed to spread across the globe, causing several hundreds of thousands of deaths and severely impacting numerous trades and industries; which has directed the World Health Organization (WHO) to declare it a global pandemic (Gates, 2020; Guarner, 2020 and Novel, 2020). In an address to the South African nation on the 15th of March 2020, President Cyril Ramaphosa declared the pandemic a National State of Disaster with the nation undergoing a level 5 lockdown from the 26th of March 2020. The primary focus of the Covid-19 pandemic continues to remain on the social human impact, and the collective efforts that has been employed to reduce the spread of the virus and in creating a vaccine. However, the immense measure of the pandemic has resulted in a significant impact on the South African economy (Robertson, 2020).

According to the construction market intelligence firm, Industry Insight, the impact of Covid-19 on the South African construction and engineering sector has been and will continue to be catastrophic. The pandemic is broadly expected to be the worst economic crisis resulting in a recession since the Great Depression of the late 1920's. This is unlike any economic shock the country has had to endure. The economy will face a significant loss of GDP that may result due to an estimated loss of between 120 000 to 140 000 formal jobs in the construction and engineering sector alone. The South African economy had already entered into a recession prior to lockdown level 5 being implemented by the President, and with reduced activity levels present, the industry is expected to decline by between 14.5% - 27.7% in 2020. Roy Mnisi, the executive director of Master Builders South Africa, further highlighted that the construction sector was struggling prior to the Covid-19 pandemic, with high levels of job loss and companies closing down, which emphasises the poor timing of the pandemic. This has been devastating for the construction and engineering sector (Cokayne, 2020).

The construction and engineering sector is dependent on the supply and flow of materials, labour, equipment and the cashflow of construction projects. Any delays and disruptions to the supply chain affects the overall project delivery. In the South African public sector construction and engineering industry, the pandemic has generated unprecedented delays, disruptions and has created a sense of uncertainty. The combination of lockdown levels, quarantining, travel restrictions and social distancing has disrupted the internal supply chain processes and procedures of construction projects, contractor labour/workforces and the availability of personnel for on-site project inspections, which has resulted in delays, disruptions and increased levels of project costs (Cokayne, 2020 and

Robertson, 2020). The pandemic has further placed unprecedented stress on government and more specifically, on public sector construction projects, which has created the possibilities of poor project delivery and widespread project failures. As a result, stakeholders actively involved with construction and engineering projects across the country has reached a consensus that Covid-19 is deemed to be a Force Majeure Event. A force majeure event has a substantial impact on construction and engineering projects resulting in the temporary suspension of projects; in the modification of contractual obligations; and often in the failure and/or termination of the contract (Baxter and Casady, 2020; Epstein et.al., 2020 and Robertson, 2020).

The rapid change of pace experienced by the pandemic has encouraged construction and engineering sector stakeholders to make changes in the manner in which the industry operates. Stakeholders are now required, more than ever, to ensure that they communicate effectively; that they are up to speed with project schedules; that they revisit and amend construction contracts including health and safety policies. They need to create an environment within construction organisations that has a centralized data management system which assists in ensuring the effective management of projects (Mendy, Stewart and VanAkin. 2020). A management system that clearly identifies and highlights the associated effects of construction project delays and the disruptions created due to the Covid-19 pandemic. A new work culture that is interactive and that enhances employment practices within the industry. The 2019 Novel Coronavirus pandemic has brought with it, unpredictable challenges for all construction and engineering sector project stakeholders which has emphasized the need for versatility and resilience within the industry (Khahro et. al., 2020 and The Perecman Firm, 2020).

2.4. The Global Effects of Project Challenges in the Construction and Engineering Sector

The construction and engineering sector worldwide, is renowned to have a great impact on the economy of a nation and often experiences complex and dynamic challenges. According to McKinsey Global Institute (2017), construction and engineering sector challenges such as delays and disruptions are a common phenomenon. Seventy seven percent megaprojects around the globe are 40% or more behind schedule and over budget. The nature of the construction and engineering sector and projects are highly complex and unique, with numerous moving parts and stakeholders involved working together to successfully complete a project. As a result, it is easy to comprehend how even the slightest changes can negatively affect a project (Ellis, 2017).

In developing countries like South Africa, these challenges are present alongside socio-economic stresses, continued resource shortages, organisational weaknesses and an over-all inability to handle key issues that affect the construction and engineering sector. In recent years, societal evidence suggests that these challenges have become greater in extent and severity. A clear measure of an effective construction and engineering sector is the successful completion and delivery of construction and engineering projects that is on time, within budget and of adequate quality; all of which are mentioned in contractual documents (Ramlee, et al., 2016). The level of efficiency and successful delivery of a project, often lead to the creation of socio-economic growth, wealth and improved standards of living for society. This may be viewed as the main criterion of project success (Islam and Trigunarsyah, 2017; and Chan and Kumaraswamy, 1997). However, the South African construction and engineering sector has experienced extensive project delays and disruptions, and in so doing exceed the preliminary time and cost budgets (Sunjka and Jacob, 2013; and Sweis, et.al, 2013). Subsequently, these challenges negatively impact the construction and engineering sector resulting in significant delays and disruptions on South African public sector construction and engineering projects (Oshungade and Kruger, 2016; and Ofori, 2000).

2.4.1. Project Delays and Disruptions

Delays are referred to in the construction and engineering sector as an extended period on a construction project and disruptions are referred to as actions that disrupt the construction programme (Kikwasi, 2012 and Stumpf, 2000). Delays and disruptions have been highlighted as on-going problems that bring about dissatisfaction to all stakeholders involved when executing a construction project (Oshungade and Kruger, 2017). The extent of delays and disruptions experienced in the South African public sector construction and engineering industry, are a potential cause for project risks that require effective management systems and procedures (Ndaliso, 2019; Oshungade, 2016; Ashton et al., 2012; Aiyetan et al., 2008; Finnerty, 2007; Sambasivan et al., 2007; Zou et al., 2006; Cohen and Palmer, 2004; Baloi and Price, 2003; Odeh et al.; 2002 and Miller and Lessard, 2001a; 2001b), highlights that the causes of delays and disruptions on projects were as a result of poor planning, client interference, poor project and site management, improper implementation of procurement and delivery management processes, decision-making, poor project management, inadequate contractor experience, insufficient finances, inefficient labour productivity, lack of resource availability, lack of communication between stakeholders, slow decision making and project mistakes during the construction stage.

Fewer studies have included factors such as contractual documents, contractual relationships, design related factors and environmental factors (Islam and Trigunarsyah, 2017; Fugar and Agyakwah-baah, 2010; and Toor and Ogunlana, 2009). Ahmed et al. (2003) categorised delays and disruption into two clusters; internal and external causes to a construction project. Internal causes arise from project stakeholders that are actively involved in the project and external causes, arise from events above and beyond the control of stakeholders, such as inclement weather, government and material suppliers. The construction and engineering sector is an integrated system that is effectively managed through systematic processes and procurement systems that employs a host of stakeholders and contractual documentation that contractually bind stakeholders involved with construction projects. Projects are therefore planned with expert stakeholder input that predefine costs, schedules and standards of quality. However, due to improper processes and procurement management systems, project delays and disruptions are inevitable (Kikwasi, 2013). A recent study conducted by Kusakcı, et al., (2017), show that globally, construction delays and disruptions are divided into eight major categories that consist of the following factors, as reflected in table 4.

Table 4: Global Causes of Delays and Disruptions

Global Causes of Delays and Disruptions		
No.	***Category***	***Causes of Delays and Disruptions***
1	***Clients***	1. Lack of finance and payments, 2. Client interferences, 3. Poor decision making and unrealistic contract durations
2	***Contractors***	1. Subcontractor delays, 2. Improper construction methods, 3. Inefficient site management, 4. Poor planning, 5. Developmental mistakes, and 6. Inadequate experience
3	***Consultants***	1. Inadequate contract management, 2. Poor preparation of construction drawings, 3. Quality assurance.
4	***Materials***	1. Resource shortages, 2. Quality and availability of materials, 3. Timeous delivery of materials.
5	***Labor and Equipment***	1. The lack of appropriate skills and equipment. 2. Low labor productivity.
6	***Contractual***	1. Variation and change of works orders, 2. Errors with contractual documentation.
7	***Contractual Relationships***	1. Inappropriate organizational structure, 2. Poor communication, 3.Major claims, disagreements and litigation.

8	***External***	1. Regulatory changes, 2. Weather condition, 3. Regulatory changes, 4. Societal problems, 5. Site and security factors.

(Source: Kusakcı, et al., 2017)

A comparative study by Oshugade and Kruger (2017) further expresses and critically reviews the causes and effects of delays and disruptions in Africa and South Africa; highlighted in table 5. It illustrates foreseen and unforeseen activities present during the lifecycle of construction and engineering projects, which result in delays and disruptions associated with successful project delivery. A consensus among the studies reflects cost and time overruns as a consistent theme in Africa and South Africa. It is only once the causes of the project delays and disruptions are identified, that the project team and stakeholders can minimize the effects (Gardezi, et al., 2013 and Akinsiku and Akinsulire, 2012).

Table 5: Significant Causes of Delays and Disruptions in Africa and South Africa

Scholars	***Country***	***Significant Causes of Delays and Disruptions***
Marzouk and El-Rasas (2014)	***Egypt***	1. Investment and payments 2. Change of works orders 3. Unforeseen circumstances or pre-existing conditions 4. Reduced levels of productivity 5. Inefficient planning and scheduling efforts
Aziz (2013)	***Egypt***	1. Delays in monthly payments 2. Corruption 3. Scarcity of plant and equipment 4. Inefficient planning and scheduling efforts 5. Poor project management
Ezeldin and Abdel-Ghany (2013)	***Egypt***	1. Slow decision making by clients 2. Inefficient planning and scheduling efforts 3. Reduced levels of productivity 4. Financial difficulties 5. Absence of resources
Sunjka and Jacob (2013)	***Nigeria***	1. Societal unrest, militancy and communal crises 2. Inefficient planning and scheduling efforts by the contractors 3. Delays in payments 4. Incorrect selection of consultants and contractors 5. Inclement weather conditions
Abd El-Razek et al (2008)	***Egypt***	1. Financial instability of contractors 2. Delays in contractor payments 3. Continuous design changes 4. Partial payments during the project lifecycle 5. Unprofessional construction practices and procedures
Akinsiku and Akinsulire (2012)	***Nigeria***	1. Financial difficulties 2. Change of works orders 3. Payment failures for completed works 5. Insufficient resources

Kikwasi (2012)	***Tanzania***	1. Change of works orders 2. Delays in contractor payments 3. Information delays 4. Financial difficulties 5. Poor project management
Nkobane (2012)	***South Africa***	1. Continuous design changes 2. Lack of effective communications 3. Poor quality 4. Unprofessional construction practices and procedures
Baloyi and Bekker (2011)	***South Africa***	1. Partial design drawings 2. Continuous design changes 3. Poor decision making by clients 4. Late issue of instructions 5. Insufficient skills and resources
Aibinu and Odeyinka (2006)	***Nigeria***	1. Financial instability of contractors 2. Financial difficulties of clients 3. Incomplete drawings 4. Maintenance problems

(Source: Oshungade and Kruger, 2017)

The success of construction projects is often measured by how well a project has been completed, on schedule, within budget, specified quality and safety benchmarks that have been set out by project stakeholders (Shane et al., 2009). Studies by various authors have found significant relationships between the above variables. Aibinu and Jagboro (2002) and Kaliba et al. (2009) highlight the relationship between schedule and cost overruns. Abdelsalam and Gad (2009) highlight the relationships between project costs and quality including the lifecycle performance of the project. Hinze (1997) mentions that in order to successfully ensure project delivery, projects are required to be completed by a safe and happy workforce. Ramanathan et al. (2012) conclude that the above variables have to work in unison to ensure that public sector construction projects meet the satisfaction of construction project stakeholders, including clients, contractors, end-users, the project team, construction workers, their families and the local community (Karami and Olatunji, 2018). However, recent reports suggest that the South African public sector construction and engineering industry are experiencing significant delays and disruptions, regardless of its efforts to achieve successful infrastructure delivery. According to Ogunlana et al., the difficulties faced by a developing country like South Africa can be attributed to the high level of inadequacies in infrastructure development (Oshugade, 2016). The delays and disruptions plagued by the South African public sector construction and engineering industry includes but are not limited to governmental policies, inefficient procurement processes, financial issues experienced by the client or contractor, delays in progress payments made by clients, inadequate skills capacity, a diverse socio-economic culture, ineffective site and stakeholder management processes, project inefficiency, lack of information technology and plant and equipment, inclement weather, resources and a disruptive labour force (Adugna, 2015; Cottle, 2014 and Mills, 2001).

2.5. The Effects of Project Delays and Disruptions in the Construction and Engineering Sector

Hisham and Yahya (2016), Aibinu and Jagboro (2002) and Sambasivan and Soon (2007) highlight six effects that are associated with delays and disruptions in construction project delivery as reflected in figures 10 and 11. These include time overruns, cost overruns, project and stakeholder disputes, total project abandonment, arbitration and litigation. Haseeb et al (2011) identifies the effects of delays and disruptions in the construction and engineering sector as claims, project desertion, disputes and reduced growth of the sector. Critical factors resulting from project delays and disruptions such as cost overruns, schedule overruns, negative influences on the project scope, incomplete project design, poor cost planning and management, contractual claims, inflation, delays in monthly progress payments, contractual disagreements, mediation, litigation and complete abandonment (Kikwasi, 2013; Van Zyl, et al.,2010 and Chileshe et al., 2010).

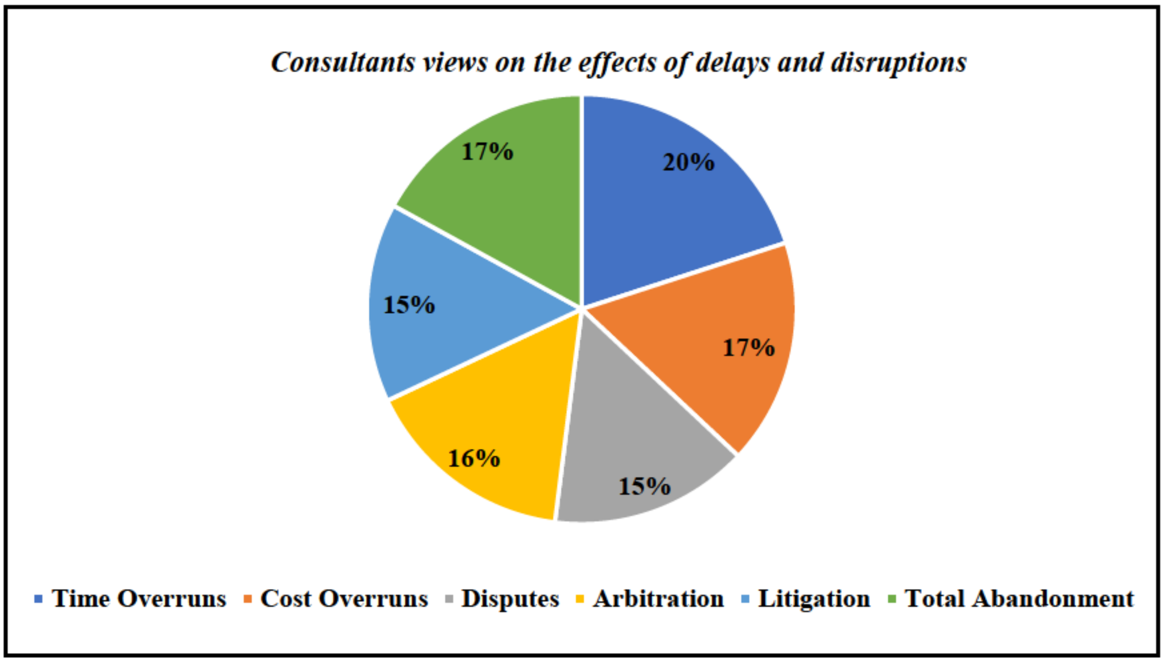

Figure 10: Pie chart reflects the main effects of delays based on the views of consultants (Hisham, and Yahya, 2016)

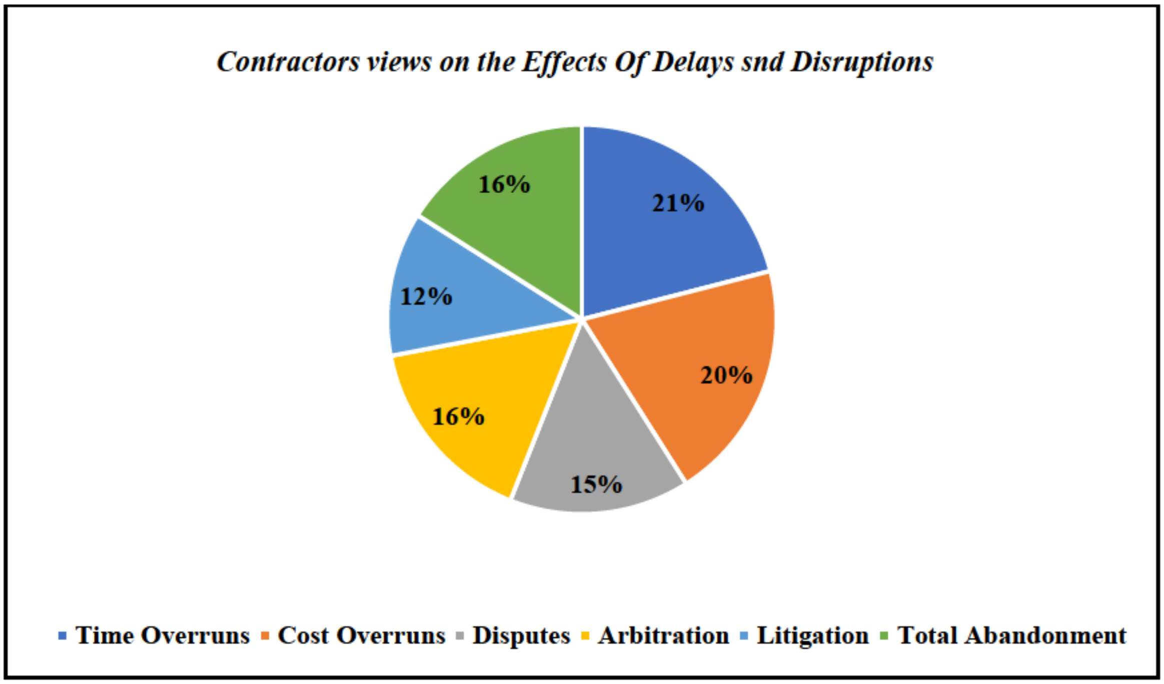

Figure 11: Pie chart reflects the main effects of delays based on the views of contractor (Hisham, and Yahya, 2016)

Based on the findings the following authors, namely Sunjka and Jacob (2013), Kikwasi (2012), Sambasivan and Soon (2007), Akinsiku and Akinsulire (2012), Mukuka, et al., (2014), Aibinu and Jagboro (2002), and Haseeb, Bibi and Rabbani (2011), consultants and contractors highlighted in table 6 that the ten effects of delays and disruptions in the successful delivery of construction projects include:

Table 6: Rankings of the Effects of Project Delays

1	Cost Overruns
2	Time Overruns
3	Disputes
4	Negative Social Impact
5	Idle Resources
6	Client Delays
7	Arbitration
8	Poor Quality of Work
9	Delays in Retrieving Profits
10	Bankruptcy

(Source: Kusakcı, et al., 2017)

2.5.1 Cost Overruns

Angelo et al., (2002) and Avots (1983) state that the phenomenon of cost overruns in the public sector is a significant issue found in developed and developing countries. Cost overruns are a result of final costs of construction projects exceeding the original estimation of project costs. These overruns add to project investments, affects decision-making, increases construction costs and the countries public sector finance might result in corruption. It is therefore vital to ensure costs are effectively managed in order to plan and allocate governmental resources (Ali and Kamaruzzaman, 2010).

The successful management of costs in the public sector portfolio of construction and engineering projects is necessary in order to ensure taxpayers are being provided with value for money. This is vital, as it measures the cost effectiveness of construction and engineering projects that are successfully completed. Cost performance is often defined as the amount of work executed, related to the defined cost of progress made on the projects (Baccarini and Love, 2014). The construction and engineering sector is as a result required to have immense control on project costs to ensure that they are maintained within budget, during the lifecycle of a project. The ability to effectively predict the final costs of infrastructure development in the public sector and to successfully ensure that it does not experience cost overruns are essential in guaranteeing the planning and resourcing of other projects, or of those that are in the planning process (Love, et al., 2017).

According to Ramli (2003), project cost management includes the effective planning of resources, cost estimating, budgeting and total cost control. These factors determine the final project costs and reflects future cost projections which involves projects of a similar scope, time and quality.

2.5.2. Time Overruns

Numerous studies have acknowledged the problem of time overruns as a global phenomenon within the international construction and engineering sector that affects the schedule of construction projects (Koushki et. al., 2005; Choudhury and Rajan, 2003; Aibinu and Jogboro, 2002; Ng et. al., 2001; Shi et. al., 2001; Abd. Majid and McCaffer, 1998; Okuwoga, 1998; Ogunlana and Promkuntong, 1996; Elinwa and Buba, 1993 and Kaka and Price, 1991). Mohamad (2010), Assaf and Al-Hejji (2006) and Alkhathami (2005) define schedule overruns as an event that extends beyond the original planned duration to complete a construction project under the agreed upon construction contract, regardless of whether the contractor is remunerated or not. Time which affects a projects schedule, is a key factor in the project life cycle. Time is considered as the most essential parameter of a project, including it being the driving force of project success (Aziz, 2013 and Aziz et al., 2013).

The negative impact of schedule overruns is a direct result of the mismanagement of construction and engineering projects during the lifespan of a project. As a result, Sunjka and Jacob (2013) and Denini (2010) identified the effects related to project schedule overruns, which includes: cost and time overruns; decrease in the clients' financial obligation; acceleration strategies; arbitration; contractual disputes; claims; poor quality; an adverse social impact; health and safety issues; litigation; contract termination and complete abandonment of a project. Saleh, et al., (2009) also identifies the negative effects of construction schedule overruns which results in the loss of interest by the relevant stakeholders; wastage of funds and time, blacklist by governmental authorities and the declination of reputation.

2.5.3. Quality

According to Stanciu, et al., (2012) and Stasiowski and Burstein, (1994), the traditional definition of quality is based on how sound a building assimilates into its environment, its psychological impact on its residents, its landscape design and the use of contemporary design concepts that capture people's thoughts and imaginations. The notion of quality and the issue of quality improvement in the construction and engineering sector is a worldwide phenomenon and has received world-wide attention. The legal fraternity defines quality in terms of professional liability, wherein all professionals are required to know and practice their trades responsibly. All construction and engineering sector professionals and stakeholders who offer their expertise to clients are subject to laws pertaining to professional liability (Arditi, and Mochtar, 2000 and Arditi and Gunaydin, 1997, 1998).

Quality performance as a project indicator may be based on the complexity of the project and interpreted as meeting the aesthetic, legal and functional requirements of a project. The level of quality may be stipulated in the project contract as a comprehensive description of what is required. The issue of quality improvement and overall performance was essential to the Rethinking Construction initiative established in the United Kingdom, which was based on enhancing the efficacy and quality of infrastructure development.

The Egan Report (1998:7) states that:

"Under-achievement can also be found in the growing dissatisfaction with construction among both private and public sector clients. Projects are widely seen as unpredictable in terms of delivery on time, within budget and to the standards of quality expected.

In the construction and engineering sector, quality can be defined as meeting the requirements of the client, architect, contractor, consultants and regulatory bodies. Therefore, the enhancement of quality in the construction and engineering sector has been at the core of various initiatives globally (Kumaraswamy and Dissanayaka, 2000 and Coffey, 1999). Figure 12 illustrates the elements of total quality management present in the construction and engineering processes as depicted by Karna (2004) and Arditi and Gunaydin (1997).

Figure 12: Elements of total quality management in the construction process (Karna, 2004 and Arditi and Gunaydin, 1997)

2.5.4. Health and Safety

The South African public sector construction and engineering industry has traditionally been managed by parameters such as cost, quality and time. However, in recent years, as increased awareness of health and safety management and its influence on the overall construction project performance has identified health and safety as a project performance measure. This has created an intense focus on health and safety by a range of industry stakeholders (Smallwood and Haupt, 2005; and Vermeulen, 2014). The concept of health is often defined as the safeguarding of an individual's body and mind from illness that may result from, processes, procedures and resources employed in the workplace. The concept of safety is referred to as the protection of individuals from physical injury. As a result, an association of both concepts exist which indicates the concern for the physical and mental health of the individual at the workplace. However, this association is ill defined (Hughes and Ferret, 2007).

The issue of health and safety within the South African construction and engineering sector has been the focus of attention for the Department of Labour (DoL), industry stakeholders and its respective role-players as the construction and engineering sector is considered to be one of the most injurious sectors, with high levels of injuries and fatalities. A number of construction and engineering sector clients, statutory bodies, associations and contracting companies have made substantial efforts to help improve the state of the South African health and safety within the construction and engineering sector, as they are seen to have a substantial influence on project health and safety performance (Lopes, Haupt and Fester, 2011). However, irrespective of their influences, the overall state of the countries construction health and safety has not been improved enough (Smallwood, et al., 2009 and Vermeulen, 2014).

Health and safety start with the approach of individuals, clients, professional statutory bodies, industry associations and contracting companies that accidents at the workplace are preventable and that requirements for creating healthy and safe work practices must be followed. However, regardless of the implementation of the best health and safety management systems, not all accidents are preventable. The onus is left upon the entities performing the construction and engineering work to enforce appropriate safety standard measures (Hislop, 1999 and Toole, 2002). The efficient and effective management of health and safety processes have seen an increased development of health and safety management systems as a source of governing the increase of risks and hazards within the construction and engineering sector (Kheni, Dainty and Gibb, 2008). The advent of client pressure, project management processes, legislations, frameworks and cost reduction measures, as factors, have been identified as encouraging the implementation of integrated safety management systems (Gibb and Ayoade, 1996).

The effective integration of health and safety management systems has highlighted the efficiency of management practices and implementation as a central factor used in the construction and engineering sector (Lingard, 2013; Hamid et al., 2004 and Douglas and Glen, 2000). Successful construction and engineering projects are the result of effective planning and execution processes, through the incorporation of health and safety aspects into a construction project. The South African Construction Regulations, requires a range of multi-stakeholder interventions and for stakeholders to consider health and safety at every stage of a projects lifecycle which includes planning, design, construction, maintenance and demolition. Therefore, effective HSMS includes not only exceptional health and safety management on site, but a cohesive approach on health and safety issues from all stakeholders participating on a project (Department of Labour, 2003 and Vermeulen, 2014). As a result, figure 13 illustrates the extent to which stakeholders can contribute to health and safety.

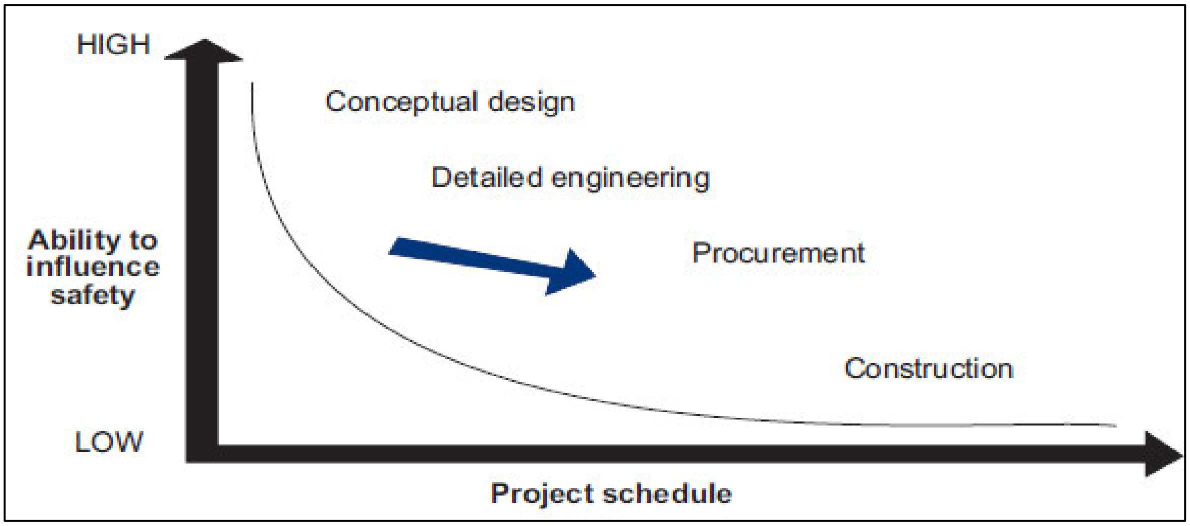

Figure 13: Extent to which stakeholders can contribute to health and safety, according to respondents (Smallwood and Haupt, 2005)

2.5.5. Client Satisfaction

Client satisfaction is an essential matter for construction and engineering sector stakeholders who are required to continuously improve their performance, in order to persevere in the presence of globalization of construction services (Cheng et al., 2006 and Al-Shorafa, 2008). According to Jin and Ling (2006), the concepts of client satisfaction is closely related to a project's success. Project success as defined by Jin and Ling (2006), highlighted that a project should be successfully completed within the objected of time, cost and quality including satisfying project stakeholders. However, traditionally, the success of a construction and engineering projects are measured through the iron triangle of time, cost and quality; where critical success factors include softer measures such as client/customer satisfaction. A set of key performance indicators for measuring project success was identified by Chan and Chan (2004), who further divided them into objective and subjective measures. Objective measures include time and cost, whereas subjective success measures included clients' satisfaction, quality, functionality, end-user's satisfaction and stakeholder satisfaction (Karna and Sorvala, 2004, and Al-shorafa, 2008).

The construction and engineering sector worldwide is considered to be under-researched with regards to client satisfaction issues as a subjective success measure (Kärnä, 2004). The demands of clients are rapidly changing as a response to globalisation, fluctuating market and organisational imperatives as well as changing government regulations and procurement processes; all of which may affect the levels of client satisfaction (Hanson et al., 2004).

Hanson, et al., (2004), highlighted ways in which client satisfaction could be improved by construction and engineering sector stakeholders. These include:

a. Choosing suitably qualified / experienced / competent professional team and main contractor.
b. Early contractor involvement.
c. Building long-term relationships with clients and sub-contractors.
d. Adopting realistic construction times.
e. In the selection process of a contractor, costs should not be the determining factor.
f. Improved reporting measures of the professional team.
g. Improving quality control measures.
h. Healthy competition from similar facilities.
i. Unfavourable macro-economic factors.

New procedures and solutions are therefore required, to meet the increased demands and standards of construction and engineering sector clients (Smith and Love, 2001). Ahmed and Kangari (1995), investigated six factors that ascertain the level of client satisfaction on a construction project, which includes time, cost, quality, communication, client orientation and response to complaints. Egemen and Mohamed (2005), highlighted that if clients are satisfied with the outcomes of a project, then they are willing to engage with the same project stakeholders to conduct construction activities thereafter. Therefore, stakeholders should ensure that client satisfaction is achieved in order to secure future construction related opportunities (Al-Shorafa, 2008).

2.5.6. Procurement Systems

Public sector procurement plays a distinctly unique role in the implementation and completion of projects within the democratic government. A government that is focused on providing valuable support to its customers, ensuring that their objectives are successfully achieved, as governing agents of the public taxes. This assist in bringing to life the political incentive of its governing bodies. The means in which procurement processes are conducted is a reflection of the government enterprise that the procurement departments that it supports (National Institute of Governmental Purchasing, 2013 and Staples and Dalrymple, 2008). In South Africa, procurement processes are essential and central to the government service delivery system (Cane, 2004).

Preceding 1994, public sector procurement was directed towards established contractors and rendered it difficult for new contractors and historically disadvantaged individuals to partake in government procurement procedures. However, the post-apartheid era has seen the South African public sector procurement being issued constitutional status and is acknowledged as a means of rectifying inequality and discriminatory policies (Bolton, 2006).

These transformations were implemented due to discrepancies in policies, including the absence of accountability, principles of good governance, supportive systems and fragmented processes. The National Treasury has also introduced a Preferential Procurement Policy Framework (PPPFA) Act No 5 of 2000, along with the employment of Supply Chain Management (SCM) and Infrastructure Delivery Management Systems as a strategic tool in order to address socioeconomic objectives (Ambe and Badenhorst-Weiss, 2012; Smart Procurement, 2011; National Treasury, 2003 and 2014). Figure 14 illustrates the South African public sector procurement legislative hierarchy according to the National Treasury (2014). The current South African public sector procurement processes function in an environment of immense scrutiny, that is directed by programme reviews, improved technology, including public and political opportunities for service delivery improvements. The procurement system has been used by government to attain socio-economic objectives which includes the protection of national trades from international competition; in refining the competitiveness of sectors; stimulating economic activity and in improving national disparities created by the apartheid era (Bolton, 2006; Thai, 2006). As a result, procurement processes extend above the concept of planning, contract development and contractual management to supply services and infrastructure delivery; but has also been used as a policy tool to rectify the levels of inequality in society (Arrowsmith 2010; Bolton, 2006; Eyaa and Oluka, 2011).

As much as the country’s procurement system enjoys the benefits of evolved systems and processes that aggregates and communicates government information effectively; not all government enterprises provide the public with transparent information about the equality, equitability, competitiveness and cost-effectiveness of procurement processes in its endeavour to provide service and infrastructure delivery. The transparency of information enables society to easily access and understand information regarding the distribution of their taxes as society has the right to demand sensible and prudent use of their taxes (Ambe and Badenhorst-Weiss, 2012). In President Obama’s 2009 inaugural address, he expressed the need for transparency in government practices and the value in ensuring government being held accountable for its actions (National Institute of Governmental Purchasing, 2013 and Construction Industry Development Board, 2004).

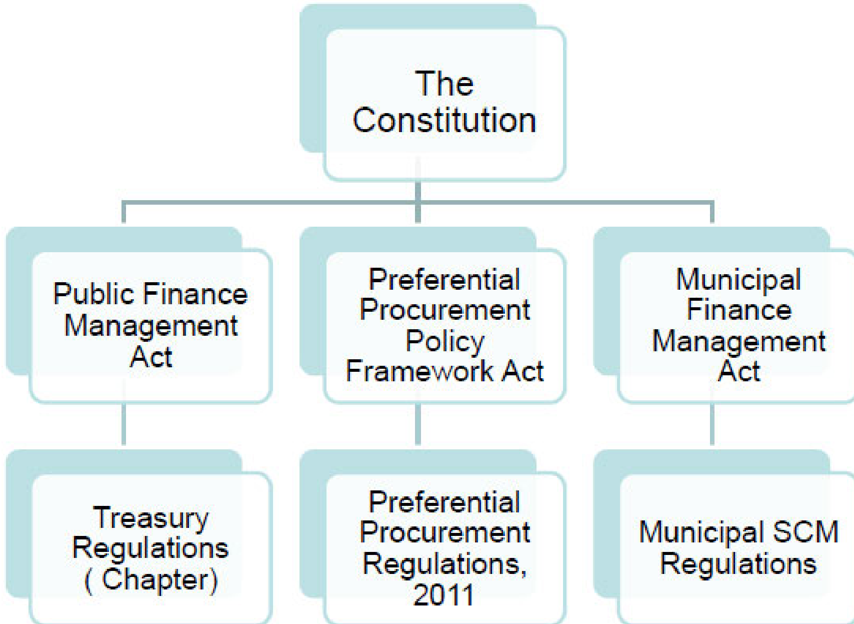

Figure 14: The South African Public Sector Procurement Legislative Hierarchy (National Treasury, 2014)

2.6. Construction Project Performance

Studies have acknowledged the South African construction and engineering sector as an essential vehicle of growth in the economy (Cottle, 2014). The construction and engineering sector's contribution has been significant over the last two decades given the history of the nation since achieving democracy in 1994 (Construction Industry Development Board, 2012; Hillebrandt 2000; Mlinga and Wells 2002; Ofori 2012a, 2007 and 1990, Giang and Pheng, 2011; Rameezdeen 2007, Olanrewaju and Abdul-Aziz, 2015). It provides infrastructure development that is required for the various sectors of the economy to flourish, by providing basic necessities which include housing, healthcare and education as well as creating employment opportunities at skilled and non-skilled levels (Palalani, 2000). The public sector is required to provide efficient and effective services. It has developed a culture for continuous improvement of its service delivery modalities, in order to make them more accessible to communities and most importantly, accessible to historically disadvantaged communities. The public sector aims to expand its infrastructural services offered while maintaining high standards. The sector also aims at improving the optimum utilisation of resources available and to ensure the optimum levels of performance of its stakeholders is maintained (The Public Service Commission, 2007).

However, it has been largely documented that the construction and engineering sector faces ongoing construction project performance issues and challenges within the public sector, in respect to successful project delivery. As a developing country, these challenges are highlighted along with a general state of affairs of socio-economic stress, prolonged resource deficiencies, large scale institutional weaknesses, skill shortages including poor performance of project stakeholders, and an inability to deal with key issues due to governments continuously changing priorities due to rapid globalisation as well as sociological, economic and political constraints (Pongpeng and Liston, 2003 and Chen, 1998).

Regardless of the effort that has been made by the public sector to improve project performance levels, criticism by society continues, regarding poor service delivery and the lack of receptiveness to societal requests (The Public Service Commission, 2007). The challenges facing the public sector construction and engineering industry also include the extent of industry development; financial contributions; government policies; culture and environment; technology; stakeholder management; the availability of skills and project delays and disruptions; all of which affect project performance (De Silva, Rajakaruna and Bandara, 2008 and Ofori,1993).

The industry has attempted through the implementation of the Construction Industry Development Board (CIDB) Act, 2000; for the development of an integrated construction and engineering sector with the aim of increasing the rate of economic growth and performance by increasing the development of physical infrastructure by the public sector construction and engineering industry (Republic of South Africa, 2000). It also continues to correct the poor perceptions by society, by addressing these concerns through measures, such as effective supply chain management, intensive capacity building, and most importantly, the introduction of key project performance management tools; such as the Infrastructure Delivery Management System to constantly evaluate construction project performance (The Public Service Commission, 2007).

2.7. Chapter Summary

This chapter is part one of two chapters that highlights an in-depth review of the theoretical framework of the research study. It is focused on reviewing existing literature, based on the various concepts expressed through the research topic. It further investigates the degree to which research questions and objectives have been examined in previous studies. The chapter includes a thoughtful insight into the nature of the public sector construction and engineering industry, challenges experienced by the industry, the effects of construction project challenges on successful project delivery and the overall issue of project performance faced by the public sector.

CHAPTER THREE

THE PUBLIC SECTOR ENVIRONMENT AND FRAMEWORK

3. Introduction

Based on the existing public sector environment and frameworks, this chapter evaluates the current public sector environment, municipal culture, statutory frameworks; national and global dynamic factors and infrastructure delivery management system. The existing modalities are examined and the literature review responds to the research questions*; "What are the frameworks and legislations that are related to the management of construction and engineering project performance in the public sector construction and engineering industry in Kwazulu-Natal?"; "What are the national and global dynamic factors that influence project performance and development in the public sector construction and engineering industry in Kwazulu-Natal?*" and "*What are the infrastructure delivery modalities that contribute to poor project delivery in the South African public sector construction and engineering industry?".* The chapter closes by discussing the various challenges with existing modalities and the assessment of the current state of the public sector environment and statutory frameworks.

3.1.The Public Sector Environment and Framework

South Africa is a diverse and multi-cultural country, with a population of approximately 53 million, that is steeped in historical struggle brought upon by apartheid laws. The South African public sector has undergone fundamental transformation and development since the initial democratic elections in 1994. The South African public sector had set on a path to an integrated transformation process, that transitioned from a single-party minority-ruled regime to a democratic government that inspired national unity. The post-apartheid era saw the new democratically elected government reform the public sector into an all-encompassing responsive sector, whose fundamental objective was satisfying to the necessary requirements of its citizens, regardless of their gender, racial, ethnic and sexual preferences or orientation. This brought about new challenges within the sector with regards to its political, economic, technological, cultural and the physical environment. The main challenge of the South African public sector was and still is to deliver improved services and to fulfil the hopes of the citizens of the country. The current South African political system is regarded as stable, but faces significant long-term challenges such as the lack of infrastructure development, high levels of unemployment and poverty (Fourie and Poggenpoel, 2016 and Fourie, 2013).

The South African public sector is responsible for meeting societal needs and in responding to an evolving economic environment; which has seen the previous two decades undergo societal, financial and intellectual resources being directed towards the improvement of public sector capacity. Public sector enterprises are therefore required to address the resultant demands from growing consumer expectations, globalisation and physical demands. Numerous economic policies and frameworks such as Chapter 10 of the Constitution of 1996, the Public Service Act of 1994, the White Paper on the Transformation of the Public Service (WTPS) of 1995, the White Paper on the Transformation of Public Service Delivery (WTPSD) of 1997 referred to as the Batho Pele principles, the Public Service Regulations of 1999, the Public Finance Management Act (PFMA) of 1999 and the Promotion of Administrative Justice Act of 2000 have been successfully implemented (Department of Planning, Monitoring and Evaluation, 2014; Fourie, 2013; and Windapo and Cattell, 2013).

Yet unemployment and the lack of growth in productivity remains high. These challenges have successfully influenced the public sector and its enterprises to construct a platform for continuous development; consisting of skills, technology, competitive costing, logistics, innovation, partnerships, efficient regulations, effective government practices and infrastructure development through the public sector construction and engineering industry (Department of Planning, Monitoring and Evaluation, 2014; Fourie, 2013; and Windapo and Cattell, 2013).

3.2. The Public Sector Municipal Culture

3.2.1. The Organizational Culture

The term organisational culture has been the subject of widespread debate, among various disciplines, all of which have offered diverse viewpoints (Bowditch and Buono, 2001 and Jreisat, 1997). However, it has been argued that organizational culture is essential to the operation of any organization (Zain-Ul-Abidin, et al., 2020). In the South African organizational context should therefore be no different. According to Schein (1985), a well renowned theorist, organisational culture is considered to be a pattern of basic assumptions that are discovered and developed by a set of individuals. Schein (2010) further mentions that the concept of culture exists at various different levels within an organisation. These include the cultural artefacts of an organisation, which reveal the values of an organisation and its behavioural patterns; espoused values that are explicitly articulated by an organisation; and underlying assumptions which pertain to an organisation as reflected in table 7. It represents the spirit of the culture of the organisation. Schein views these assumptions as the key aspect of an organisations culture, and an understanding of these assumptions are necessary for a member to understand the organisations culture (Schein, 2010).

Table 7: Organisational Culture Concepts

Cultural web	***Symbols and Titles***
Artefacts	Authoritative Relationships – decisions, strategic direction and operation
	Organizational Structure – a directive of power
	Control Systems – directed and controlled governance
	Rituals and Routines - daily acceptable behavior
Espoused Values	Myths and Stories - status
Basic Assumptions	The Paradigm – purpose, function, mission and goals

(Source: Schein, 2010; 2004)

Organisational culture may be used interchangeably with other concepts such as organisational climate and organisational values, that assist in imparting organisational action and in binding members of the organisation together. The term organizational culture also includes the members of an organisation and their continued patterns of perceptions, interpretations and actions of the organisation's members. It refers to the amalgamation of their languages, beliefs, ideology, rituals, stories and historical buildings (Schneider, Brief and Guzzo, 1996).

"An organisation's culture is reflected in what is valued, the dominant leadership styles, the language and symbols, the procedures and routines, and the definitions of success that make an organisation unique (Cameron and Quinn, 2011:22).*"*

The organisational culture in the public sector environment, plays an essential role in the functioning of the organisation. Parker and Bradley (2000) highlight that public sector organisations are inhibited by the hierarchical culture of political activities and political authorities, rather than market controls. The activities of the public sector forms part of a wide-ranging governmental strategy for social development and economic management. As a result, the extent of public sectors resources and the nature of organisational limitations differ. By having a great understanding of these differences, the resilience of a hierarchical culture in the public sector may be more challenging in the public sector than in the private sector (O'Riordan, 2015). This understanding provides insight into the organisational culture of South African public sector enterprises

The organisational cultural model present in South African public sector organisations, are a vital aspect of the organisation as it is based on the historical identity and destiny of society (Prah, 2001). O'Donnell and Boyle (2008) highlight the importance for public sector managers in understanding an organisations culture when planning and adjusting to organisational change. This sense of culture, assists members of an organisation in obtaining a sense of identity and in improving their efficiency and performance. Once employees understand that they have a sense of identity and belonging to the organisation, they maintain a sense of commitment to the organisation that they belong to.

Cameron and Quinn (2011) developed a well-known typology of an organizations cultural model that argues that organizational cultures are two dimensional. The first dimension entails a range of control and flexibility while the second dimension distinguishes between a company's external and internal orientation. These dimensions are further subdivided into four groups; clan culture which includes a sociable and responsive workplace where leaders take on the role of authoritative figures; adhocracy culture which is a self-motivated workplace with leaders that inspire innovation; market culture which includes a competitive workplace with demanding leaders and a hierarchy-based culture which includes a formal workplace environment where leaders are directors. The South African public sector has, as a result, developed organizational cultural models, depicted in figure 15; that illustrates the various factors that impact an organizations performance creating a distinction between various organizations and its motivation towards its members (Panagiotis, et al., 2014; Robbins, 2012 and Schein, 1985).

Figure 15: Organisation Culture Model (Provincial Government Western Cape, 2009)

There are extensive variations in the definitions of organisational culture, and most models contain the characteristics of observed behavioural regularities; relationships; strategies; norms; responsiveness; leadership; dominant values; philosophy; rules; coordination and organisational climate. However, none of these characteristics can solely represent the heart of an organisations culture, but collectively, these characteristics reflect and give meaning to the unique organisational culture of the South African public sector environment (Finance and Accounting Services Sector Education, 2013 and Provincial Government Western Cape, 2009).

3.2.2. The Political Culture

Over two decades after the inception of democracy in South Africa, society has continued to be plagued by a legacy entrenched by social issues generated by the apartheid era. South Africans have inherited a legacy that is structurally and racially entrenched by socioeconomic inequalities. It has considered the transformative process into a democratic society as not only a case of democratization but also as a restructuring of a society as a whole. The inception of a democratic society has raised the expectations of society and the public sector with regards to politics, culture and practices. This had resulted in widespread optimism of the future of the country. However, after more than two decades of democracy, the level of optimism among members of society, has dissipated due to the inertia of socio-economic development (von Fintel and Ott, 2017; Alexander, 2010; Leibbrandt, et al., 2010; Suttner, 2004a; 2004b; and Verba and Almond, 1963).

A democratic political culture in the public sector is an essential requirement for the maintenance of a democratic government. Verba and Almond (1963:13), defines the term political culture "*as the particular distribution of patterns of orientation toward political objects among the members of a nation*."

Therefore, political culture imparts itself to the psychological dimension of systems, that include political values, beliefs and attitudes. The South African political culture is a set of inter-related values, goals, motives, habits, thoughts and assumptions of stakeholders about the reality of the public sector; that oversee actions taken; with regards to socio economic delivery. The support provided by public sector stakeholders, effectively contributes to good governance and towards socio economic infrastructure delivery (Thornton, 2005 and Gibson, Duch and Tedin 1992). The importance of the South African post-apartheid culture towards social development, individuality and purpose is as essential as the political culture to an effective political system. However, political culture is a significant factor that impacts the political system and the significant effort made towards a democratic governance in South Africa. The political culture and support provided by public sector stakeholders impact the efficacy of government, state-run enterprises and society, to the degree to which political steadiness and democratic governance is intertwined and nurtured (Matlosa, 2003 and Prah, 2001). Jackson and Jackson (1997) observed that "political culture is one of the most powerful influences that shape a political system. It creates norms – beliefs about how people should behave - and these norms influence social behaviour." Four inter-related 'principles' of political culture exists in the South African public sector which includes respect, fairness, jealousy, and suffering. These principles are vital to the political discourse at local government and in its practices (Frank, 2014; Thornton, 2005; and Matlosa, 2003).

3.2.3. The Socio-Economic Culture

Major socio-economic transformation in South Africa has been at the forefront over the preceding 25 years, in an attempt to achieve social equality and surpass the legacy of racial discernment. The socio-economic transformation of society has been aided by the implementation of a far-reaching institutional framework. This has promoted the development of a diverse middle class over the last decade. The political elections in 1994 witnessed South Africa mark the conclusion of white minority rule and the commencement of a new era of economic, social and political transformation in the country. However, while political power has diverted with promise of change, the economy continued to be largely dominated by the white minority. As a result, socio-economic transformation has shown to be a significant challenge. The Black Economic Empowerment (BEE) strategy associated with public sector institutional frameworks, involves the use of legislations, regulations, reformation of state-run institutions, partnerships, preferential procurement, skills development programmes and financial assistance. This strategy has been the cornerstone of socio-economic transformation in the South African public sector, with a specific aim to promote the advancement of historically disadvantaged individuals in every sector of the economy (Sánchez-Marín, 2017; Deutsche Bank, 2006 and Cottle, 2004).

3.3. The Public Sector Procurement Processes: Regulatory and Legislative Frameworks

Pautz, Watermeyer, and Jacquet (2003), state that the commitment of the South African government towards social and economic development has created a substantial increase in the levels of investment in infrastructure development across the country. As a result, South Africa's construction and engineering sector has experienced substantial transformation and has become an essential factor in the success of the economy. A vast array of legislations, frameworks and policies that are explicit to the public sector was approved with the government becoming the sector's largest client, in its efforts to promote the sector's ability to provide economic and social infrastructure (Ogunsanya et. al, 2016). Post 1994 saw the growth of South Africa's post-apartheid construction and engineering sector take shape. In 1995 the Department of Public Works released a paper for contemplation by government, titled "*Establishing an enabling environment to ensure that the objectives of the RDP and related initiatives by Government are realized in the Construction and Allied Industries*" (Department of Public Works, 1999:8) which was followed by "Captains of Industry Initiative" in 1996, which provided widespread research into the criterion required to enable an environment that promotes construction and engineering sector development (Construction Industry Development Board, 2004).

The Green Paper was later released in 1997, resulted in a collaboration between governmental, state departments and construction and engineering sector. This process was assisted by the Inter-Ministerial Task Team on Construction Industry Development. The Construction Green Paper of 1998 resulted in a workshop on "Planning for Construction Industry Development" that constituted of 60 public and private stakeholders that resolved to create the Construction Industry Development Board. The purpose of the board was to schedule public sector spending, registration of reputable contractors, support programs to nurture the emerging sector and to ensure outputs that affect industry performance are met. This process ultimately resulted in the White Paper, "*Creating an Enabling Environment for Reconstruction, Growth and Development in the Construction Industry*" of 1999 (Department of Public Works, 1999:10).

On completion of the launch, the White Paper task team achieved the following milestones:

a. Establishing the Public Finance Management Act 1999 and a three-year Medium-Term Expenditure Framework (MTEF);
b. Establishing the Construction Education and Training Authority in 2000;
c. Establishing the Council for the Built Environment and six councils responsible for regulating the built environment professions in 2001; and
d. Establishing the Construction Industry Development Board (CIDB) in 2001.

The establishment of the Public Finance Management Act 1999 enabled state-run enterprises to create regulations that are applicable to all public sector institutions regarding a legislative framework for appropriate procurement systems which are impartial, competitive, fair and cost effective (Watermeyer, 2011). However, the public sector procurement processes in South Africa, functions in an environment of immense scrutiny that is motivated by program evaluations, technology and public sector expectations and political opportunities for service enhancements (Eyaa and Oluka, 2011 and Bolton, 2006). The South African public sector procurement system, is of great importance as it involves an immense magnitude of funds channeled through government procurement processes. It is often the single largest purchaser, ranging between 9% and 13%. As a result, it is seen as a system that plays a vital role in any economy (Gul, 2010; OECD, 2007 and Odhiambo and Kamau, 2003). Public sector procurement systems are therefore used as an instrument for policy, to address the inequality, prejudiced and impartial laws of the apartheid era (Bolton, 2006).

In 2000, the Preferential Procurement Policy Framework was implemented in an effort to enable historically disadvantaged individuals to be accommodated in procurement processes and ensuring their needs are met. Procurement processes that promote societal, industrial or environmental policies are therefore vital to the South African governments service delivery system. However, it does promote secondary objectives as reflected in table 8 (Bolton 2006 and Cane, 2004). Furthermore, the legislative frameworks and policies that have been implemented are often undermined by the systems overall lack of responsibility, political intrusion, unqualified and inexperienced stakeholders, lack of technical skill capacity, lack of regulatory framework understanding and noncompliance with policies and respective framework. These challenges often contribute to the dominance of corruption within the public sector (Horn and Raga 2012).

Table 8: Public Sector Procurement Objectives as per The Constitution

Objective		***Reference***
Primary	Impartiality, equitability, equality, competitiveness and cost efficiency	Section 217(1)
Secondary	Contractual preferences and the protection or advancement of disadvantaged individuals	Section 217(2)

(Source: Watermeyer, 2011; Wolvaardt and Pauw, 2009 and Bolton, 2006)

The legislative frameworks and policies include; the Constitution of the Republic of South Africa of 1996; Public Finance Management Act 1 of 1999; Preferential Procurement Policy Framework Act No 5 of 2000; Promotion of Administrative Justice Act No 3 of 2000; Promotion of Equality and the Prevention of Unfair Discrimination Act No 4 of 2000; Construction Industry Development Board Act No 38 of 2000; Municipal Finance Management Act No 56 of 2003; Broad-based Black Economic Empowerment Act 53 of 2003 and the Prevention and Combating of Corrupt Activities Act No 12 of 2004 etc. (Migiro and Ambe, 2008).

3.3.1. The Constitution of the Republic of South Africa of 1996

The *Constitution of the Republic of South Africa of 1996*; Section 217 (1) and (3) states that any legislation passed at the state level of government recommends a framework in which the preferential procurement policy should be employed. The procurement processes implemented by national and provincial departments, state-run enterprises and municipalities, is administered by a range of legislation (Ambe and Badenhorst- Weiss 2012). The Constitution highlights that the procurement system is required to be clear, competitive, cost effective and equitable. In the absence of fair and accountable systems and with the vast number of resources that are acquired through the public procurement system lends the system to be susceptible to corruption and the misuse of funds.

3.3.2. Public Finance Management Act of 1999

The *Public Finance Management Act of 1999*, Section 76 (4) (c) dictates that the National Treasury is required to develop a set of regulations associated with a framework for suitable procurement systems which is transparent, competitive, cost effective and equitable (Watermeyer 2011 and Republic of South Africa 1999). The Act establishes a governing framework for public sector procurement, which includes national and provincial departments, state-run enterprises and municipalities. Section 27(3) allows for the Medium-Term Expenditure Framework which allows for Infrastructure Delivery Management System as a regulatory framework. It has a direct focus on project delivery outcomes, effective functioning of the procurement systems and a successful delivery management system that are in agreement with related legislation. Furthermore, Section 38 of the *Act*, allows for accounting officers of public sector departments to ensure that departments maintain effective, operative and direct systems of risk management, internal controls and audits, and appropriate procurement and delivery management system. The duty of the accounting officer is to ensure that effective measures are implemented that assist in the prevention of unauthorized, corrupt, irregular and wasteful losses and expenses that result from criminal conduct (Webb, 2010 and Republic of South Africa, 1999).

3.3.3. Preferential Procurement Policy Framework Act No 5 of 2000

The *Preferential Procurement Policy Framework Act of 2000* established the functional process and implementation of preferential procurement policies (Ambe and Badenhorst-Weiss 2012). Section 217(3) of the 1996 Constitution provides for an implementation framework of preferential procurement policies which highlights the preference of historically disadvantaged individuals (Moeti 2014). According to Munzhedzi (2016), public sector procurement systems have however become decentralized. This has resulted in a vulnerable government that is prone to mismanagement, fraud and corruption as local government and state-run enterprises have been afforded the opportunity to develop their respective procurement systems and policies within the realm of the national regulatory framework (The Department of Public Service and Administration; 2003). Further regulations passed by The National Treasury states that various structures of government ought to establish three categories of commissions; bid specification, bid adjudication and bid award committees in an attempt to regulate and provide efficient and effective procurement systems (Pauw, 2011).

3.3.4. Construction Industry Development Board Act No 38 of 2000

The *Construction Industry Development Board Act of 2000* is a national body established by an Act of Parliament (Act 38 of 2000) to oversee the sustainability and growth of construction enterprises across the country. The CIDB establishes national standards for project delivery and operates by means of a Code of Conduct and through the establishment of standardized construction procurement processes based on best practices. The CIDB is also responsible for establishing a set of requirements for procurement systems to be implemented within the construction industry. These procurement systems are aimed at establishing uniformity and standardization in its procurement practices, documentation and procedures. The CIDB strives to maintain a national register of construction related projects and contractors (Construction Industry Development Board, 2015 and National Treasury, 2012).

3.3.5. Municipal Finance Management Act 56 of 2003

The local government *Municipal Finance Management Act of 2003* was established to provide a sustainable financial management system for municipalities and other state-run enterprises in the local domain of government. The Act was further established to provide standards, models and regulatory frameworks for procurement systems and processes that are to be executed at national treasury and the local domain of government (Hanks, Davies and Parera; 2008).

3.3.6. Broad-Based Black Economic Empowerment Act No 53 of 2003

The Broad Based Black Economic Empowerment Act of 2003 which was further amended by the *B-BBEE Act 46 of 2013* combined with government's amended Black Economic Empowerment Codes of Good Practice aimed at the ICT sector. The Act was established with an objective to address inequities resultant from apartheid policies including the methodical exclusion of historically disadvantaged individuals from meaningful contribution to the economy. Furthermore, the Act recognizes the interconnectedness nature of the sector and their role in the economic and societal development of the country (National Government Gazette, 2016). The legislative frameworks highlighted above underpin the South African public sector and its procurement systems, which aims to empower the economy through the empowerment of historically disadvantaged individuals. It also seeks to provide an effective public sector that strives to enable effective service and infrastructure delivery (Ababio, Vyas-Doorgapersad and Mzini 2008). The various legislative frameworks that have emerged, are an outcome of pre-democratic procurement systems in South Africa which was plagued by discernment and prejudices that favourably considered the white minority and disadvantaged the black majority which included, Africans, Indians and Coloured.

Therefore, the democratic government promptly introduced and continues to amend/develop significant reforms in the public sector procurement system to address the socio-economic objectives of the country (Ambe and Badenhorst-Weiss 2012).

3.4. The Public Sector Procurement Infrastructure Delivery Management System

In the 21st century of societal development, metropolitan cities function as both national and global economic engines. Dynamic management systems are therefore required for successful urban infrastructure development, which are a key success factor for societies around the globe. According to CIESEN (2005), cities accommodate 3% of the total land mass internationally, and less than 2% in South Africa, even though cities are home to the majority of the world population. In 2014, 54% of the world population was urbanized, with 64% of the urbanized population living in South African cities. The South African public sector environment consists of eight metropolitan cities that accommodate 64% of the population and produce 57% of national economic output. Underpinning this level of national economic output is a diverse and extensive set of asset portfolios with a current replacement cost in excess of R 600 billion. A cities asset provides access to sustainable resources, a clean and safe environment, including a range of social services. Cities also provide the flexibility and space for a complex, innovative, higher order social and cultural achievement.

Between the period 1996 and 2012, the South African national economy increased by 59% while the economies of the eight metropolitan cities grew by 79% (Boshoff and Childs, 2016 and National Treasury, 2015). Cities provide the space for complex interaction, higher order social and cultural achievement, and innovation. However, despite the numerous advantages, cities are characterized by unequal consumption of non-renewable resources, fragmentation, socio-economic disparity, environmental pollution and various social ills that are unique to the South African climate. The eight metropolitan cities in South Africa face challenges related to the changes in the levels of demand and in the improvement of spatial efficacy. The South African framework of SANS 55001 makes provision for the above challenges to integrate into an organization's objectives. These objectives affect the standards of service and project delivery, demand management and in coordinating the lifecycle strategies of asset portfolios (Boshoff and Childs, 2016).

In recognising the vital importance of metropolitan cities and the complex environment in which the operate, The Construction Industry Development Board in conjunction with The National Treasury Public Finance Management Act of 1999 Section 27(3), Department of Public Works and the Development Bank of Southern Africa; in collaboration with the eight municipalities have embarked on an initiative known as The Cities Infrastructure Delivery and Management System. This system represents a personalized and unique asset management system that complies with the standards of SANS 55000/1 related to asset management, ISO 10845 related to construction procurement, relevant accounting, financial reporting and asset management standards that are in keeping with South African legislative frameworks and policies for the urban built environment the founding bodies further established The Infrastructure Delivery Management System. The IDMS is a policy tool developed by government as a means of implementing strategies that enhance the socio-economic growth and development through infrastructure delivery. The Infrastructure Delivery Management System and Toolkit, provides an all-inclusive set of policies and processes accompanied by a body of knowledge for infrastructure delivery management in the South African public sector that addresses the poor planning, skills adversity, lack of uniformity and poor reporting and/or monitoring in the public sector (Municipal Infrastructure Support Agent, 2019; Boshoff and Childs, 2016).

It is a model that defines the procedures that establish public sector procurement management systems and engineering and construction project delivery; as it applies to all aspects of infrastructure delivery. The model aims to reflect the diverse needs of each cities engineering and construction and engineering sector, and to respond to the societal demands placed on it for successful infrastructure delivery in South Africa. The IDMS model is divided into 3 components; portfolio management; project management and operations and maintenance which highlight the fundamental processes that are associated with successful infrastructure delivery in the public sector, reflected in figure 16 (Construction Industry Development Board, 2016).

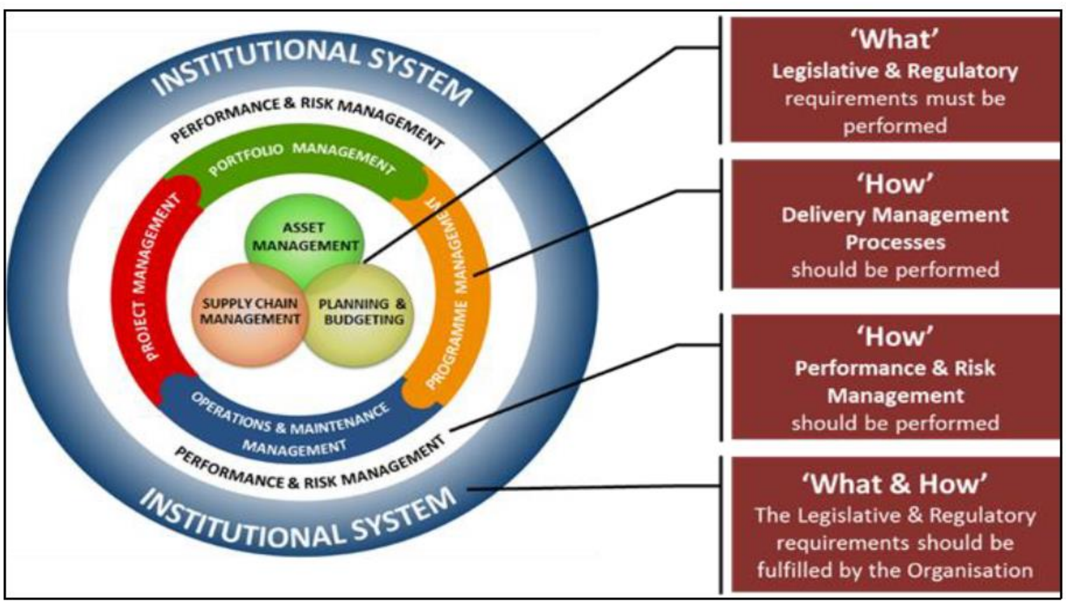

Figure 16: 2017 IDMS Concept Diagram (Municipal Infrastructure Support Agent, 2019)

The IDMS consists of the following systems:

a. Infrastructure planning system;
b. Infrastructure gateway system (IGS);
c. Construction procurement system (CPS);
d. Program and project management system; and
e. Operations and maintenance systems.

IDMS is a government management system that is intended to be linked to the Medium-Term Expenditure Framework (MTEF). The fundamental and strategic theme of IDMS lies in addressing the four dimensions of successful infrastructure delivery, namely: institutions, people, organisational behaviour and human resource systems (Lekgotla, 2011). An IDMS toolkit was further established to guide the implementation of the IDMS process; which has an integral focus on project outcomes, value for money processes and comprehensive functioning of the procurement and supply chain management, including delivery management systems that are compliant with relevant legislation. IDMS is also responsible for budgeting, planning, procurement, operation, maintenance, monitoring, delivery and the evaluation of infrastructure. It is comprised of set of interrelated components that establish processes which aid in the transformation of inputs into outputs (Construction Industry Development Board, 2016 and Coetzee, 2004).

The key purpose of the IDMS toolkit is to offer a procedural framework and to create a uniform approach across all users of the IDMS:

a. Promote efficient, reliable, predictable and repeatable IDM processes, based on best practice and legislative requirement,
b. New innovative procedures that include customer profiling, asset data models, needs and demand analysis,
c. Spatial capital development,
d. Investment planning,
e. A project delivery system based on fit for purpose development,
f. A platform for promoting successful infrastructure delivery by contributing towards a transformed society,
g. To focus on the 5 life cycle strategies which promotes the development and implementation of the life cycle programs,
h. To provides essential guidelines for procurement management processes and infrastructure delivery that are required to deliver, operate and maintain infrastructure,

i. To aid in the facilitation of a standardized uniform approach to infrastructure delivery management processed through the various domains of government and;
j. To ensure that the toolkit effectively assists the various departments in complying with applicable legislative requirements (Municipal Infrastructure Support Agent, 2020; Construction Industry Development Board, 2016 and Coetzee, 2014).

The IDMS toolkit presents a network of processes, techniques and best practices that further serves the asset management and finance register for the South African public sector across the eight metropolitan cities as represented in figures 17 and 18 respectively (Boshoff and Childs, 2016 and Construction Industry Development Board, 2016).

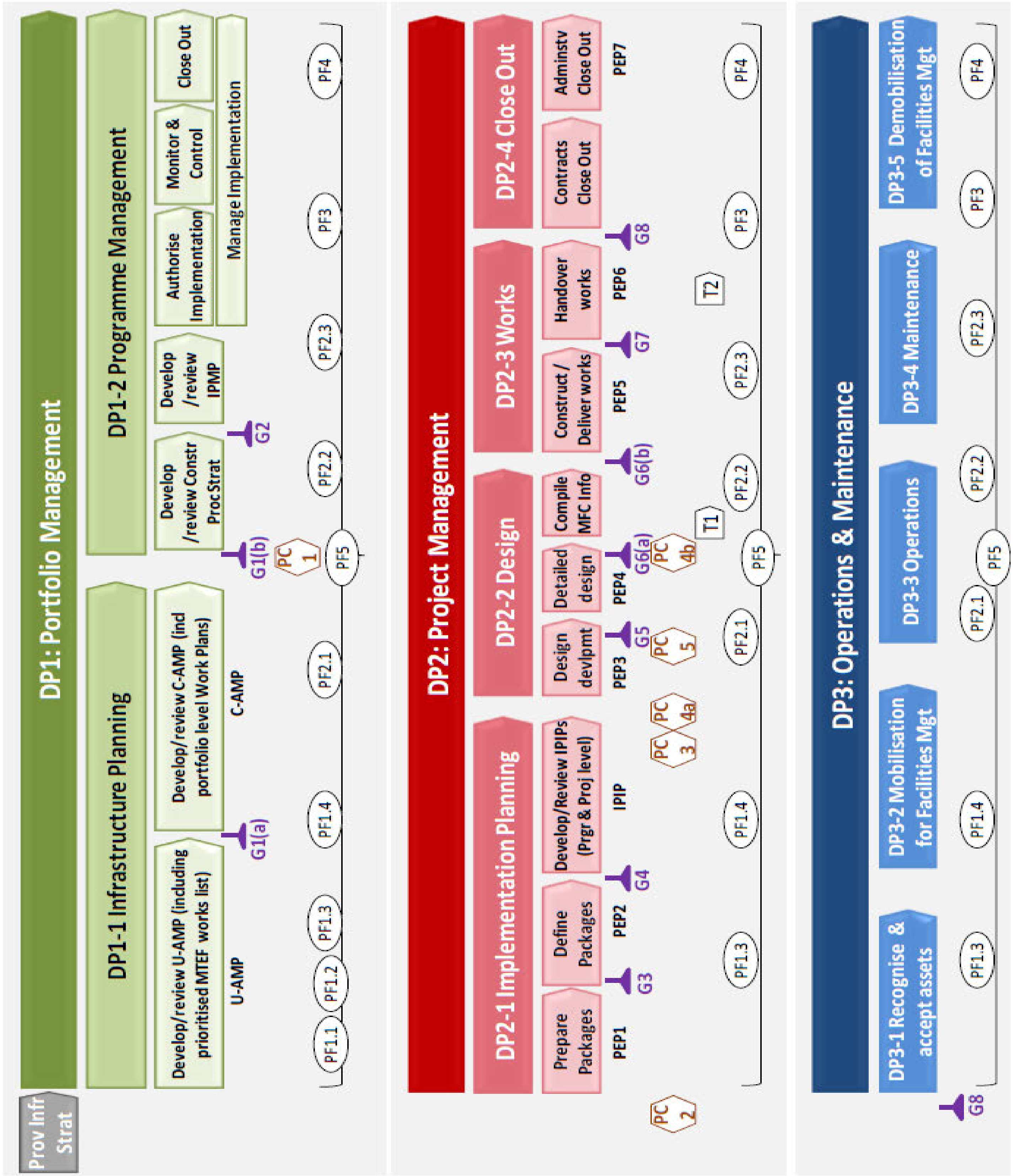

Figure 17: Infrastructure Delivery Management Core Infrastructure Processes (Municipal Infrastructure Support Agent, 2019)

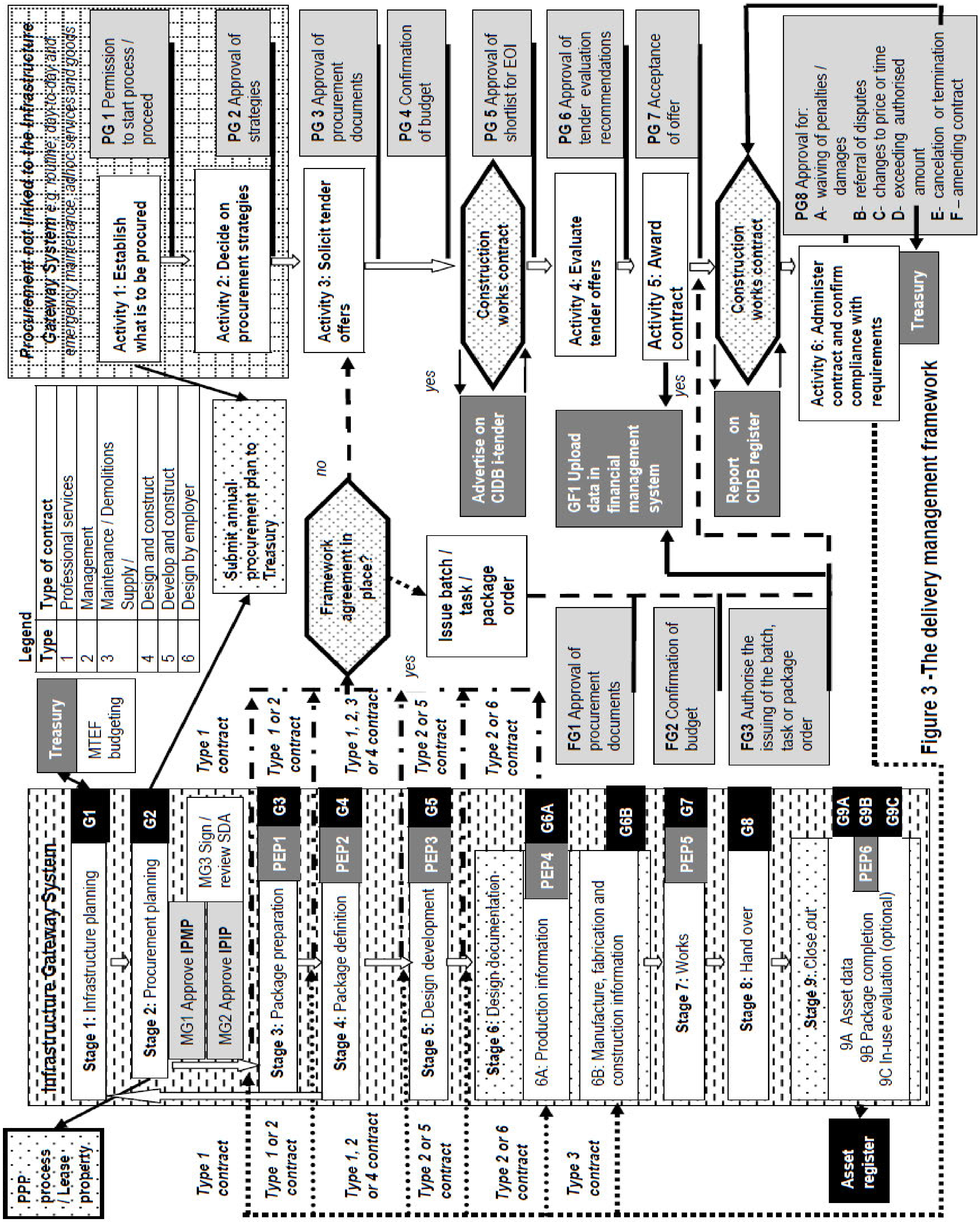

Figure 18: Infrastructure Delivery Management Core Infrastructure Processes Cntd. (Municipal Infrastructure Support Agent, 2019)

Globally, the infrastructure needs of society are constantly increasing, yet the resources required to finance largescale investments are failing to keep pace. Furthermore, business models for the successful implementation, completion and maintenance of projects are not being achieved (Ernst and Young, 2011). As a result, an increased gap exists between societal needs and the levels of investment which is dependent upon the economies financial markets, level of economic growth and environmental pressure (Coetzee, 2014). Worldwide, governments rank the implementation of infrastructure policy and development as their greatest concerns. Contemporary infrastructure that is in keeping with the modern world, is seen as being essential to the future economic competitiveness of a country and is critical in the socio-economic growth of an urbanised environment (Ernst and Young, 2011 and Urban Land Institute, 2011).

In South Africa, the association between socio-economic development and infrastructure delivery is gathering immense attention in the current strained economic climate as the infrastructure crisis is immense, complex and a multi-dimensional problem that challenges government and its metropolitan municipalities. In comparison to other municipalities, The City of Cape Town has ensured that the Western Cape is adequately served with infrastructure, having provided the highest national percentages of households with access to basic needs and infrastructural services (StatsSA, 2019 and Provincial Government Western cape, 2009). However, a large number of individuals still live-in abject poverty with poorly serviced areas with low levels of infrastructure development in provinces across the country. The failure of municipalities in successfully offering infrastructure services often occurs when there are inadequate investments and asset maintenance. As a result, the development of the infrastructure delivery management systems as depicted in the Kwazulu-Natal Infrastructure Delivery Management System Progress in figure 19; aids in the provision of portfolio management, project management and operations and maintenance management processes (Evans, 2013 and Palmer et al., 2016).

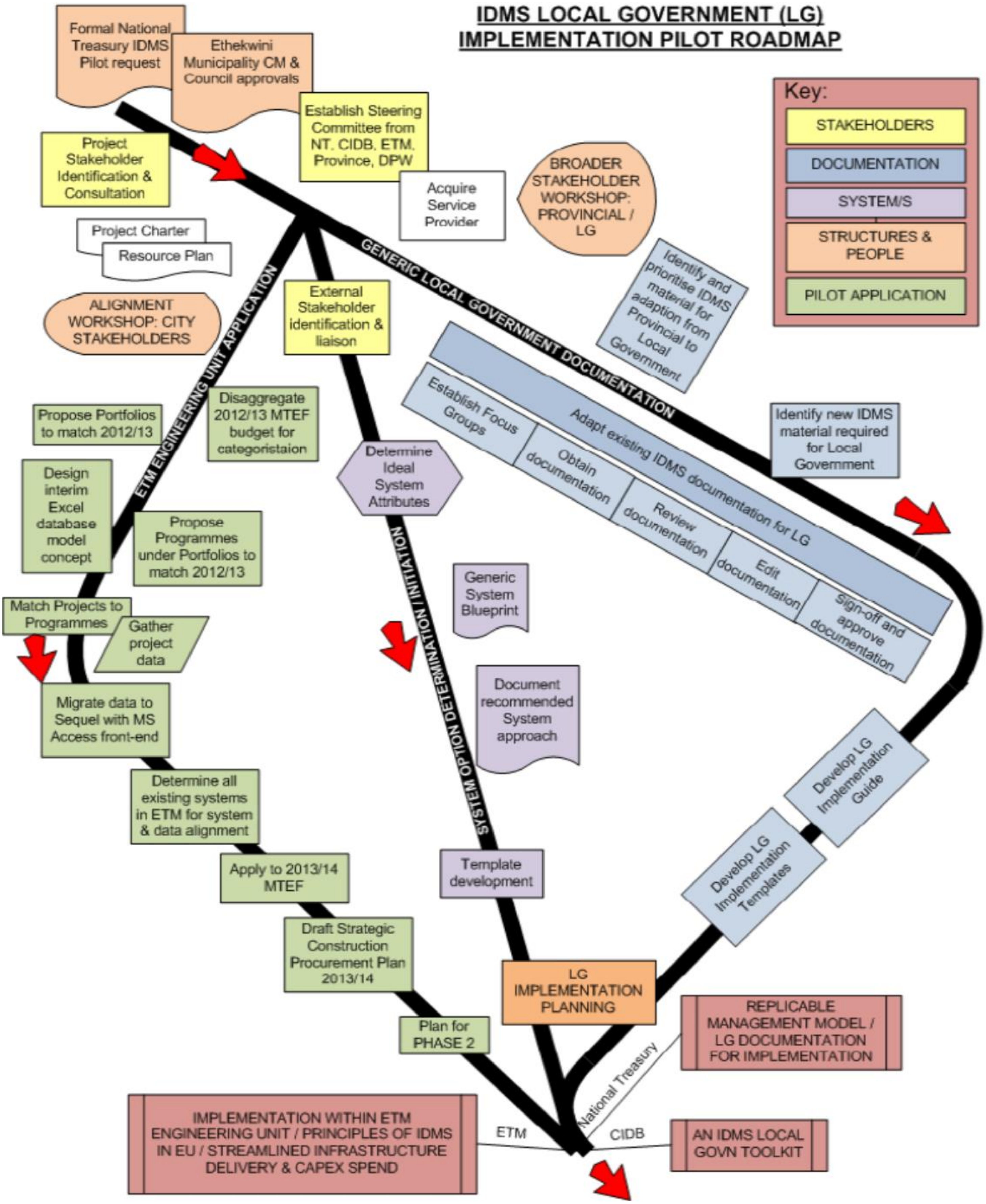

Figure 19: Kwazulu-Natal Infrastructure Delivery Management System Progress (Coetzee,2014)

The internal challenges of municipal institutes in the successful delivery of infrastructure, is the need to successfully align internal and external stakeholder organisations; in an attempt to create an enabling environment that is supportive of the IDMS and associated legislative frameworks. In 2015, The Standard for Infrastructure Procurement and Delivery Management (SIPDM) was published with an aim to regulates infrastructure procurement and delivery management processes that incorporates the SANS 10845 standards for construction procurement. The SIPDM promotes an environment that allows the efficient transfer of information and delivery management processes that includes effective business processes; from design to procurement, operation, maintenance and in the disposal of assets. An environment that understands the importance of efficient delivery management processes, namely a municipal environment embedded with IDMS that provides for and encourages capacity development through accredited project management training; as reflected in figure 20: The IDMS interactive model (Evans, 2013 and Coetzee,2014).

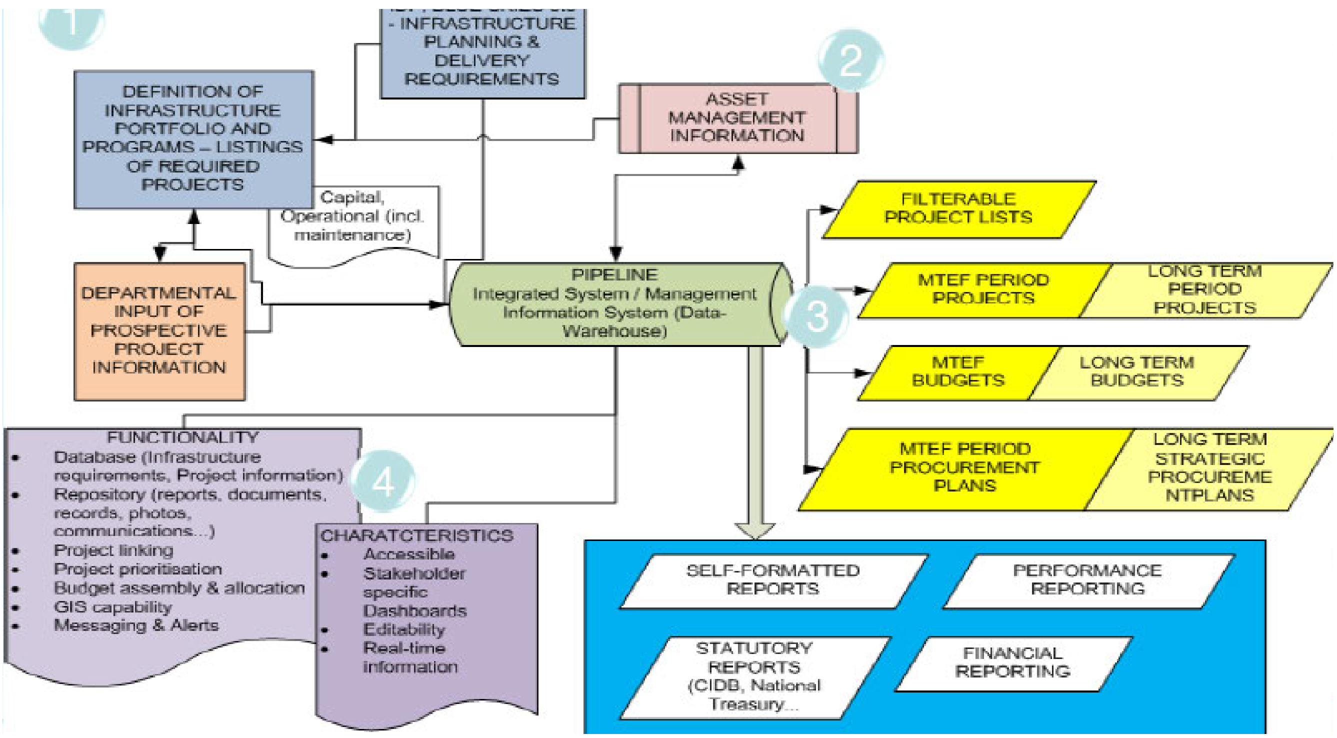

Figure 20: IDMS Interactive Model (Evans, 2013)

3.5. Public Sector Procurement Challenges

The National Planning Commission (NPC) had published a detailed report in 2011, that highlighted the key challenges that South Africans face includes a significant level of inequality in society and in the process of achieving constitutional objectives (National Planning Commission, 2013). The conclusion of the report highlighted that South Africa follows a nonchalant approach with their procurement systems and processes which often results in the country failing to meet its objectives. It is imperative to note that public sector procurement systems play an essential part of procurement in the South African public sector and therefore should be used as an instrument for the effective organization of public sector procurement practices. Despite the development and implementation of public sector procurement systems such as the Infrastructure Development Management System (IDMS) as a strategic tool; immense challenges exist with procurement systems and the implementation of IDMS in the South African public sector.

These include:

a. Lack of accountability, unethical behaviour, corruption and fraud,
b. Lack of skills and capacity,
c. Inadequate planning and financial management,
d. Non-compliance with public sector procurement policies and regulations,
e. Inadequate evaluation and monitoring of public sector procurement policies and regulations,
f. Decentralisation of public sector procurement system and,
g. Ineffectiveness socio-economic policies (MISA, 2020).

According to the World Bank (cited by Foster, 2008), despite efforts to alleviate levels of inequality through the development of socio-economic policies and procurement systems, the underdevelopment of infrastructure is hindered by the overarching deficiencies in public sector procurement systems, poor infrastructure delivery and in the maintenance of infrastructure. The report highlighted that infrastructure development and the successful delivery thereof had accounted for 85% of GDP. However, in South Africa, the inability of public sector institutions and provincial governments to effectively spend their capital budgets annually has for numerous years been a sore point with National Treasury (Walls et al, 2015). The total capital expenditure by public sector institutions has subsequently decreased from R272 billion in 2017 to R250 billion in 2018. An 8% reduction of R22 billion.

According to the Capital Expenditure (CAPEX) Report published in 2018 by Statistics SA, public sector institutes have recorded the largest CAPEX budget for 2018 at R111 billion in comparison to the allocated R127 billion in 2017. However, this was overshadowed by a 4% decline by municipalities, from R62 billion to R60 billion between 2017 and 2018 respectively. The CAPEX report further indicates that the national government budget had declined by 5%, 16 billion to R15 billion respectively; with an increase of R3 billion for key assets such as land and existing buildings. However, a decrease was noted for capital expenditure on all new construction and engineering projects from R182 billion to R161 billion between 2017 and 2018 respectively (Statistics South Africa, 2019). This illustrates the inefficiencies and challenges present with IDMS and in the public sector environment; in successfully administering the CAPEX budget allocated for socio-economic infrastructure development. Furthermore, the roles and responsibilities between various provincial departments, industry stakeholders and within government are unclear; with current provincial structures not aligned to infrastructure delivery management systems, and procurement processes which are an essential part of procurement in the South African public sector (National Planning Commission, 2013 and Auditor General, 2013).

3.6. Chapter Summary

This chapter is part two of two chapters that highlights an extensive review of the theoretical framework of the research study. It is focused on reviewing literature that reflects the fundamental concepts embedded in the research study and investigates the degree to which research questions and objectives have been expressed in previous research studies. The chapter includes a thoughtful insight into the nature of the public sector environment, municipal structure, regulatory and legislative framework, public sector procurement systems and the impact of infrastructure delivery management systems on successful project delivery.

CHAPTER FOUR
CONCEPTUAL RESEARCH MODEL

4. Introduction

A conceptual research model is a succinct and accurate consolidation of all research related aims and objectives that are relevant to the operational and behavioural characteristics of the research study that is presented in a predefined format. The model offers a basis for the development of the simulated structural program. The first step in constructing a conceptual research model is to explicitly identify a set of fundamental research concepts. These concepts and the factors that directly or indirectly affect the study, are reflected in the model as classes or types. It should be noted that there are no commonly recognized guidelines for establishing or evaluating collections of classes (Robinson, et al., 2015; and Parsons and Wand, 1997).

4.1. The Purpose of a Conceptual Research Model

The conceptual model should be comprehensive and fair. The model should be concise as to develop a framework of the research study. One of the main purposes of the conceptual model is to validate the framework for the research study. Table 11 further expresses the definition, purpose and benefits of conceptual modelling (Robinson, et al., 2015; and Parsons and Wand, 1997).

4.2. The Benefits of a Conceptual Research Model

a. The model enables the objectives of the research study to be clearly acknowledged through discerning discussion and agreement by the research team.
b. The model enables critical aspects of the study to be clearly defined.
c. The model assists the research team in making significant decisions about the level of harshness that is required in the specification of the research factors, concepts and characteristics.
d. The model assists the research team with varying perspectives and an array of views on what components are essential and relevant research output.
e. The model enables the construct of unbiased factors and relationships between concepts. It also assists in the validation of a simulation model, that establishes a level of credibility of the research study.

Table 11: Conceptual Modelling: Definition, Purpose and Benefits

Conceptual Model	***Arbez and Birta (2015)***	***Robinson (2015)***	***Tolk (2015)***	***Wagner (2015)***
Classification	A terse and precise consolidation of all behavioral and structural characteristics of the research study.	A non-software specific description of the simulation expressing the research objectives, ideas, outputs, information, expectations and refinement of the model.	The conceptual model is results of the processes that lead from the task to the specification of the conceptual model. It highlights the ontological components of the research problem that comprises of expectations and constraints.	Conceptualization is seen as a resolute autonomous description of a problem. It creates a self-regulating simulated design model that may be assumed for a set of research questions.
Purpose	The conceptual model aids stakeholders to debate the behavioral characteristics of the research study. It should also aim to be a comprehensive description for computer programs.	A simulation model will not occur without a conceptual model, as the conceptual model is used as a means of communication.	The conceptual model captures and communicates the study with potential unforeseen simulation users.	The model captures a complete and large part of the research problem wherein a simulation study is conducted where the research questions can be explored.
Benefit	The conceptual model ensures that important features of the research study evolve from discussions with stakeholders.	A standard conceptual model is the foundation for controlling and managing activities in the development and use of a simulation model?	The ability to build trust by explicitly detailing the conceptual model which is essential in the composition or reuse of research study.	The conceptual model can assist in clarifying research questions, the scope and purpose of a research simulation project.

(Source: Robinson, Arbez, Birta., Tolk and Wagner, 2015)

The conceptual model for this study illustrates the theoretical basis for the model framework, that is formulated from key concepts highlighted in the literature review. This influences the foundation for the research questions identified for empirical tests.

4.3. The Factors of a Conceptual Research Model

The development of the research model and its factors have been derived from an extensive literature review and qualitative pilot studies, that highlight seven major components for successful construction project completion in the public sector. These include various external factors, that includes; international and national market conditions, government frameworks and statutory regulations, unforeseen factors and project characteristics that may act separately or in combination with each other (Shane et al., 2009).

The research model factors:

a. Project Stakeholder Influences (PSI)
b. Project Characteristics Factor (PCHF)
c. Project Challenges Factor (PCF)
d. Socio-Economic Factors (SEF)
e. Statutory Frameworks and Legislation Factors (SFLF)
f. National and Global Dynamic Factors (NGDF)

The research model further adopts a quantitative empirical study which measures the relationships between the six latent constructs and their corresponding research indicators for each set of factors, illustrated in table 10.

Table 10: Latent Constructs and Corresponding Indicators

Factors	***Research Indicators***	***Reference***
Project Stakeholder Influences	Clients (PSI1) Consultants (PSI2) Contractors (PSI3) Public Sector Officials (PSI4)	Ng et al., (2008); Iyer and Jha, (2004); Naoum, (2003) and Wright, (1997)
Project Characteristics Factor	Project Type (PCHF1) Project Scope (PCHF2) Project Size (PCHF3) Project Complexity (PCHF4) Project Budget Size (PCHF5)	Vleem, (2018); Jørgensen (2016); McLeod and MacDonell (2011); Cho, Hong, and Hyun (2009); and Wohlin and Andrews (2003)
Project Challenges Factor	Government Policies, Legislatures and Frameworks (PCF1) Financial Contributions (PCF2) Skills Capacity (PCF3) Socio-Economic Culture (PCF4) Stakeholder Management (PCF5) Information Technology (PCF6) Sustainability (PCF7) Industry Development (PCF8)	CIDB, (2020); Haupt and Armoed, (2017); Oppong et al., (2017); Coetzee, (2014); Cheng, (2014); Fourie, (2014); Malkat and Byung-Gyoo, (2012); Emuze, (2011); Hapuarachchi and Senaratne, (2008); The Public Service Commission, (2007); Du Plessis, (2002); Chege and Rwelamila, (2001); Ofori, (2000) and Cleland, (2002)
Socio-Economic Factors	GDP(SEF1) CPI (SEF2) GFCF (SEF3) Employment Rate (SEF4) Skills Shortage (SEF5) Poverty and Inequality (SEF6) Crime (SEF7) Social Services (SEF8) Monetary Policies (SEF9) Investor Confidence (SEF10) Fiscal Policies (SEF11) Transformation Policies (SEF12)	Balló, (2016); Kosla, (2015); Xu et al., (2015); Myers, (2013); Kaklauskas et al., (2011); Cottle, (2004); Pillay and Naude, (2006); Pillai et al., (2002); Wier, (2000) and Akintoye et al., (1998)
Statutory Frameworks and Legislation Factors	Political Policies (SFLF1) Public Sector Policies and Management Systems (SFLF2)	Department: Planning, Monitoring and Evaluation, (2015); Fourie, (2014); and Windapo et. al., (2013); Horn and Raga

	Equity Policies (SFLF3) Building Regulations (SFLF4) Construction Contracts and Procurement Processes (SFLF5)	(2012); Watermeyer, (2011) and CIBD, (2004)
National and Global Dynamic Factors	Global Political Dynamics (NGD1) Global Economic Trends (NGD2) National Economic Trends (NGD3)	Alagidede, (2016); NZIER, (2014); Cesa-Bianchi, (2013); García, (2005) and Chang, (2002)

4.3. The Proposed Hypotheses

The research study hypothesized the relationship between the influencing factors and successful project delivery in South Africa, based in the Kwazulu-Natal region focusing on an extensive literature review process.

H1: The roles and influence of public sector construction project stakeholders' have an effect on successful construction project delivery.

H2: Construction project characteristics influence successful public sector construction project delivery.

H3: Construction project challenges, such as delays and disruptions influence successful public sector construction project delivery.

H4: Socio-economic factors influence successful public sector construction project delivery.

H5: Statutory frameworks and legislator factors are related to the management of construction project performance in the public sector construction and engineering industry.

H6: National and global dynamic factors impact project performance and development in the public sector construction and engineering industry.

H7: The infrastructure development management system contributes to project delays and disruptions in the South African public sector construction and engineering industry.

4.4. The Proposed Conceptual Structural Strategic Infrastructure Delivery Management Model

Figure 21 presents a proposed conceptual model of the various constructs and relationships between the latent constructs and their corresponding indicators for each set of factors. The conceptual model is based on the proposed hypothesised relationships reflected above. The model further illustrates the hypothesized relationships of the constructs that are proposed to have statistically significant relations. A detailed discussion of the various constructs, the relationships between the latent constructs and associated variables; including the rationale is provided in Chapter Seven.

Figure 21: Proposed Conceptual Structural Strategic Infrastructure Delivery Management Model

4.6. Chapter Summary

This chapter presents the theoretical foundation for the conceptual framework formulated from the extensive literature review of the study. It highlights a detailed illustration of the essential connections between the literature and the conceptual research model. This forms the foundation for the proposed hypotheses that are presented for empirical testing. The chapter highlights the relationship between successful construction project delivery and the factors that impact its success.

CHAPTER FIVE

RESEARCH METHODOLOGY

5. Introduction

Choosing an appropriate research methodology is essential in order to achieve efficient scientific research, which is based on relating research objectives to the characteristics of the associated research methodologies. The research processes encompass a creative, thought provoking undertaking, that is systematic in an attempt to enhance a knowledge base and to use this knowledge to either establish or confirm facts, develop new theories, resolve problems and offer innovative solutions. Two important categories of research design are associated with research methodology; this includes qualitative research and quantitative research methods. Researchers select either a quantitative and/or qualitative process according to the nature of the topic, research questions, aims and objectives in order to identify, collect and analyse the data collected in an effort to enhance our understanding of the research topic. The research process consists of the following research phases: a) the definition of research questions, b) The collection of data, c) the processing of data, d) answering of research questions and, e) presentation of the research findings (Basias and Pollalis, 2018 and Goertz and Mahoney, 2012).

5.1. Research Philosophy and Approach

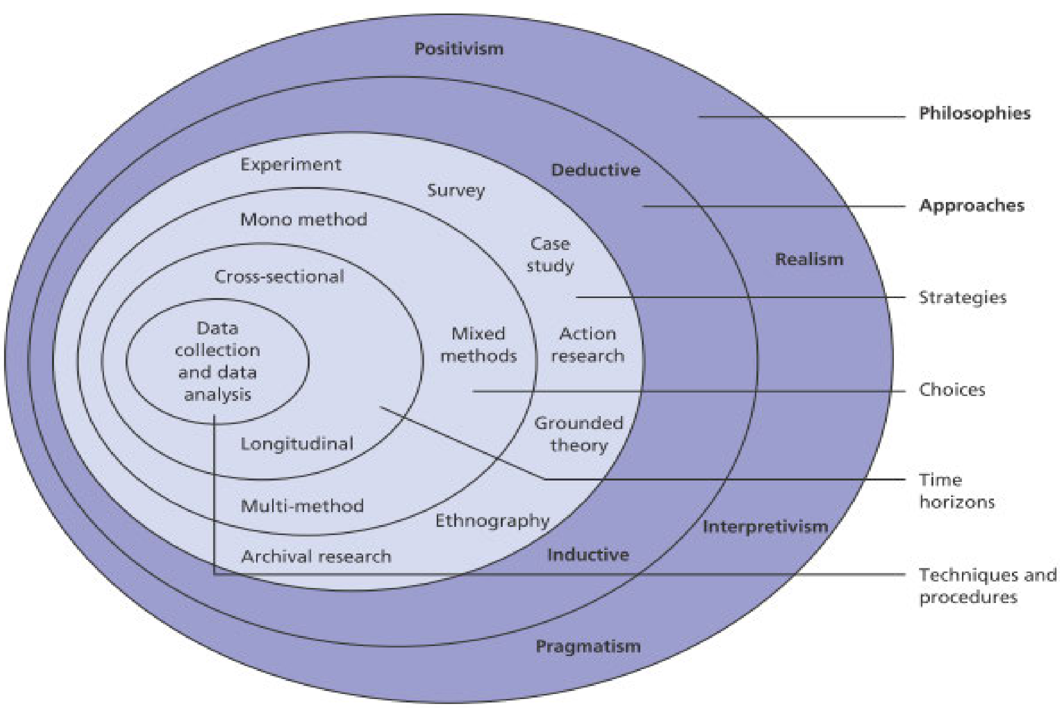

Figure 22: The Research Onion (Saunders, et al., 2015)

According to Saunders et al, (2015 and 2009), the term research philosophy identifies with the nature and development of knowledge. Numerous studies have employed diverse classifications, metaphors and categorizations of research philosophies and paradigms relative to the various research methods, as illustrated in figure 22. Many of which contain overlapping meanings and levels of prominence (Saunders et al., 2009; Ritchie et al., 2003; Guba, 1990; Guba and Lincoln, 1989). Advocates of research philosophies have over the decades, expressed beliefs and knowledge in what has been understood as paradigm "wars". These paradigms include ontology, epistemology, and axiology, which have a shared theme; yet allows for a degree of variations (Saunders et al., 2009; Guba and Lincoln, 1994; Becker, 1996).

According to Ritchie et al., (2003) the ontological research perspective includes aspects of avarice, realism, critical realism, relativism and idealism; while the epistemological research awareness includes positivism and interpretivism as illustrated in figure 22. As a result, Saunders et al. (2009) and Guba and Lincoln (1994) reflect a viewpoint on the philosophies of research, from an ontological, epistemological, axiological perspective, which further classifies and associates positivism, post-positivism and constructivist to critical realism (Guba and Lincoln, 1989). These philosophies highlighted above are not indifferent to one another, however, they all share a similar set of norms (Mkansi and Acheampong, 2012).

a. Ontology

Blaikie (1993) defines ontology as the study or science of being. Ontology relates to the fundamental nature of reality and the issues that are present (Easterby-Smith, 2012). According to Merrill (2010); ontology exits in terms of two fundamental categories; realism and nominalism. The concept of realism adopts that reality exists autonomously of individuals and their interpretations and perceptions of it. Nominalism adopts that individuals experience the world through their respective understanding of it, which lends itself to be subjective (Neuman, 2014). Furthermore, the overarching concept of internal realism assumes that reality and its truth are trying to observe directly, while relativism adopts that the truth is reliant on the vantage points of the observers (Bryman, 2016 and Smith et al., 2009).

b. Epistemology

According to Dudovskiy (2016), the epistemological research philosophy is concerned about how we as society understand the truth of the world, which is rooted in ontology. Two basic paradigms exist within epistemology; which includes positivism and constructivism. Positivism believes that the knowledge and truth should be produced through a scientific approach, whereas constructivism claims that the reality of things are a composition of various opinions and viewpoints of individuals and as a result, reality is highly subjective (Andrew et al., 2013).

Epistemology is closely associated with ontology, pertaining to what constitutes reality. According to Easterby-Smith, et al., (2008), epistemology questions what is and what are the limitations with respect to knowledge (Eriksson and Kovalainen, 2008). Chia (2002) and Hatch and Cunliffe (2006) explains epistemology as knowing how you can know. This is extended by looking at how knowledge is created, the criterion that differentiates between good and bad knowledge and the manner in which reality should be represented. The authors further highlight the inter-dependent relationship between epistemology and ontology, and the manner in which the two research philosophies inform, and depends upon, one another (Smith et al., 2009).

c. Axiology

Axiology is a part of research philosophy that examines judgments about worth and substance. It is a system of social enquiry that is of concern. In axiology, the role that your own values have within the research study plays a significant role at all stages of the research process and ensures its credibility. Heron (1996) states that our core values as individuals are the overarching reason for all human interaction. Heron (1996) further highlights that researchers often express axiological skill by expressing their ideals as a foundation for arguments and judgements about the research study (Saunders, 2016).

5.1.1. Research Paradigms and Approach

Paradigms are categorised by fundamental ontological, epistemological and axiological aspects assumed during the research process. The research paradigm thereafter directs the methodological approach to be implemented in the research study. The paradigm provides an all-inclusive awareness of the theoretical knowledge of the study and articulates the methodological strategies required to either prove or disprove the study (Denzin and Lincoln, 2016; Marsh and Stoker, 2010; Tuli, 2010 and Dash, 2005). Table 11 illustrates the four worldviews on research paradigms with table 12 offering philosophical debates.

Table 11: The Four Worldviews on Research Paradigms

Positivism	***Constructivism***	***Transformative***	***Pragmatism***
Determination	Understanding	Political	Consequences of Actions
Reductionism	Multiple Participant Meetings	Power and Justice Oriented	Problem Centered
Empirical Observation and Measurement	Social and Historical Construction	Collaborative	Pluralistic
Theory Verification	Theory Generation	Change Oriented	Real world practice oriented

(Source: Adapted from Mertens; 2005 and Creswell; 2003)

Table 12: Philosophical Debates

Research Approaches	***Philosophical Debates Based on The Various Approaches***
Mixed Methods	Two viewpoints exist in the philosophical debate of a mixed method approach. Denscombe (2007) and; Johnson and Onwuegbuzie (2004) highlight that mixed methods are thought to be entrenched in a pragmatic approach. However, according to Zachariadis, et al., (2013), mixed methods research adopts a sense of critical realism as the theoretical foundation.
Qualitative Approach	According to Guba and Lincoln (1994), four research paradigms that exist within the qualitative research sphere. These include, positivism, post-positivism, critical theory and constructivism. Various authors express that interpretive and critical paradigms are central to a qualitative research approach (McNabb, 2008; Denzin and Lincoln, 2005).
Quantitative Approach	Authors highlight that a positivist and naturalist philosophies are commonly applied to quantitative research approaches, however other scholars highlight that social constructionism, post positivism and critical realism as other philosophical stances (Alvesson and Skoldberg; 2009; Polit and Beck, 2008, 2010; Roberts and Steen, 2001).
Qualitative vs. Quantitative Approach	The research debate among various scholars intensifies when deciding which research philosophy is best for a single research approach (Becker, 1996 and Bryman, 1984).

(Source: Mkansi and Acheampong, 2012)

The pragmatic research paradigm was created as the debate between a positivist and constructivist research paradigm intensified. Its logic of inquiry includes the use of induction, deduction and abduction of the research study (de Waal, 2001). The pragmatic research paradigm refers to the participants' experiences and knowledge which is mediated through the researchers (Creswell et al., 2011; and Tuli, 2010). The pragmatic research paradigm adopted for this research study places the research question as the central theme of the study and aims to understand the research problem (Mackenzie and Knipe, 2006 and Creswell, 2003). A pragmatic research paradigm states that in order for a research study to be validated, the criterion for valid knowledge should be based on both a logical and theoretical rigour; that is also dependant on the interpretation, perception, and overall experience of the real world (Veal and Darcy, 2014).

A quantitative research methodology was therefore accepted for this study. Exploratory pilot surveys and questionnaire surveys were administered to public sector engineering and construction industry professionals; in order to gather data; with the research question being central to the research study. The data collection and analysis methods provide an insight of the research question with no philosophical constancy to any alternate paradigm. Figure 23 reflects the relationship between ontology, epistemology, and methodology adopted for this research study. After extensive analysis, findings and recommendations of the study are then highlighted (Onwuegbuzie and Leech, 2004).

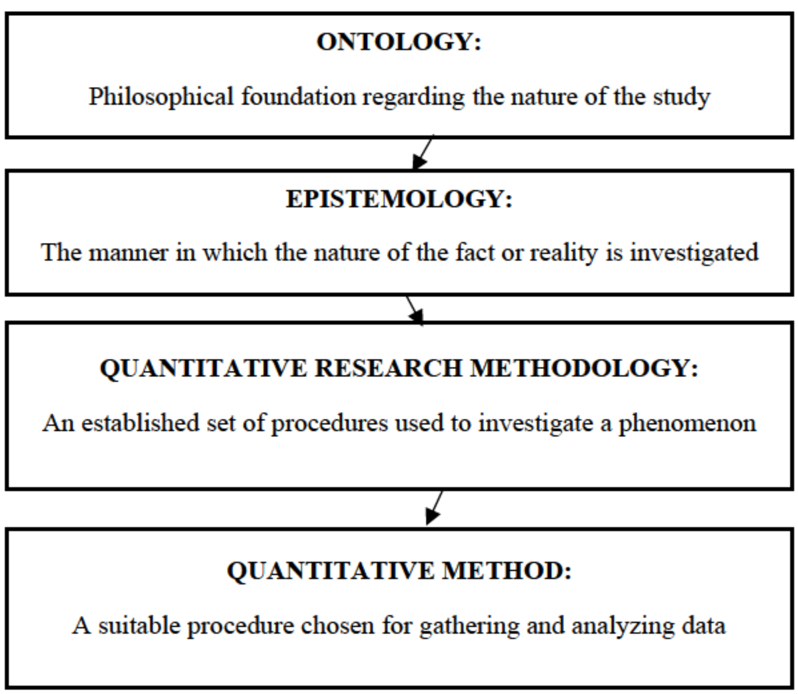

Figure 23: The relationship between ontology, epistemology, and methodology (Dash, 2005; Marsh and Stoker, 2010 and Tuli, 2010)

5.2. Research Framework

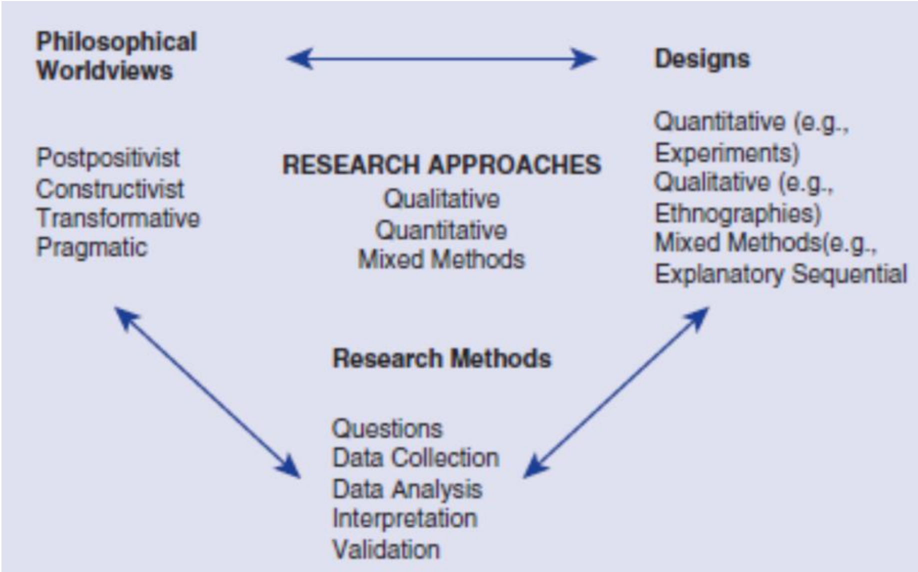

Figure 24: Foundations for a Research Framework (Creswell, 2014; 2009)

5.2.1. Quantitative Research Methods

A quantitative research method is an explanatory method where the variables of the research study are explicitly defined and numerical data is present. A quantitative research method further explores the hypotheses of study based on current literature and previous studies that are to be measured using scientific methods (Ahmedshareef et al., 2014). Quantitative research methods employ mathematical and statistical analysis for the sampling process of the data. The statistical analysis employed can also produce a degree of statistical significance which poses the conclusion of whether the hypothesis of the research study should be accepted or rejected (Avagimov and Zeigarnik, 2016). Furthermore, clear and concise documentation of instruments allows researchers to analyze the level of reliability and validity of the research study (Hishinuma et al., 2016). As a result, based on the reliability and validity of the study, the research findings, recommendations and conclusions may be generalized to the population (Edmondson and Mcmanus, 2007).

According to Bryman et al., (2000), researchers chose quantitative research methodologies as a preferred method for data collection processes. However, a survey instrument evaluates statistical situations and do not offer a detailed explanation of the processes involved. Furthermore, quantitative research measures cannot assist in understanding the numerous undercurrents of the phenomena (Fekete et al., 2010). Creswell (2003), also highlighted that quantitative research methods lends itself to emphasis on a single level analysis. Table 13 illustrates the key features of quantitative research methods.

Table 13: Key Features of Quantitative Research Methods

	Quantitative
Aim	To measure items in order to explain what is observed.
Purpose	Predictions and underlying explanations.
Tools	Tools include questionnaire surveys.
Data Collection	Structured.
Output	Statistical data
Sample	A large number of representative cases.
Objective/Subjective	An objective understanding.
Researcher Role	Separated from the subject matter.
Analysis	Statistical.

(Source: McDonald and Headlum, 2017)

The research methodology implemented in this research study is dependent on the research question, objectives, measurables, research constraints and the validity and reliability of the research study (Weathington, 2012). The research methods will be based on the extensive literature review and on the degree of the research development (Edmondson and Mcmanus, 2007). The initial part of the research was designed to identify and explore the concepts through exploratory research methods, that includes an exploratory survey with industry professionals and experts. The quantitative data collection process and analysis includes a survey questionnaire accompanied by statistical data analysis methods. The findings, conclusions and recommendations of the research study is validated by the results from the quantitative research methods and has therefore been considered as choice for this study. An extensive research analysis is seen as an insightful approach in order to ascertain a deeper understanding of the research problem, to enhance the internal and external validity of the research and to aid in drawing conclusions from the research findings (Fellows and Liu, 2015 and Jick, 1979)

5.3. The Research Process

The research design of the study highlights the research framework employed to address the research problems, questions and objectives raised in the research study (Scandura and Williams, 2000). The research design further constitutes of suitable strategies and approaches that are used to access research information, data collected, the concept researched and the manner in which the data is accessed (Mitchell and James, 2001).

The research process highlighted in the flowchart below, reflects the research strategy adopted for this study. The study was divided into three stages, namely; exploratory, descriptive and validity.

Stage one: The exploratory stage commenced with recognizing the research problem, recommending research questions, and determining a clear set of research objectives. Thereafter, an extensive literature review was executed, after which the research objectives, research questions and research constructs were refined. A pilot study was implemented through an exploratory pilot survey to identify constructs for the questionnaire survey.

The research constructs identified from literature and the pilot study include; national and global dynamics, the public sector construction and engineering industry, socio-economic factors, project characteristics, project stakeholders' influences, and statutory and regulatory factors.

Stage two: The descriptive stage of the research study which included the exploratory pilot survey and survey questionnaire process which was conducted with construction and engineering sector professionals registered employed at organizations that were registered with the Construction industry Development Board; to gather mixed method data for testing the research model created from the previous literature and the pilot study. The research model was further refined based on the findings from the statistical data analysis through the use of SPSS v26 and AMOS.

Stage three: The validation stage of the research study was supported by the literature review, exploratory pilot survey and the survey questionnaire, as it sought to validate and refine the research model, findings, conclusion and recommendations of the study.

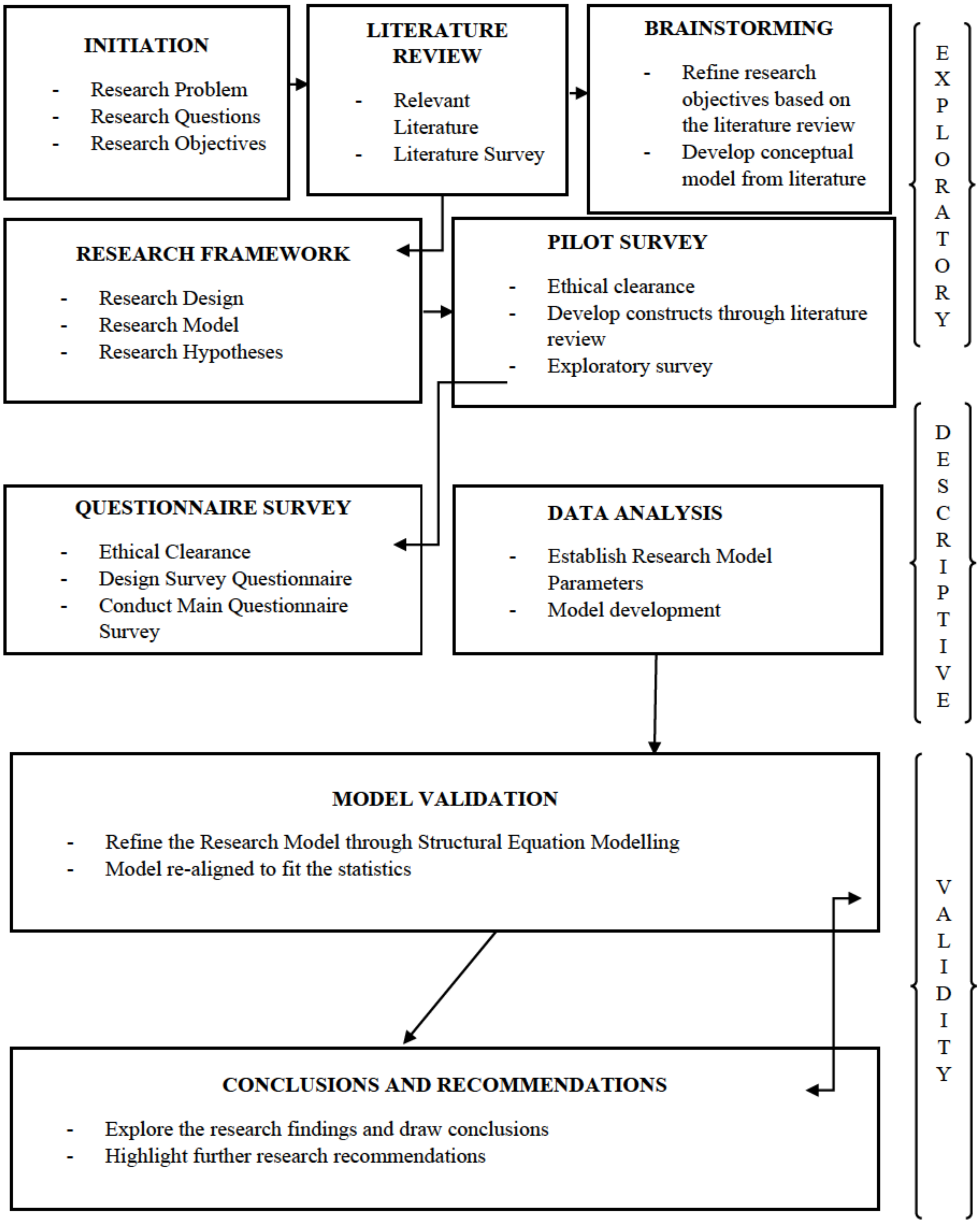

Figure 25: Flowchart illustrating the Research Processes of the Study

5.3.1. Quantitative Data Collection Process

Quantitative data collection methods are based on structured data collection and random sampling processes that enable diverse experiences to occur in a predetermined response category. This type of quantitative data collection process assists in producing results that are easy to generalize, compare and summarize. Quantitative research is concerned with the identification and testing of hypotheses that are derived from literature. Based on the type of research questions, participants may be randomly identified for the purpose of the research study. However, if this is not possible, and the intent of the study is to generalize data, the researcher will employ probability sampling to identify participants from a larger population (Kabir, 2016a; 2016b).

Typical quantitative data gathering strategies include:

a. Close ended surveys,
b. Experiments,
c. Observing and recording distinct events,
d. Obtaining relevant data from management information systems.

<u>5.3.2.1. Survey Questionnaires</u>

Survey research studies are used to:

"*answer questions that have been raised, to solve problems that have been posed or observed, to assess needs and set goals, to determine whether or not specific objectives have been met, to establish baselines against which future comparisons can be made, to analyze across time and generally, to describe what exists, in what amount, and in what context* (Isaac and Michael, 1997:136)."

According to Kraemer (1991), survey research contains three distinguishable features. These include its ability to quantitatively describe specific aspects, the collection of subjective data and the ability of the research study to generalize the findings with respect to the target population. The survey questionnaire relies on independent and dependent variables that are used to outline the scope of the research study. The researcher is therefore required to predict a model that recognizes the relationships between the variables. The survey questionnaire is developed in order to test the model against the observed literature observed (Glasow, 2005). Survey questionnaires are separated into structured and unstructured surveys (Bill, 2007). Structured survey questionnaire consists of close-ended questions while unstructured survey questionnaires consist of open-ended questions that enable respondents to provide tangible answers (Cycytota and Harrison, 2006).

Once the conceptual model has been developed from the extensive literature review, the study will employ an exploratory pilot survey to 50 selected participants and the main survey questionnaire to 750 participants, in order to collect and refine concepts from the data, which includes closed-ended questions. This enables respondents to provide their views with the term other as an open option to specify details for the research study. A detailed information and consent letter greeting respondents, with a self-introduction of the researcher and of the study, the research questions, objectives and purpose of the study, the data collection methods, the certainty of anonymity and confidentiality and the contact details of the researcher; will be issued along with the survey questionnaire.

5.4. Sampling Techniques

The Merriam-Webster Online Dictionary (2020), defines the process of sampling as "*the act, process, or technique of selecting a representative part of a population for the purpose of determining parameters or characteristics of the whole population.*" This understanding has been popularized over the centuries, however in recent years some researchers have differing understandings regarding sampling within the qualitative research domain (Gentles, et al., 2015). Sample size is dependent on five factors; the level of accuracy; the anticipated statistical power; the capacity of the researcher to attain contact to the subjects related to the research study; the level of which the population may be stratified and the choice of relevant units of measure for analysis. This research study employs a mixed research approach. The sample size for qualitative studies is generally considered to be less than those used in quantitative studies (Glasow, 2005). According to Ritchie, Lewis and Elam (2003); every study has a point of diminishing return to a qualitative sample. This is a result of frequencies being of relative importance in qualitative research methods.

Crouch and McKenzie (2006), explain this characteristic of qualitative research as being associated with the meaning of the study rather than making generalized hypothesized statements. Mason, (2010) highlights that in qualitative research, numerous issues can affect the sampling process and the principle used to guide the process should be centered around the concept of saturation. This concept has been explored and debated in great detail by various authors and researchers alike. Bertaux (1981), adapted from Guest et.al., (2006) states that a saturated sample size of 15 is considered to be the smallest acceptable sample; while Creswell (1998) highlights the smallest allowable sample size of 20-30 is acceptable. Morse (1999) states a sample size of between 30-50 interviews to be an acceptable standard for qualitative research. This process will be used as a sampling method for this research study (Mason, 2010 and Tuli, 2010).

For the purpose of this research study, a probability sampling technique shall be used for the quantitative research analysis as utilizes a random selection process. The sample process assumes that the participants in the target population have an identifiable but unequal probability to be randomly selected into the sample. In a questionnaire sampling, a simple random stratified sampling method is one of the probability methods that were used in this research study, which allows for the equal opportunity for the participants of the target population (Gronmo, 2019 and Palta, 2003).

The sample size requirements in quantitative research, predominantly in the use of structural equation modeling (SEM) is a challenge often faced by researchers. Due to the current advances and ease of use of software programs in the various approaches to statistical modeling in quantitative research, there has been a surge in research studies that have employed latent variable analyses. The strength of software programs and SEM is its flexibility. This enables the investigation of complex associations and factor analysis with the use of innumerable data evaluations across alternate models. However, the use of SEM also creates difficulties in the development of a generalized set of guidelines regarding sample size requirements (Wolf et al. 2013; MacCallum, et al., 1999). Authors have developed various rules-of-thumb which includes (a) a minimum sample size of 100 or 200 (Boomsma, 1982, 1985), (b) 5 or 10 observations per parameter (Bentler and Chou, 1987), and (c) 10 cases per variable (Nunnally, 1967). These rules tend to be problematic as they are not specific to a particular model and often leads to extensively over estimated or underestimated sample size requirements. Evidence suggest that simple structural equation method models could be meaningfully tested even if sample size are small (Hoyle, 1999; Hoyle and Kenny, 1999; Marsh and Hau, 1999). According to Wolf et. al., (2013), sample size requirements ranging from 30 up to 450 cases containing simple critical factor analysis with four indicators and loadings that compute to 0.80 are acceptable and present meaningful patterns of association between the parameters of the research study and sample size.

5.5. Ethical Consideration

According to Devinney and Siegel, (2012); the ethics used in research refers to the moral principles that are used to guide the research process, from conception through to the final completion and is often followed by research publications. However, while is it permissible for the public and researchers alike to conduct research, groups and individuals also have the right to protect their privacy and thoughts on the research matter being investigated. As a result, research organizations and respective institutions have established reputable research ethics committees that are responsible to produce an ethical code for research in an attempt to direct individuals in their research processes (Pearce and Huang, 2012; Aguinis and Henle, 2002; Gibson, et al., 2014 and Munhall, 1988).

The Human Sciences Research Council of South Africa is responsible for promoting reputable research that will benefit South African. The research is therefore aimed at supporting societal goals and belongs to the public domain. It is therefore required to withstand public scrutiny at all times. Accordingly, The University of Kwazulu-Natal Humanities and Social Sciences Research Ethics Committee has a code of ethical conduct for research that involves human participants. All research undertaken by staff and students at The University of Kwazulu-Natal are required to comply with rules and regulations stipulated by the committee, which enables the freedom of researchers to apply the necessary measures in order to generate the best outcomes (HSRC SA, 2020). According to the Human Sciences Research Council of South Africa, the code of ethical conduct for research by active researchers should be in accordance with the ethical principles of the committee that includes; privacy and confidentiality, respect for persons, the minimization of harm to researchers, participants, groups and institution, informed voluntary consent, the avoidance of conflict of interest, understanding and compassion to the demographic backgrounds of participants both culturally and in social justice (HSRC SA, 2020). Prior to the research study being conducted, The University of Kwazulu-Natal Humanities and Social Sciences Research Ethics Committee, requires the researcher to attain ethical approval via an on-line application process where supplementary documentation are provided to attain the approval certificate in order to conduct research procedures (UKZN Research, 2020).

5.6. Adopted Data Analysis Methods

5.6.1. Quantitative Analysis Method

Research has been labelled as a systematic inquiry or investigation where data is collected, analyzed and interpreted in an effort to accurately describe, understand, control and predict an educational or psychological phenomenon (Burns, 1997 and Mertens, 2005). Statistical software packages were used for the quantitative nature of this research study with focus on SPSS v26 and AMOS; as the process of statistical analysis is dependent on the research questions and research objectives developed by the researchers. The preliminary data analysis process administered through SPSS identifies missing values and data distribution. AMOS statistical software could later be employed for testing the research question and hypothesis in order to examine the causal and effect relationship between a number of independent and dependent variables.

5.6.2.1. Data Screening

According to Downing and Haladyna (2006), data is required to be analyzed and separated in order to ensure that the data is reliable and valid for testing the causal theory. A thorough analysis and screening process of the quantitative data collected is required in order to ascertain a comprehensive description, which is crucial to an inclusive comprehension of the data and suitable use of statistical methods. Furthermore, a thorough analysis of the data and comprehensive description can illustrate whether or not the data satisfies the assumption of the statistical analysis employed (Lynch, 2003 and Grissom and Kim, 2001, 2012).

In this research study, the quantitative data collected from the questionnaire survey, aims to test the conceptual research model which will further be validated by interviews. The survey questionnaire enables the respondents to express the degree of influence of the factors associated with construction and engineering project delays and disruptions on the successful project delivery in the public sector. Histograms are used to explicitly illustrate the frequency of the five-point Likert-scale for individual constructs reflected in the survey questionnaire. Box-Plots are further used in order to distinguish the outliers identified through statistical analysis. Outliers may impact your results, drawing the mean away from the median. The Normality of the data is later determined through the data screening process, with the use of Q-Q Plots. This is identified by the shape, skewness, and kurtosis (flat/peaked). If the research study reflects abnormal data, it will have a significant influence on the regression of the conceptual model which will be reflected through the statistical software employed such as SPSS and AMOS (Lawan, 2011).

5.6.2.2. Regression Analysis

Regression analysis has been identified as one of the most frequently used tools in research studies. Regression analysis allows researchers to analyze and evaluate the relationships between a given variable Y (dependent variable) and one or more other variables $X1$, $X2$, $\cdots$, Xn (predictors or independent variables) (Marsh and Cormier, 2001). It provides an insight into the research data that few other techniques can. Regression analysis models often include more than one independent variable and are therefore called multiple regression models (Larose, 2015). An essential hypothesis for regression analysis is that a linear relationship exists between the dependent and independent variables (Sarstedt and Mooi, 2014 and Morrison, et al., 2004). The key benefits of using regression analysis includes the present of a significant relationship between independent variables and dependent variables, the indication of the effects of relative strength between different independent variables and dependent variables and the ability to make predictions (Mooi, 2014). The formula to calculate Regression Analysis is shown in the equation below:

$$Yi = a + b1X1i + b2X2i + \cdots + b3X3i$$

Where: a is the consent of the regression model and bi are the coefficients of the regression model.

This research study aims to develop the relationships between the successful construction project delivery with the respective constructs. Regression analysis as a research tool was selected as it highlights the rudimentary understanding of the relationships and assist in their evaluation. The process of regression analysis enables the researcher to confidently determine which factors matters the most, which factors can be ignored, and how these factors influence each other within the context of the research study. Research tools such as genetic algorithms, perform well on discrete data, whereas neural networks usually perform efficiently on continuous data. Statistical analysis software such as AMOS will assist in developing algorithms for exploratory factor analysis and an algorithm for structural equation modelling.

5.6.2.3. Principal Component Analysis

Principal component analysis is referred to as a method which employs a set of sophisticated mathematical principles in order to convert a great number of correlated variables into a smaller number of variables called principal components. The origin of principal component analysis lies in a multivariant data analysis process, similar to Factor Analysis, and is commonly used as the first step in trying to accurately analyze large sets of data. It combines linear regression analysis with principal component analysis. Principal component analysis is traditionally conducted on a square symmetric matrix, SSCP matrix made up of pure sums of squares and cross products, covariance matrix which consists of the scaled sums of squares and cross products, or correlation matrix that which consists of sums of squares and cross products from standardized data.

The aim of principal component analysis in this research study is to excerpt the foremost important information, to compress the overall size of the dataset, to streamline the description of the dataset and to analyze the assembly of the variables and observations. The most important use of principal component analysis in this research study, is its representation of multivariate data as smaller set of variables in order to observe trends, jumps, clusters and outliers. This enables the researcher to observe the relationships between observations and variables, and among the variables.

The principal component analysis process mitigates any multicollinearity issues that may arise, but also highlights the independent variables that should be predictors. After the process of principal component analysis, the new variables created through spatial patterns' remove the properties caused by multicollinearity, as the ideal predictors to use in a regression analysis. As a result, the new variables are orthogonal and uncorrelated which represent linear combinations of the original variables. Principal component analysis brings together the measure of how each variable is associated with one another through a covariance matrix; the directions in which our data are dispersed through a review of eigenvectors and the relative importance of these different directions represented through eigenvalues (Zhao, et al., 2014; Abdi and Williams, 2010 and Richardson, 2009).

Given a set of independent variables $X1$, $X2$, Xp, the covariance matrix for the set of the independent variables is shown in the equation below.

$$V=1p\Sigma XtXtTpt=1$$

and

$$\lambda iai=Vai$$

Where: λi is the eigenvalue of V and ai is the corresponding eigenvector.

The principal components can be computed in the following equation:

$$PCt(i)=aitXt,\ i=1,2,\ldots,p$$

The number of principal components is condensed due to numerous eigenvectors being used where their corresponding eigenvalues are greater or equal to 1.

The percentage of total variance of the original data is calculated in the equation below:

$$Li=\lambda i\Sigma\lambda ipi=1\times 100\%$$

Where: λi represents the ratio of the component i to the total components, p is the total number of components and Li represents the variance of component i.

Therefore, the cumulative variance is shown in the equation below:

$$L(m)=\Sigma Limi=1$$

The sensible number of principal components selected is dependent upon the cumulative variance being above 85-90%.

5.6.2.4. Exploratory Factor Analysis

Factor analysis uses mathematical procedures in an attempt to simplify and comprehend the relations among variables and to pursue interrelated measures in order to ascertain patterns in a set of variables. In order to accurately perform factor analysis, a univariate and multivariate normality has to exist within the data collected (Child, 2006 and Yong and Pearce, 2013). The process of discovering the easiest method of analysis of the observed data is commonly known as parsimony, which is the objective of factor analysis (Goldberg and Velicer, 2006 and Harman, 1976). Factor analysis aims to identify and further breakdown measurable and observable variables to a reduced set of latent variables that have a shared variance. This is known as reducing dimensionality of the study (Bartholomew, et al., 2011).

Exploratory factor analysis is used by the researcher, to discover a summary of constructs when the nature of the constructs is unknown. It is further used when a researcher wants to determine the sum of factors that influence the variables (Goldberg and Velicer, 2006; DeCoster, 1998; Tucker and MacCallum, 1997 and McDonald, 1985). Exploratory factor analysis uses the process of factor loading, which can be categorized based on their level of magnitude; greater than + .30 reflects minimum consideration level, + .40 reflects more important and + .50 reflects practically significant. The power and significance level of the research may be determined by the sample size, as exploratory factor analysis generally perform better with a larger sample size. As a result, a sample of size of n is required in this research study to attain a factor loading of .55 with a power of .80 (Statistics Solution, 2020 and Comrey and Lee, 2013).

This research study employs the use of exploratory factor analysis as the researcher wants to ascertain the number of factors influencing variables and to analyze which variables ‘go together’ (DeCoster, 1998). In principal component analysis, when a factor is retained, both specific variance and common variance is retained; however, in exploratory factor analysis only a common variance is retained. It is easier to focus on key factors with exploratory factor analysis, rather than having to consider too many variables that may be trivial. Therefore, exploratory factor analysis is useful for placing variables into meaningful categories (Yong and Pearce, 2013).

The classical factor analysis mathematical model, denotes ***p*** as the number of variables ***(X1, X2,…,Xp)*** and ***m*** denotes the number of underlying factors ***(F1, F2,…,Fm)***. ***Xj*** is the variable represented in latent factors. As a result, the model assumes that there are ***m*** underlying factors with linear relationship between the variables. This model plans to replicate the maximum correlations shown in the equation below:

$$X_j = a_{j1}F_1 + a_{j2}F_2 + \ldots\ldots a_{jm}F_m + e_j$$

Where: j = 1, 2, …….,p.

The boundaries of exploratory factor analysis are that the identification process of the factors may be challenging, as the factor names may not correctly reflect the variables. Some variables may pose a difficulty with its interpretation as they may reflect split loadings (Tabachnick and Fidell, 2020, 2007).

5.6.2.5. Structural Equation Modelling

Structural equation modelling is a multivariate statistical modeling technique, which has been extensively used in the behavioral sciences. It is a generalized framework often based on theoretical constructs; that includes pathway analysis, factor analysis, simultaneous econometric equations, regression analysis and latent growth curve models (Stein et al. 2012 and Bollen, 1989). Structural equation modelling is used to examine the relationships between measured variables and latent constructs (Hox and Bechger, 2014; Byrne, 2012, 2010 and Raykov, 2006). Structural equation modelling may be employed in quantitative methodological research, to estimate a system of linear equations to test the fit of a hypothesized "causal" model. It seeks to identify complex relationships between one or more dependent and independent variable (Stein et al. 2012 and Hox and Kleiboer, 2007). The correlation matrixes derived from the hypothesized causal model and the collected data, are mathematically examined and assessed by structural equation analysis which produces a set goodness of fit index that indicates how well the hypothesized model fits the data (Raykov, 2006). Structural equation modelling consists of two sub models; the measurement model determines relationships between the latent variables, measured variables, regression paths and the structural model highlights relationships between the latent variables (Stein et al., 2012).

Figure 26: A diagram sample in AMOS (Source: Byrne, 2010)

The linear equation can be expressed in the equation below:

$$Measured\ variable = \alpha Latent\ variable + error$$

Where: α *is estimated by structural equation modelling and e is the error variance generated from modelling*

This research study adopted structural equation modeling as it is a multivariate statistical analysis technique that is used to analyze structural relationships. The technique combines factor analysis and multiple regression analysis, highlighted above and it is used to analyze the structural relationship between measured variables and latent constructs. The methodology can be viewed as a combination of three statistical techniques: multiple regression, path analysis, and factor analysis. It has the purpose and benefit of determining the extent to which a proposed theoretical conceptual model, is supported by the collected data. Structural equation modeling technique is therefore employed in the study for its confirmatory factor analysis of the proposed model instead of an exploratory analysis.

5.7. Research Model, Test Planning and Implementation

The research study adopted a descriptive survey methodological process as the empirical data for the study was obtained from an exploratory survey and questionnaire survey process. At the design stage of the study, an exploratory survey and questionnaire survey was developed. The data and collected from the pilot surveys of select public sector industry professionals registered with the Construction Industry Development Board. The questionnaire survey will then be distributed to construction sector professionals that are actively involved in public sector projects. A random sampling method was used to identify and define the sample size representative of the target population. Furthermore, statistical analysis methods consisting of principal component analysis, reliability test, validity tests and structural equation modelling are used to analyze the quantitative data in order to test the research model.

5.7.1. Reliability

Reliability is the degree to which a research instrument produces the same result on numerous recurrent trials. It further determines the degree to which the measures are free from error, and the degree to which the findings and conclusions may be generalized (Ang, 2014 and Lund et al., 2014). Without a reliable research instrument, researchers would be incapable to formulate theories, deduce conclusions or make assumptions about the generalizability of the research study. The greater the reliability levels or internal consistency, the greater the outcomes and conclusions can be generated and generalized. As a result, the internal consistency measure of reliability determines the level of soundness a measurement instrument is measuring the concept that a researcher wants to measure. The test for internal consistency involves the comparison of the results from survey respondents to determine if they have similar opinions (Chahoud et al., 2017; De Leng et al., 2017 and Ramada et al., 2014). For the purpose of this research study, the Cronbach's alpha reliability test was employed given its universal and frequent use as a measure of reliability (Taber, 2018; Bonett and Wright, 2015; Saunders at al., 2015; Tavakol and Dennick, 2011). To improve the levels of reliability, the external sources of variations are minimized through uniform measurement methods and by maintaining the anonymity of responses (Huck, 2007).

5.7.2. Validity

Validity is often defined as the extent a research study correctly assesses the specified concept that the researchers attempt to measure. Whereas the second quality measure, reliability is more-so concerned with the accuracy of the research instrument and processes involved while validity focuses on the overall success of the study based on the measure that were set out (Heale and Twycross, 2015 and Creswell, 2014). There are three major types of validities: external validity, internal validity and construct validity. External validity refers to the degree to which the research results are easily transferable and generalizable. External validity is often enhanced by the selection of the sample population that statistically represent the target population (Marcellesi, 2015). However, internal validity refers to the precision of which the research study was conducted and the degree to which the researchers have considered alternative measures and explanations for any causal relationships explored (Huitt, 1998 and Campbell and Stanley, 1966). The reliability and validity of a research study are equally significant as the findings and conclusions of the research study. They support the research study by placing it into context (Fellows and Liu, 2015). Construct validity refers to the operationalization of a concept, idea, or behavior; as it is concerned with the extent to which the construct is measured in comparison with the hypothesized construct (Mona and Martin, 2016).

Construct validity has two components: convergent and discriminant validity. In an attempt to circumvent poor construct validity, the following process was adopted in this research study. The constructs are generated from an extensive literature review process which was further refined by the pilot survey interviews. The data was later analyzed through statistical process methods to provide statistical evidence that prove the constructs are adequate. Table 14 highlights the various types of validity processes, with table 15 reflecting a comparison of validities often employed in research studies.

Table 14: Types of Validity

Types of Validity	***Description***
Content	The degree a research instrument analysis and statistically interprets all constructs.
Construct	The degree a research instrument analysis and statistically interprets intended construct.
Criterion	The degree a research instrument analysis and statistically correlates with instruments that measure the same variables.

(Source: Heale and Twycross, 2015)

Table 15: A Comparison of Validities in Research

Validity Components	***Definition***	***Type***	***Suggested Technique***
Face Validity	The degree a measurement instrument is designed.	Recommended	Post hoc theory, expert assessment of items; Cohen's Kappa Index (CKI)
Content Validity	The degree a measurement instrument is relevant and representative of the construct.	Highly recommended	Literature review; expert panels or judges; CVRs; Q-sorting
Construct Discriminant Validity	The degree a measurement instrument of different constructs diverges or correlates with one another.	Mandatory	MTMM; PCA; CFA; PLS AVE; Q-sorting
Construct Convergent Validity	The degree a different measure of the same construct correlate with one other.	Mandatory	MTMM; PCA; CFA; Q-sorting
Criterion Predictive Validity	The degree a measure forecasts another measure.	Mandatory	Regression Analysis, Discriminant Analysis
Criterion Concurrent Validity	The degree a measure relates to another measure.	Mandatory	Correlation Analysis
Criterion Postdictive Validity	The degree a measure relates to the scores on another established instrument.	Mandatory	Correlation Analysis
Reliability Internal Consistency	The degree a measurement of a phenomenon delivers dependable results.	Mandatory	Cronbach's a; correlations; SEM reliability coefficients

(Source: Straub et. al., 2004; Netemeyer et. al., 2003; Viswanathan, 2005; Engellant et. al., 2016 and Taherdoost, 2016)

5.7.2.1. Cronbach's Alpha

The Cronbach's Alpha reliability test is widely adopted in social and organizational sciences, and is identified as the most widely used measures of internal consistency reliability, as the internal consistency of an instrument reflects how sound the items in the test, evaluates the construct (Streiner, 2003 and Cronbach, 1951). Reliability and validity are two fundamental elements required to evaluate data collection instruments. Cronbach's Alpha internal consistency reliability defines the reliability of a sum of q measurements, where the q measurements represent q raters, that represent the items, concepts or constructs on a survey questionnaire (Bonett and Wright, 2015; Schoonheim-Klein et al., 2008 and Tavakol et al., 2011). Therefore, Cronbach's Alpha test shall be conducted on the survey questionnaire employed in this research study to collect data. The data analysis process, seeks to quantify the internal consistency of the constructs and items in the questionnaire. The reliability of the questionnaire will further illustrate validity and reliability of the results.

The value of Cronbach's alpha ranges from 0 to 1, with the value closer to 1 reflecting the higher the reliability of the items. The formula to calculate Cronbach's alpha is shown in the equation below:

$$\boldsymbol{\alpha = N \cdot \bar{c}\bar{v} + (N-1) \cdot \bar{c}}$$

Where: N is the number of items, $\bar{v}$ *is the average variance and* $\bar{c}$ *is the average covariance between items.*

5.8. Chapter Summary

This chapter describes the research methodology and techniques employed for the research study. A mixed research methodology was used to address the disadvantages that presented itself when dealing with qualitative and quantitative research methods. Probability sampling techniques were adopted in the selection of industry professionals with survey questionnaires and semi-structured interviews administered. The collected data shall be analyzed using statistical software packages, making sure to test the reliability and validity of the findings.

CHAPTER SIX:

DATA ANALYSIS

6. Introduction

The data analysis process comprises of six components; part one of the data analysis process analysis the results expressed in the pilot survey questionnaire of select construction and engineering sector professionals; part two of the data analysis process highlights the demographic results from the quantitative survey questionnaire that were collected from the professionals in the engineering and construction industry; part three identified the preliminary tests regarding the data acceptance, commonality and reliability of the study. Part four of the analysis process expresses the validity of the study through the analysis of a semi-structured interviews with key industry professionals; part five focuses on the model development process using SEM, which includes confirmatory factor analysis, model modification and model refinement. The final data analysis component highlights the goodness-of-fit measure of the model. A comparative between the goodness-of-fit indices for the proposed SEM and final SEM are also reflected.

6.1. Quantitative Analysis

The quantitative survey method implemented an exploratory pilot survey to gather responses from experienced industry professionals on the factors influencing project delays and disruptions of construction and engineering projects in the South African public sector. The quantitative analysis process further assisted in the refinement and validation process of the factors influencing project delays and disruptions that were identified from an extensive review of previous literature. The pilot study survey further aided in classifying the factors into six identifiable groups, which had formed the basis of the questionnaire survey. Key public sector industry professionals actively involved in the Kwazulu-Natal region were selected via the Construction industry Development Board database and the municipality; and invited to participate in the qualitative semi-structured interview. The selected individuals included heads of public sector departments, senior managers and managers. A total of 50 invitations were sent out; with responses from 8 participants due to the impact of the Covid-19 pandemic on the availability of the research participants. Findings from the exploratory pilot survey was used to develop the main research instrument.

The main research instrument, survey questionnaire, was adopted to ascertain the views and opinions of industry stakeholders and professionals that are actively involved in the construction and engineering sector in Kwazulu-Natal. 853 registered organizations registered at Grade 6 and above, were identified on the Construction Industry Development Board database for the Kwazulu-Natal region, as these are the grades that are invited to participate in large-scale public-sector infrastructure projects. 103 organizations were identified as suspended and/or blacklisted on the database. Therefore only 750 organizations were contactable and eligible for participation the questionnaire survey. The questionnaire surveys were distributed via email as well as by invitation through their registered associations requesting a senior selected professional from the organization to respond to the questionnaire survey that was hosted on Google forms and that were sent via email. A total of 103 respondents participated in the questionnaire survey, with eight respondents presenting data that were missing or had presented irregularities. Tabachnick and Fidell (2019) states that if there are less than 5% of the data points missing from the instrument, the variance may be ignored. Furthermore, the missing data may be analyzed through robust data analysis processes, which makes necessary allowances for missing data. Teo, Tsai and Yang (2013) cite data which represents up to 10% of missing data is permissible when multivariate analysis is employed.

In this research study, IBM SPSS Modeller Software was used to identify missing data points. Cases that presented one missing data point, were replaced with the mode of the other scores of the measurement scale; as items in the measurement scale had measured the same concept. As a result, a total of 96 respondents were considered which indicated an overall response rate of 13%, which was deemed acceptable considering the impact of the Covid-19 pandemic on the availability of the respondents to participate in the research study.

6.2.1. Primary Analysis for Consistency

Primary analysis for consistency includes a descriptive data analysis process employed on the quantitative questionnaire survey. The survey questionnaire is comprised of two sections. Section one focuses on the profiles of respondents which assists in the comparison of the research respondents' ratings across all biographical profiles; with section two of the survey questionnaire focusing on the factors that influence successful construction and engineering project delivery in the South African public sector. The data analysis was conducted using IBM Statistical Package for Social Science Statistics v26.0, with the statistical data analysis reflecting frequencies, valid percentages, mean ratings, standard deviations, factor analysis, reliability and validity testing of the respondents profile which includes their gender, age, profession, professional position, specialization, professional experience; and on the factors influencing successful construction and engineering project delivery in the South African public sector. The consistency tests are essential to the research study as they ensure the reliability and validity of the data; with the mean rating reflecting the overall acceptance by the respondents and the exploratory factor analysis highlighting the commonalities that exist within the dataset. Once the commonality, acceptance and reliability of all the measurement indicators in the dataset is conducted, the confirmatory factor analysis would be conducted to test the conceptual measurement model.

6.2.1.1. Section One: Profile of Respondents

Table 16, indicates the overall profile of the research respondents. The results indicate that 92.7% of the respondents were male, with 33.4% of the respondents were between the age group 50 – 59. The profiles further represent 85.4% of the respondents being main contractors in the engineering and construction industry, with 7.3% of respondents being project managers and 7.3% of respondents being engineers. The survey questionnaire aimed to collect data from professional respondents that were actively involved in the industry and who held significant positions. As a result, the professional position of the 96 respondents reflects that 51% of the respondents held the position of chief executive officer within an organization in the construction and engineering industry. A total of 42.8% of the respondents have been actively involved in the construction and engineering industry for a period of between 10 – 19 years with a further 22.9% of the respondents being involved in the industry between 20 – 29 years. Overall, the data represents a high level of professional experience among the respondents with knowledge of the construction and engineering industry in the Kwazulu-Natal public sector.

Table 16: Profile of Respondents

Profile of Respondents		
Gender Composition		
Gender	***Frequency***	***Valid %***
Male	89	92.7
Female	7	7.3
Total	***96***	***100.0***
Age Composition		
Age Group	***Frequency***	***Valid %***
30 - 39	28	29.1
40 - 49	29	30.2

50 - 59	32	33.4
60 - 69	7	7.3
Total	**96**	**100.0**
Profession Composition		
Profession	***Frequency***	***Valid %***
Main Contractor	82	85.4
Project Manager	7	7.3
Engineer	7	7.3
Total	***96***	***100.0***
Professional Position Composition		
Professional Position	***Frequency***	***Valid %***
Chief Executive Officer	49	51.0
Senior Manager	21	21.9
Manager	19	19.8
Employee	7	7.3
Total	***96***	***100.0***
Professional Experience Composition		
Professional Experience	***Frequency***	***Valid %***
0 - 9	14	14.6
10 - 19	41	42.8
20 - 29	22	22.9
30 - 39	19	19.7
Total	***96***	***100.0***

6.2.1.2. Section Two: Factors Influencing Successful Construction and Engineering Project Delivery

Table 17 highlights the mean ratings, standard deviation and normality testing of the 6 constructs and 38 factors that influence successful construction and engineering project delivery in the South African public sector. The statistics illustrate that the influencing factor project budget size expressed the highest contribution with a mean value of 9.13. The statistical data analysis further highlighted that global political dynamics expressed the lowest contribution with a mean value of 4.96.

Table 17: Mean Rating and Ranking of the Influencing Factors

Code	***Influencing Factors***	***Mean***	***Std. Dev***	***Rank***
PCHF5	Project Budget Size	9.135	1.3425	**1**
PCHF3	Project Size	8.510	1.6669	**2**
PCHF4	Project Complexity	8.479	1.7530	**3**
PCHF2	Project Scope	8.479	1.6285	**4**
PSI2	Consultant Influence	8.322	2.1299	**5**
PSI3	Contractor Influence	8.270	2.7510	**6**
PCF2	Financial Contributions	8.041	2.2753	**7**
PCHF1	Project Type	7.968	1.9971	**8**
PCF5	Stakeholder Management	7.895	2.4386	**9**
SFLF5	Construction Contracts and Procurement Processes	7.750	2.1812	**10**
SFLF1	Political Policies	7.718	1.8789	**11**
PSI1	Client Influence	7.531	2.8505	**12**
PCF4	Socioeconomic Culture	7.479	1.7227	**13**
PCF3	Skills Capacity	7.427	2.2791	**14**
PCF1	Government Policies Legislature and Frameworks	7.416	1.6585	**15**
SFLF4	Building Regulations	7.333	2.3604	**16**
SEF7	Crime	7.250	2.2895	**17**
PCF3	Skills Shortage	7.135	2.1502	**18**
SFLF2	Public Sector Policies and Management Systems	6.989	2.0078	**19**
PCF7	Sustainability	6.968	1.4970	**20**
PCF6	Information Technology	6.947	1.7005	**21**
PCF8	Industry Development	6.843	1.7789	**22**
SEF8	Social Services	6.666	2.0399	**23**
SEF12	Transformation Policies	6.572	2.2883	**24**
PCF9	Force Majeure Events	6.572	2.6066	**25**
SFLF3	Equity Policies	6.437	2.1609	**26**
SEF4	Employment Rate	6.406	2.5155	**27**
SEF9	Monetary Policies	6.354	2.2146	**28**
SEF10	Investor Confidence	6.354	2.4707	**29**
SEF11	Fiscal Policies	6.135	2.0602	**30**
NGD3	National Economic Trends	6.135	2.7819	**31**
PSI4	Public Sector Officials Influence	6.000	3.0122	**32**
SEF6	Poverty and Inequality	5.875	2.5965	**33**
SEF1	Gross Domestic Product	5.760	2.1654	**34**

SEF2	Consumer Price Index	5.750	1.6858	**35**
SEF3	Gross Fixed Capital Formation	5.677	1.5993	**36**
NGD2	Global Economic Trends	5.114	1.9296	**37**
NGD1	Global Political Dynamics	4.968	2.2169	**38**

The Kolmogorov-Smirnov and Shapiro-Wilk methods were conducted on the dataset collected from respondents to measure the levels of normality. Various authors assert that the Shapiro-Wilk test for normality is the most influential method when compared to existing methods used to measure normality of the sample (Razali and Wah, 2011; Keskin, 2006 and Mendes and Pala, 2003). Table 18, indicates that the data is significantly different from the normal distribution at 0.000. As a result, maximum likelihood estimation with robust standard errors and chi-square was employed in order to account for the non-normality of the dataset.

Table 18: Mean Rating, Standard Deviation and Normality Testing

	N	***Mean***	***Std. Dev***	***Kolmogorov-Smirnov[a]***			***Shapiro-Wilk***		
				Stat	***df***	***Sig.***	***Stat***	***df***	***Sig.***
Project Stakeholder Influence									
Client Influence	96	7.531	2.850	.223	96	.000	.794	96	.000
Consultant Influence	96	8.322	2.129	.295	96	.000	.764	96	.000
Contractor Influence	96	8.270	2.751	.315	96	.000	.644	96	.000
Public Sector Officials Influence	96	6.000	3.012	.184	96	.000	.906	96	.000
Project Characteristics									
Project Type	96	7.968	1.997	.262	96	.000	.808	96	.000
Project Scope	96	8.479	1.628	.314	96	.000	.785	96	.000
Project Size	96	8.510	1.666	.272	96	.000	.796	96	.000
Project Complexity	96	8.479	1.753	.224	96	.000	.810	96	.000
Project Budget Size	96	9.135	1.342	.303	96	.000	.666	96	.000
Project Challenges									
Government Policies, Legislatures and Frameworks	96	7.416	1.658	.200	96	.000	.889	96	.000
Financial Contributions	96	8.041	2.275	.222	96	.000	.799	96	.000
Skills Capacity	96	7.427	2.279	.235	96	.000	.866	96	.000
Socio-Economic Culture	96	7.479	1.722	.155	96	.000	.899	96	.000
Stakeholder Management	96	7.895	2.438	.295	96	.000	.798	96	.000

Information Technology	96	6.947	1.700	.211	96	.000	.915	96	.000
Sustainability	96	6.968	1.497	.252	96	.000	.885	96	.000
Industry Development	96	6.843	1.778	.194	96	.000	.899	96	.000
Force Majeure	96	6.572	2.606	.127	96	.001	.903	96	.000
Socio-Economic Factors									
Gross Domestic Product	96	5.760	2.165	.214	96	.000	.854	96	.000
Consumer Price Index	96	5.750	1.685	.121	96	.001	.935	96	.000
Gross Fixed Capital Formation	96	5.677	1.599	.215	96	.000	.901	96	.000
Employment Rate	96	6.406	2.515	.226	96	.000	.893	96	.000
Skills Shortage	96	7.135	2.150	.127	96	.001	.923	96	.000
Poverty and Inequality	96	5.875	2.596	.155	96	.000	.920	96	.000
Crime	96	7.250	2.289	.212	96	.000	.891	96	.000
Social Services	96	6.666	2.039	.148	96	.000	.941	96	.000
Monetary Policies	96	6.354	2.214	.147	96	.000	.916	96	.000
Investor Confidence	96	6.354	2.470	.149	96	.000	.887	96	.000
Fiscal Policies	96	6.135	2.060	.163	96	.000	.921	96	.000
Transformation Policies	96	6.572	2.288	.137	96	.000	.925	96	.000
Statutory Frameworks and Legislation Factors									
Political Policies	96	7.718	1.878	.195	96	.000	.886	96	.000
Public Sector Policies and Management Systems	96	6.989	2.007	.182	96	.000	.926	96	.000
Equity Policies	96	6.437	2.160	.185	96	.000	.927	96	.000
Building Regulations	96	7.333	2.360	.177	96	.000	.883	96	.000
Construction Contracts and Procurement Processes	96	7.750	2.181	.206	96	.000	.863	96	.000
National and Global Dynamic Factors									
Global Political Dynamics	96	4.968	2.216	.164	96	.000	.897	96	.000
Global Economic Trends	96	5.114	1.929	.179	96	.000	.920	96	.000
National Economic Trends	96	6.135	2.781	.259	96	.000	.868	96	.000

6.2.2. Secondary Analysis for Consistency: Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was used to analyze the various factors highlighted in the proposed conceptual model. The data analysis process included reliability testing, discriminant validity and convergent validity of the constructs and variables of the survey instrument. The unidimensional of the various constructs and variables was determined using the factor extraction method. According to Pallant (2020), the aim of EFA is to determine the smallest manageable set of common components that accounts for the intercorrelations of a set of variables. The internal consistency reliability tests were also conducted using the Cronbach's alpha coefficient in order to ascertain the consistency of the data set with values greater than or equal to 0.7 being considered as acceptable. Furthermore, Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was adopted to assess the factor analyzability of the data, with a KMO cut-off value of greater than or equal to 0.7 ($p<0.05$) being implemented for this research study (Pallant, 2020 and Tabachnick and Fidell, 2019, 2001).

The Kaiser's criterion measure was also conducted on data sets where the results of an eigenvalue greater than 1 were considered as being significant. Eigenvalues that equated to less than 1 were considered insignificant and were eliminated as it signifies the extent of total variance of a factor (Pallant, 2011). Factor or validity loadings of the various components of the conceptual model were also calculated with a loading value of 0.4 and above being considered as acceptable (Pallant, 2010, 2020 and Hair, et al., 2013).

<u>6.2.2.1. Conceptual Model Constructs</u>

6.2.2.1.1. Construct One: Project Stakeholder Influence

Table 19 highlights the unidimensional and reliability of the first construct, project stakeholder influence, and the four factor elements, using Exploratory Factor Analysis (EFA). The results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct. Table 23 further illustrates the factor loadings for all four factor elements, where all four elements expressed factor loading above 0.40. The communalities of the four factors also reflected values less than 0.999, demonstrating that four factor elements were within an acceptable range. These factors could be identified as key factors determining the influence of project stakeholder influence on successful construction and engineering project delivery in the South African public sector.

Table 19: Exploratory Factor Analysis Statistics for Project Stakeholder Influence

Items	*Factor Element*	*Factor Loading*	*Corrected item-total Correlation*	*Communalities*	
				Initial	*Extraction*
B1.1	Client Influence	.929	.854	.730	.863
B1.2	Consultant Influence	.785	.744	.564	.616
B1.3	Contractor Influence	.814	.766	.605	.663
B1.4	Public Sector Officials Influence	.806	.752	.592	.649

Extraction Method: Maximum Likelihood

The statistical measure of reliability was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The four factor elements represent a Cronbach's alpha coefficient of 0.896 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project stakeholder influence which reflected a value of 0.831, greater than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability.

Table 20: Reliability Statistics of Project Stakeholder Influence

Items	*Cronbach's Alpha*	*KMO*	*Bartlett's Test of Sphericity*		
			Appr. Chi-Square	*df*	*Sig.*
4	.896	.831	236.487	6	.000

The results represented in the table 21 indicates an Eigenvalue of 3.084 that was greater than 1. This factor element denotes, a variance of 77.08% in the data which is above the recommended cut off value of 50%. As a result, adequate evidence of convergent validity and discriminant validity was provided for the project stakeholder influence construct.

Table 21: Total Variance for Project Stakeholder Influence

Factor	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	3.084	77.088	77.088	2.790	69.762	69.762
2	.387	9.687	86.774			
3	.331	8.279	95.054			
4	.198	4.946	100.000			

Extraction Method: Maximum Likelihood

6.2.2.1.2. Construct Two: Project Characteristics

Table 22 highlights the unidimensional and reliability of the second construct, project characteristics, and the five factor elements, using Exploratory Factor Analysis (EFA). The results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct. Table 22 further illustrates the factor loadings for all five factor elements, where all five elements expressed factor loading above 0.40.

The communalities of the five factors also reflected values less than 0.999, demonstrating that five factor elements were within an acceptable range. These factors could be identified as key factors determining the influence of project characteristics on successful construction and engineering project delivery in the South African public sector.

Table 22: Exploratory Factor Analysis Statistics for Project Characteristics

Items	***Factor Element***	***Factor Loading***	***Corrected item-total Correlation***	***Communalities***	
				Initial	***Extraction***
B2.1	Project Type	.762	.715	.629	.581
B2.2	Project Scope	.823	.719	.717	.677
B2.3	Project Size	.297	.292	.162	.088
B2.4	Project Complexity	.999	.892	.876	.999
B2.5	Project Budget Size	.863	.769	.782	.744

Extraction Method: Maximum Likelihood

The statistical measure of reliability was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The five factor elements represent a Cronbach's alpha coefficient of 0.848 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project stakeholder influence which reflected a value of 0.767, greater than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability.

Table 23: Reliability Statistics of Project Characteristics

Items	***Cronbach's Alpha***	***KMO***	***Bartlett's Test of Sphericity***		
			Appr. Chi-Square	***df***	***Sig.***
5	.848	.767	343.584	10	.000

The results represented in the table 24, indicates an Eigenvalue of 3.313 that was greater than 1. This factor element denotes, a variance of 66.25% in the data which is above the recommended cut off value of 50%. As a result, adequate evidence of convergent validity and discriminant validity was provided for the project characteristics construct.

Table 24: Total Variance for Project Characteristics

Factor	***Initial Eigenvalues***			***Extraction Sums of Squared Loadings***		
	Total	***% of Variance***	***Cumulative %***	***Total***	***% of Variance***	***Cumulative %***
1	3.313	66.256	66.256	3.089	61.775	61.775
2	.965	19.302	85.559			
3	.433	8.658	94.216			
4	.202	4.041	98.257			
5	.087	1.743	100.000			

Extraction Method: Maximum Likelihood

6.2.2.1.3. Construct Three: Project Challenges

Table 25 highlights the unidimensional and reliability of the third construct, project challenges, and the nine factor elements, using Exploratory Factor Analysis (EFA). The results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct. Table 25 further illustrates the 2 factor loadings for the nine-factor element above and below 0.40. The communalities of the nine factors further reflects values less than and equal to 0.999, demonstrating that nine factor elements were within an acceptable range. An analysis in the communalities further highlight an issue with selected items due to its high level of commonalities. The data was later re-assessed.

Table 25: Exploratory Factor Analysis Statistics for Project Challenges

Items	Factor Element	Factor Loading		Corrected item-total Correlation	Communalities	
		1	2		Initial	Extraction
B3.1	Government Policies, Legislatures and Frameworks	.462	.754	.767	.911	.782
B3.2	Financial Contributions	.671	.354	.765	.787	.576
B3.3	Skills Capacity	.546	.552	.770	.922	.604
B3.4	Socio-Economic Culture	.454	.765	.766	.846	.791
B3.5	Stakeholder Management	.574	.708	.781	.926	.831
B3.6	Information Technology	.723	.083	.475	.890	.530
B3.7	Sustainability	.999	-.009	.735	.981	.999
B3.8	Industry Development	.914	.219	.783	.977	.883
B3.9	Force Majeure	.151	.139	.197	.864	.042

Extraction Method: Maximum Likelihood

The statistical measure of reliability was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The nine factor elements represent a Cronbach's alpha coefficient of 0.887 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project challenges which reflected a value of 0.457, less than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability, however in order to obtain a clear factor solution, the factor elements were required to be re-assessed.

Table 26: Reliability Statistics of Project Challenges

Items	Cronbachs's Alpha	KMO	Bartletts's Test of Spericity		
			Appr. Chi-Square	df	Sig.
9	.887	.457	995.289	36	.000

The results represented in table 27, indicates 2 factor elements with an Eigenvalue greater than 1. These factor elements denote, a variance of 74% in the data which suggests a likely multidimensionality of the sub-scale.

Table 27: Total Variance for Project Challenges

Factor	***Initial Eigenvalues***		
	Total	***% of Variance***	***Cumulative %***
1	5.321	59.128	59.128
2	1.343	14.917	74.045
3	.923	10.255	84.299
4	.741	8.235	92.534
5	.308	3.421	95.955
6	.156	1.734	97.689
7	.117	1.298	98.987
8	.083	.924	99.912
9	.008	.088	100.000

Extraction Method: Maximum Likelihood

In order to obtain a clear factor element solution of the outcome expectation statistical construct, items B.3.3, B3.7, B3.8 and B3.9 were excluded with the exploratory factor analysis reiterated. Table 28, highlights the unidimensional and reliability of the third construct, project challenges, and the five factor elements it now presents. The reiterated results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct. The table further illustrates the factor loadings for the five-factor element above 0.40. The communalities of the five factors further reflects values less than and 0.999, demonstrating that five factor elements were within an acceptable range. These five factors could be identified as key factors determining the influence of project challenges on successful construction and engineering project delivery in the South African public sector.

Table 28: Outcome Expectation Statistics for Project Challenges

Items	***Factor Element***	***Factor Loading***	***Corrected item-total Correlation***	***Communalities***	
				Initial	***Extraction***
B3.1	Government Policies, Legislatures and Frameworks	.932	.855	.794	.868
B3.2	Financial Contributions	.628	.613	.411	.395
B3.4	Socio-Economic Culture	.887	.778	.747	.786

B3.5	Stakeholder Management	.874	.828	.724	.763
B3.6	Information Technology	.559	.512	.358	.313

Extraction Method: Maximum Likelihood

The statistical measure of reliability of the reiterated EFA was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The five factor elements represent a Cronbach's alpha coefficient of 0.872 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project stakeholder influence which reflected a value of 0.812, greater than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability.

Table 29: Outcome Expectation Reliability Statistics of Project Challenges

Items	***Cronbachs's Alpha***	***KMO***	***Bartletts's Test of Spericity***		
			Appr. Chi-Square	***df***	***Sig.***
5	.872	.812	307.028	10	.000

Table 30, indicates an Eigenvalue of 3.125 that was greater than 1. This factor element denotes, a variance of 68.56% in the data which is above the recommended cut off value of 50%. As a result, adequate evidence of convergent validity and discriminant validity was provided for the project challenges construct.

Table 30: Total Variance of Outcome Expectations for Project Challenges

Factor	***Initial Eigenvalues***			***Extraction Sums of Squared Loadings***		
	Total	***% of Variance***	***Cumulative %***	***Total***	***% of Variance***	***Cumulative %***
1	3.428	68.569	68.569	3.125	62.505	62.505
2	.689	13.774	82.343			
3	.539	10.784	93.127			
4	.205	4.102	97.229			
5	.139	2.771	100.000			

Extraction Method: Maximum Likelihood

6.2.2.1.4. Construct Four: Socio-Economic Factors

Table 31 highlights the unidimensional and reliability of the fourth construct, socio-economic factors, and the 12 factor elements, using Exploratory Factor Analysis (EFA). The results illustrate that the corrected item-total correlation values were greater than and less than the recommended cut-off value of 0.3. This indicates that the factor elements were less than adequate and certain factor elements were not good measures of the construct. Table 35 further illustrates the 3 factor loadings for the 12-factor element above and below 0.40. The communalities of the 12 factors further reflects values less than and equal to 0.999, demonstrating that 12 factor elements were within an acceptable range. An analysis in the communalities further highlight an issue with selected items due to its high level of commonalities. The data was later re-assessed.

Table 31: Exploratory Factor Analysis Statistics for Socio-Economic Factors

Items	***Factor Element***	***Factor Loading***			***Corrected item-total Correlation***	***Communalities***	
		1	***2***	***3***		***Initial***	***Extraction***
B4.1.	Gross Domestic Product	.770	.232	.051	.698	.952	.650
B4.2	Consumer Price Index	.999	-.023	.002	.663	.984	.999
B4.3	Gross Fixed Capital Formation	.884	.161	-.012	.729	.981	.808
B4.4	Employment Rate	.373	.631	.632	.765	.918	.937
B4.5	Skills Shortage	.223	.598	.306	.528	.987	.502
B4.6	Poverty and Inequality	.053	-.057	.766	.132	.899	.593
B4.7	Crime	.097	.230	.621	.349	.884	.449
B4.8	Social Services	.409	.230	.735	.631	.977	.760
B4.9	Monetary Policies	.489	.432	-.124	.591	.978	.441
B4.10	Investor Confidence	.642	.698	-.216	.752	.944	.945
B4.11	Fiscal Policies	.563	.689	-.323	.657	.980	.895
B4.12	Transformation Policies	.628	.632	-.347	.676	.995	.914

Extraction Method: Maximum Likelihood

The statistical measure of reliability was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The 12 factor elements represent a Cronbach's alpha coefficient of 0.882 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project challenges which reflected a value of 0.393, less than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability, however in order to obtain a clear factor solution, the factor elements were required to be re-assessed.

Table 32: Reliability Statistics of Socio-Economic Factors

Items	*Cronbach's Alpha*	*KMO*	*Bartlett's Test of Sphericity*		
			Appr. Chi-Square	*df*	*Sig.*
12	.882	.393	1610.404	66	.000

The results represented in the table 33, indicates 3 factor elements with an Eigenvalues greater than 1. These factor elements denote, a variance of 80% in the data which suggests a likely multidimensionality of the sub-scale.

Table 33: Total Variance for Socio-Economic Factors

Factor	*Initial Eigenvalues*		
	Total	*% of Variance*	*Cumulative %*
1	5.905	49.206	49.206
2	2.556	21.302	70.508
3	1.178	9.821	80.329
4	.875	7.290	87.619
5	.505	4.211	91.829
6	.335	2.795	94.624
7	.292	2.435	97.059
8	.218	1.820	98.879
9	.064	.533	99.412
10	.053	.443	99.855
11	.015	.128	99.983
12	.002	.017	100.000

Extraction Method: Maximum Likelihood

In order to obtain a clear factor element solution of the outcome expectation statistical construct, items B.4.2, B4.3, B4.5, B4.8, B4.9, B4.10, B4.11, and B4.12 were excluded with the exploratory factor analysis reiterated. Table 38, highlights the unidimensional and reliability of the fourth construct, socio-economic factors, and the four factor elements it now presents. The reiterated results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct. Table 34 further illustrates the factor loadings for the four-factor element above 0.40. The communalities of the four factors further reflects values less than and equal to 0.999, demonstrating that four factor elements were within an acceptable range. These four factors could be identified as key factors determining the influence of socio-economic factors on successful construction and engineering project delivery in the South African public sector.

Table 34: Outcome Expectation Statistics for Socio-Economic Factors

Items	*Factor Element*	*Factor Loading*	*Corrected item-total Correlation*	*Communalities*	
				Initial	*Extraction*
B4.1.	Gross Domestic Product	.445	.310	.231	.198
B4.4	Employment Rate	.999	.719	.523	.999
B4.6	Poverty and Inequality	.466	.383	.260	.217
B4.7	Crime	.595	.558	.364	.354

Extraction Method: Maximum Likelihood

The statistical measure of reliability of the reiterated EFA was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The four factor elements represent a Cronbach's alpha coefficient of 0.698 showing a low yet acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project stakeholder influence which reflected a value of 0.626, greater than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability.

Table 35: Outcome Expectation Reliability Statistics of Socio-Economic Factors

Items	*Cronbach's Alpha*	*KMO*	*Bartlett's Test of Sphericity*		
			Appr. Chi-Square	*df*	*Sig.*
4	.698	.626	88.966	6	.000

Table 36, indicates an Eigenvalue of 2.144 that was greater than 1. This factor element denotes, a variance of 68.56% in the data which is above the recommended cut off value of 53%. As a result, adequate evidence of convergent validity and discriminant validity was provided for the socio-economic factors construct.

Table 36: Total Variance of Outcome Expectations for Socio-Economic Factors

Factor	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2.144	53.608	53.608	1.768	44.199	44.199
2	.957	23.933	77.541			
3	.571	14.285	91.825			
4	.327	8.175	100.000			

Extraction Method: Maximum Likelihood

6.2.2.1.5. Construct Five: Statutory Frameworks and Legislation Factors

Table 37 highlights the unidimensional and reliability of the fifth construct, statutory frameworks and legislation factors, and the five factor elements, using Exploratory Factor Analysis (EFA). The results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct. Table 37 further illustrates the 2 factor loadings for the five-factor element above and below 0.40. The communalities of the five factors further reflects values less than and equal to 0.999, demonstrating that five factor elements were within an acceptable range. An analysis in the communalities further highlight an issue with selected items due to its high level of commonalities. The data was later re-assessed.

Table 37: Exploratory Factor Analysis Statistics for Statutory Frameworks and Legislation Factors

Item	*Factor Element*	*Factor Loading*		*Corrected item-total Correlation*	*Communalities*	
		1	*2*		*Initial*	*Extraction*
B5.1	Political Policies	.859	-.032	.387	.794	.739
B5.2	Public Sector Policies and Management Systems	.999	-.005	.471	.813	.999
B5.3	Equity Policies	.364	.783	.731	.770	.746
B5.4	Building Regulations	.248	.938	.740	.820	.942
B5.5	Construction Contracts and Procurement Processes	.100	.833	.568	.670	.704

Extraction Method: Maximum Likelihood

The statistical measure of reliability was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The five factor elements represent a Cronbach's alpha coefficient of 0.796 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project challenges which reflected a value of 0.556, less than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability, however in order to obtain a clear factor solution, the factor elements were required to be re-assessed.

Table 38: Reliability Statistics of Statutory Frameworks and Legislation Factors

Items	*Cronbachs's Alpha*	*KMO*	*Bartletts's Test of Spericity*		
			Appr. Chi-Square	*df*	*Sig.*
5	.796	.556	367.406	10	.000

The results represented in table 39, indicates 2 factor elements with an Eigenvalue greater than 1. These factor elements denote, a variance of 88% in the data which suggests a likely multidimensionality of the sub-scale.

Table 39: Total Variance for Statutory Frameworks and Legislation Factors

Factor	*Initial Eigenvalues*		
	Total	*% of Variance*	*Cumulative %*
1	2.786	55.725	55.725
2	1.653	33.054	88.779
3	.313	6.265	95.044
4	.172	3.436	98.480
5	.076	1.520	100.000

Extraction Method: Maximum Likelihood

In order to obtain a clear factor element solution of the outcome expectation statistical construct, items B.5.2 was excluded with the exploratory factor analysis reiterated. Table 40, highlights the unidimensional and reliability of the fifth construct, statutory frameworks and legislation factors, and the four factor elements it now presents. The reiterated results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct.

Table 40 further illustrates the factor loadings for the three-factor element were above 0.40, with one-factor below 0.40. The communalities of the four factors further reflects values less than 0.999, demonstrating that four factor elements were within an acceptable range. These four factors could be identified as key factors determining the influence of statutory frameworks and legislation factors on successful construction and engineering project delivery in the South African public sector.

Table 40: Outcome Expectation Statistics for Statutory Frameworks and Legislation Factors

Item	*Factor Element*	*Factor Loading*	*Corrected item-total Correlation*	*Communalities*	
				Initial	*Extraction*
B5.1	Political Policies	.204	.157	.088	.042
B5.3	Equity Policies	.831	.766	.683	.691
B5.4	Building Regulations	.993	.854	.801	.987
B5.5	Construction Contracts and Procurement Processes	.813	.686	.670	.661

Extraction Method: Maximum Likelihood

The statistical measure of reliability of the reiterated EFA was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The four factor elements represent a Cronbach's alpha coefficient of 0.789 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project stakeholder influence which reflected a value of 0.690, greater than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability.

Table 41: Outcome Expectation Reliability Statistics of Statutory Frameworks and Legislation Factors

Items	*Cronbachs's Alpha*	*KMO*	*Bartletts's Test of Spericity*		
			Appr. Chi-Square	*df*	*Sig.*
4	.789	.690	213.060	6	.000

Table 42, indicates an Eigenvalue of 2.586 that was greater than 1. This factor element denotes, a variance of 64.65% in the data which is above the recommended cut off value of 50%. As a result, adequate evidence of convergent validity and discriminant validity was provided for the project challenges construct.

Table 42: Total Variance of Outcome Expectations for Statutory Frameworks and Legislation Factors

Factor	***Initial Eigenvalues***			***Extraction Sums of Squared Loadings***		
	Total	***% of Variance***	***Cumulative %***	***Total***	***% of Variance***	***Cumulative %***
1	2.586	64.654	64.654	2.380	59.507	59.507
2	.981	24.517	89.171			
3	.301	7.533	96.704			
4	.132	3.296	100.000			

Extraction Method: Maximum Likelihood

6.2.2.1.6. Construct Six: National and Global Dynamic Factors

Table 43 highlights the unidimensional and reliability of the sixth construct, national and global dynamic factors, and the three factor elements, using Exploratory Factor Analysis (EFA). The results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3. This indicates that the factor elements were adequate and relatively good measures of the construct. Table 43 further illustrates the factor loadings for all three factor elements, where all three elements expressed factor loading above 0.40. The communalities of the three factors also reflected values less than 0.999, demonstrating that three factor elements were within an acceptable range.

These factors could be identified as key factors determining the influence of national and global dynamic factors on successful construction and engineering project delivery in the South African public sector.

Table 43: Exploratory Factor Analysis Statistics for National and Global Dynamic Factors

Items	***Factor Element***	***Factor Loading***	***Corrected item-total Correlation***	***Communalities***	
				Initial	***Extraction***
B6.1	Global Political Dynamics	.857	.679	.755	.735
B6.2	Global Economic Trends	1.000	.872	.825	.999
B6.3	National Economic Trends	.658	.571	.476	.433

Extraction Method: Maximum Likelihood

The statistical measure of reliability was determined by the Cronbach's alpha test, with findings being greater than the recommended 0.7. The three factor elements represent a Cronbach's alpha coefficient of 0.825 showing an acceptable internal reliability. The Kaiser-Meyer-Olkin (KMO) test was employed to determine the strength of the item intercorrelations for project stakeholder influence which reflected a value of 0.554, less than the cut off value of 0.60. Bartlett's test of Sphericity of $p<0.000$ was obtained, indicating that the data meets the criterion for factor analyzability.

Table 44: Reliability Statistics of National and Global Dynamic Factors

Items	***Cronbachs's Alpha***	***KMO***	***Bartletts's Test of Spericity***		
			Appr. Chi-Square	***df***	***Sig.***
3	.825	.554	183.894	3	.000

The results represented in table 45, indicates an Eigenvalue of 2.328 that was greater than 1. This factor element denotes, a variance of 77.59% in the data which is above the recommended cut off value of 50%. As a result, adequate evidence of convergent validity and discriminant validity was provided for the national and global dynamic factors construct.

Table 45: Total Variance of Outcome Expectations for National and Global Dynamic Factors

Factor	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2.328	77.598	77.598	2.167	72.233	72.233
2	.567	18.892	96.490			
3	.105	3.510	100.000			

Extraction Method: Maximum Likelihood

Table 46 highlights the overall reliability and the corrected item-total correlation statistics of the 6 constructs that influence successful construction and engineering project delivery in the South African public sector. The findings reflect unidimensional and reliability of the 6 constructs and the 23 factor elements that was extracted using Exploratory Factor Analysis (EFA). The results illustrate that the corrected item-total correlation values were greater than the recommended cut-off value of 0.3, which indicates that the factor elements were adequate and good measures of the construct. Table 46 further illustrates the Cronbach's reliability tests, with findings being greater than or relatively equal to the recommended 0.7. The 6 constructs and 23 factor elements illustrated below are identified as the proposed model for Structural Equation Modelling and are recognized as the key factors determining the influence on successful construction and engineering project delivery in the South African public sector.

Table 46: EFA: Final Corrected Item-Total Statistics for the 6 Constructs

Construct	*Factor Elements*	*Corrected Item-Total Correlation*	*Cronbach's Alpha if item deleted*
Project Stakeholder Influence	Client Influence	.854	***0.896***
	Consultant Influence	.744	
	Contractor Influence	.766	
	Public Sector Officials Influence	.752	
Project Characteristics	Project Type	.854	***0.748***
	Project Scope	.715	
	Project Size	.719	
	Project Budget Size	.892	
Project Challenges	Government Policies, Legislatures and Frameworks	.855	***0.850***
	Financial Contributions	.613	

	Socio-Economic Culture	.778	
	Stakeholder Management	.828	
	Information Technology	.512	
Socio-Economic Factors	Gross Domestic Product	.310	***0.698***
	Employment Rate	.719	
	Poverty and Inequality	.383	
	Crime	.558	
Statutory Frameworks and Legislation Factors	Equity Policies	.766	***0.911***
	Building Regulations	.854	
	Construction Contracts and Procurement Processes	.686	
National and Global Dynamic Factors	Global Political Dynamics	.679	***0.825***
	Global Economic Trends	.872	
	National Economic Trends	.571	

6.3. Chapter Summary

This chapter highlights the data analysis process of the research study and presents the findings captured by a mixed research methodology. The chapter further presents the findings based on the analysis of the data collected via google forms and emailed responses. The research analysis process was conducted using the SPSS version 26 and AMOS version 27. The coded data was analysed in order to identify the overall views of respondents, with the research findings being discussed in the context of previous literature; the development of structural equation models; validity and reliability analysis; regression models; path analysis and model modification. A comprehensive overview of the conceptual model shall be analysed with the model design, model components, model variables, model inter-relationships and a final model development for successful construction project delivery illustrated.

CHAPTER SEVEN:
MODEL DEVELOPMENT AND VALIDATION

7. Introduction

Structural equation modeling offers an overall general and expedient framework for statistical analysis that comprises of several traditional multivariate techniques and procedures, such as regression analysis, factor analysis, discriminant analysis and an extensive path analysis (Hox and Bechger, 2014 and Fan, 2005,1999). Structural equation models are often illustrated by graphical path diagrams and are represented in a set of matrix equations. The advantage of SEM is that it can be employed to develop a variety of relationships between theoretical constructs that are represented by regression or path coefficients. SEM also enables the testing of hypothesized relationships that exist between observed variables and latent constructs. Latent variables expressed in the model development process eliminates measurement errors and improves the overall ability to generalize and validate the research design (Hox and Bechger, 2014).

Structural equation modelling has been adopted for this research study over other multivariate analysis techniques and procedures as it considers the measurement errors that are innate to subjective operational measurement; and to further develop, analyze and explore hypothesized relationships present in the model (Molwus et al., 2017). SEM as an analysis tool enables several statistics analysis procedures to be adopted and used in the research study. It enables the grouping of influencing factors that impact the successful delivery of public sector engineering and construction projects where confirmatory factor analysis can be used; and in order to effectively test the hypothesized relationships, regression analysis can be used in a structured manner. The development of an SEM research model includes the following steps highlighted below.

a. The identification and definition of model components that are sourced from previous theoretical literature and empirical studies;
b. The development of hypothetical relationship based on the aim and objectives of the research study;
c. The model development process based on data collected from the survey questionnaire;
d. The verification of the model by identifying the goodness-of fit measures and;
e. The validation of the model.

Various authors have debated the acceptable sample size regarding the use and application of SEM in research studies; with some authors recommending a large sample size; and others a smaller sample size (Doloi et al., 2011; Eriksson and Pesamaa, 2007; Ozorhon et al., 2007, 2010; Mainul Islam and Faniran, 2005 and Mohamed, 2002). Studies by Hernandez et al. (2006) and Feskens and Hox (2011) state that when appropriate statistical methods and models were applied, useful results were produced despite having small sample sizes ranging from 5, 10, 15, 20, 30 to 500 respondents.

7.1. Model Development through Structural Equation Modeling

7.1.1. Structural Equation Modelling

Structural Equation Modelling is the process of modelling casual relations between observed variables. This process seeks to include all observed variables that have a significant connection in the process of curiosity. The initial step in structural equation modelling is to specify the model, a set of statements highlighting the relationships between observed variables; and the model's latent constructs. SEM therefore comprises of multiple regression analysis and factor analysis (Raykov, 2012). The application of SEM in a research study aims to capture compound relationships between a single or multiple dependent variable that can be sourced from mixed method data (Hox and Kleiboer, 2007).

According to Hair, et. al., (2013), there are two approaches to SEM modelling, namely; the covariance-based SEM (CB-SEM) method and the partial least squares method of SEM (PLS-SEM). The objective of covariance-based SEM is to reproduce the theoretical covariance matrix while the objective of the partial least squares' SEM approach is to maximize the variance of dependent latent constructs. While both approached are suitable to test the hypothetical relationships between the latent constructs, this research study adopts the covariance-based SEM research approach. The overall fit of the correlation matrix derived from the hypothesized model and collected data creates a Goodness of Fit index that indicates the manner in which the hypothesized model fits the analyzed data (Raykov, 2006). Maydeu-Olivares and Garcia-Forero (2010) highlight that the goodness of fit measure/index is an active area of research with respect to SEM, classical SEM applications and in the development of multivariate models. Partial least squares method of SEM (PLS-SEM) does not enable the computing of the goodness of fit measure, which is used as reliable tool for analyzing the fit of proposed model to the empirical dataset collected (Zhao, 2017 and Rigdon, 2016).

In the absence of a goodness of fit assessment for the model, we cannot conclude the validity of the model (Zhao, 2017 and Barrett, 2007). The application of a CB-SEM technique employs stringent requirements in identifying the assumptions of the observed variables that are expected to be multivariate and normally distributed. Zhao (2017) further states that this process is imperative for SEM estimation; in particular Generalized Least Squares (GLS) and Maximum Likelihood (ML) estimating of the CB-SEM analysis. Any disregard of these methods may result in the violation of this assumption and may result in inaccurate calculations of the Chi-square and T-test.

7.1.2. Structural Equation Modelling Specification

Structural Equation Modelling specification is initially developed based on the theoretical framework of the research study (Zhao, 2017; Gainey and Klass; 2003 and Molenaar et al.; 2000). The SEM specification seeks to follow the conceptual research model; with the key influencing factors impacting successful construction and engineering project delivery in the South African public sector. These factors/latent constructs include; project stakeholder influences, project characteristics, project challenges, socio-economic factors, statutory framework and legislation factors, and national and global dynamic factors. The model represents a theoretical framework where the five latent constructs were identified from the original conceptual framework. The five latent constructs were selected due to their exploratory factor loadings greater than 0.40 and reliability test computed above 0.7 for the observed variables in each latent construct.

7.1.3. Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) and the implementation of Structural Equation Modelling is employed as an iterative process wherein modifications are specified in the initial results of the research study and parameter constraints are adjusted in an effort to improve the fit of the model. If a parameter constraint is removed due to the high modification index value, the researcher may theoretically defend the changes that are expressed; in an effort to enable the final model from deviating from the initial theoretical conceptual model (Schreiber et al., 2006). Confirmatory factor analysis was employed for this research study to examine the strength and suitability of the relationship between latent constructs and associate measurement indicators. It provides information on the individual variables and fit indices in an effort to assess how best the data set fits the theoretical conceptual model.

Schreiber et al. (2006) highlights that confirmatory factor analysis is a statistical technique that researchers employ in order to limit the number of observed variables into a reduced number of latent variables. This is conducted through careful examination of the covariation between observed variables. The following fit indices were measured for this research study, namely; The Absolute Fit Indices, Incremental Fit Indices and Parsimonious Fit Indices that are indicated in table 47 below.

Table 47: Criterion and Thresholds for Model Fit Indices

Model Fit Indices	***Acceptable Threshold***	***Threshold***	***Source***
Absolute Fit Indices			
Relative Normed Chi-Square Value	< 2 Value < 0.05	Good Fit Good Fit	Tabachnick and Fidell (2019); Brown (2006); Hoe (2008); Hooper et al. (2008); Schreiber et al. (2006); Schumacker and Lomax (2004); Hu and Bentler (1999);
Root Mean Square Error of Approximation	Value is 0.06 - 0.08	Acceptable Fit	
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	Good Fit Acceptable Fit	Brown (2006); Hooper et al. (2008); Schreiber et al. (2006); Schumacker and Lomax (2004); Hu and Bentler (1999);
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	Good Fit Acceptable Fit	Brown (2006); Hooper et al. (2008); Schreiber et al. (2006); Schumacker and Lomax (2004); Hu and Bentler (1999);
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	Good Fit Acceptable Fit	Brown (2006); Hooper et al. (2008); Schreiber et al. (2006); Schumacker and Lomax (2004); Hu and Bentler (1999);
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	Good Fit Acceptable Fit	Brown (2006); Hooper et al. (2008); Schreiber et al. (2006); Schumacker and Lomax (2004); Hu and Bentler (1999);

7.2. Model Analysis and Goodness-Of-Fit Measure

7.2.1. Project Stakeholder Influence Measurement Model

The confirmatory factor analysis for *Project Stakeholder Influence* latent variable is presented in figure 27, including the standardized factor loadings. The standard factor loadings of the latent variables range from 0.78 to 0.93 were all statistically significant and the result indicated convergent validity. The model did not include any cross loadings; therefore, the standardized factor loadings were interpreted as the correlation between the observed variable and the construct it loaded on to.

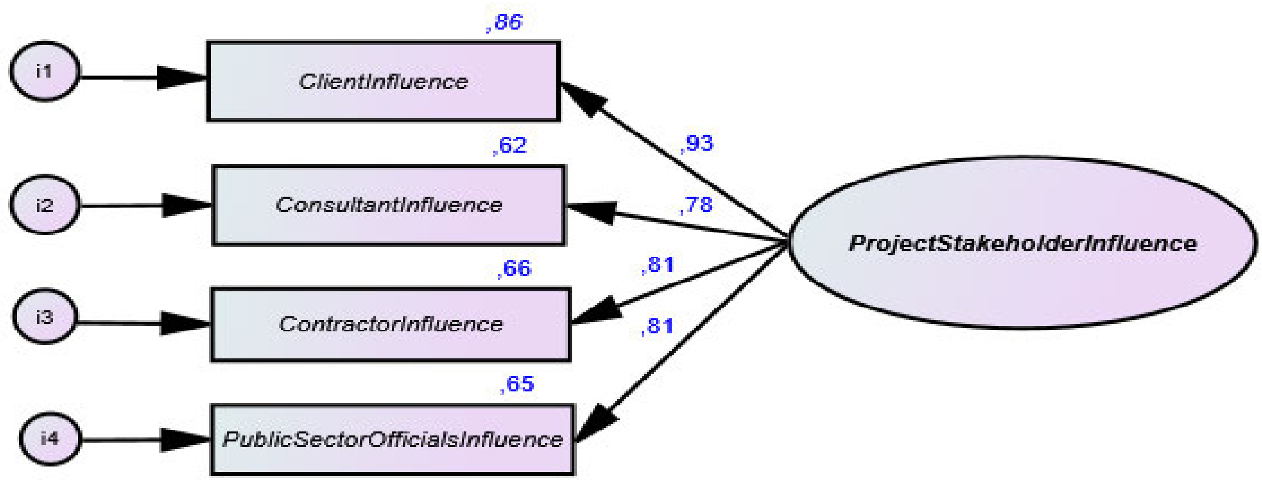

Figure 27: Measurement Model for Construct One: Project Stakeholder Influence

Legend: **i1, i2, i3, i4** – error terms

The Goodness-of-Fit test was conducted for construct one, with the results reflected in table 48. The Absolute Fit Indices; CMIN/df = 0.574 and the RMSEA value = 0.077 indicate that the theoretical model of project stakeholder influence fits the empirical data acceptably good. The Incremental Fit Indices; CFI (1.000), IFI (1.004), NFI (0.995) and TLI (1.011) were indicative of a good fit and as a result suggest an acceptable model fit. The overall validity of the observed variables in Construct One: Project Stakeholder Influence were robust and statistically significant.

Table 48: Goodness-of-Fit for Construct One: Project Stakeholder Influence Sub-Model

Construct One: Project Stakeholder Influence			
Model Fit Index	***Threshold***	***First SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.574	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.077	Acceptable fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.004	Good fit

Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.995	Good fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.011	Good fit

7.2.2. Project Characteristics Measurement Model

The confirmatory factor analysis for the *Project Characteristics* latent variable is presented in the figure 28, including the standardized factor loadings. The standard factor loadings of the latent variables range from 0.23 to 0.90 were all statistically significant and the result indicated convergent validity. The model did not include any cross loadings; therefore, the standardized factor loadings were interpreted as the correlation between the observed variable and the construct it loaded on to.

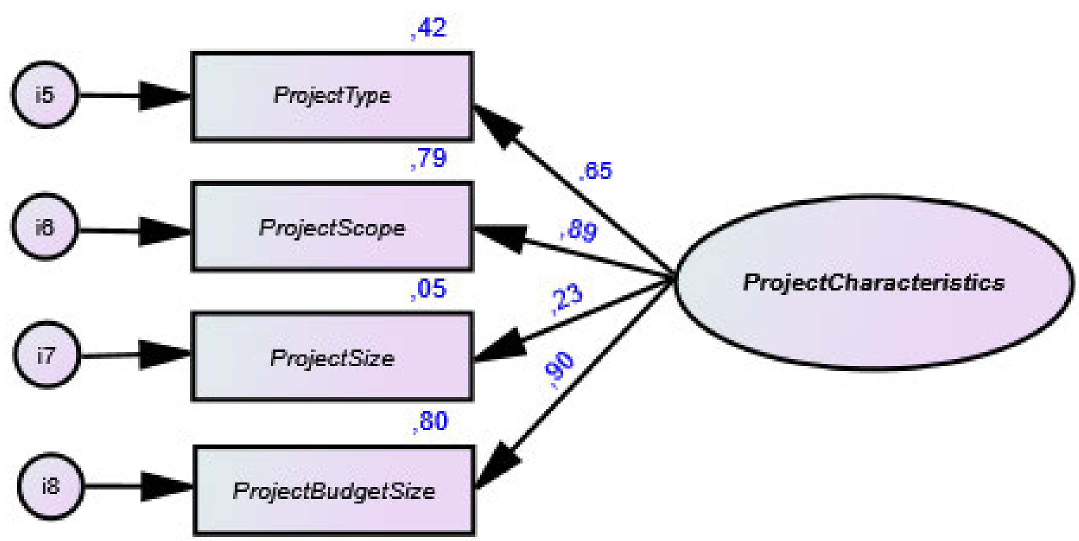

Figure 28: Measurement Model for Construct Two: Project Characteristics

Legend: **i5, i6, i7, i8** –error terms

Table 49 reflects the Goodness-of-Fit test which was conducted for construct two. The Absolute Fit Indices; CMIN/df value = 0.004 and the RMSEA value = 0.073 indicate that the theoretical model of project characteristics illustrates a good fit for the empirical data. The Incremental Fit Indices; CFI (0.938), IFI (0.940), NFI (0.927) and TLI (0.814) were indicative of a mediocre to acceptable fit. In an effort to attain an improved fit, measurement model re-specification and refinement was conducted.

Table 49: Goodness-of-Fit for Construct Two: Project Characteristics Sub-Model

Construct Two: Project Characteristics			
Model Fit Index	***Threshold***	***First SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.004	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.073	Acceptable fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.938	Acceptable fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.940	Acceptable fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.927	Acceptable fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.814	Mediocre fit

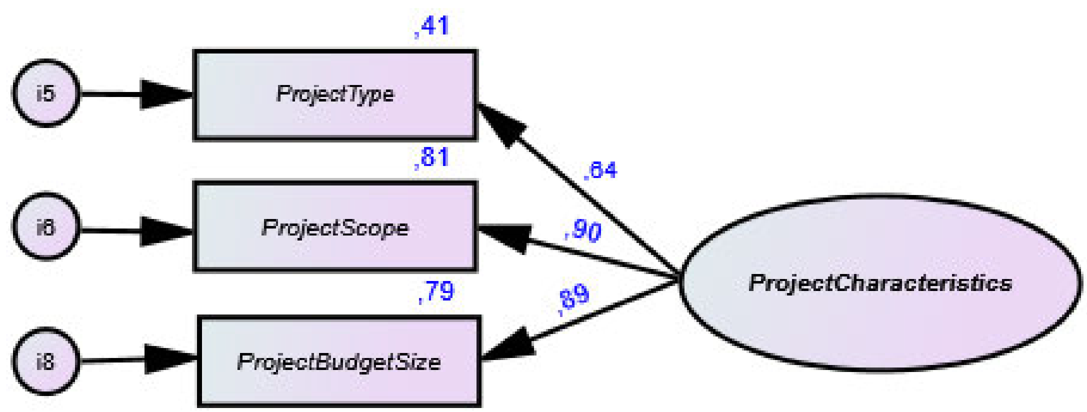

Figure 29: Refined Measurement Model for Construct Two: Project Characteristics

Legend: **i5, i6, i8** –error terms

Figure 29 reflects the model re-specification according to the modification indices provided by the data analysis process of SEM. The indicator metrics that reflected the highest residual correlations were identified along with the error terms within the factor. The variable "*project size*" was removed in order to attain an improved model fit. The model was re-tested after it was refined, with the results illustrated in table 50. The results show that the model fit indices improved with the Absolute Fit Indices; CMIN/df = 0.000 and the RMSEA value = 0.000 indicating that the theoretical model of the construct, project characteristics fitting the empirical data acceptably good. The Incremental Fit Indices; CFI (1.000), IFI (1.000), NFI (1.000) and TLI (-) were indicative of a good fit and as a result suggest an acceptable refined model fit.

Table 50: Goodness-of-Fit for Construct Two: Project Characteristics Sub-Model

Construct Two: Project Characteristics			
Model Fit Index	***Threshold***	***Refined SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.000	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.000	Good fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	-	-

7.2.3. Project Challenges Measurement Model

The confirmatory factor analysis for the *Project Challenges* latent variable is presented in the figure 30, including the standardized factor loadings. The standard factor loadings of the latent variables range from 0.63 to 0.92 and were all statistically significant indicating convergent validity. The model did not include any cross loadings; therefore, the standardized factor loadings were interpreted as the correlation between the observed variable and the construct it loaded on to.

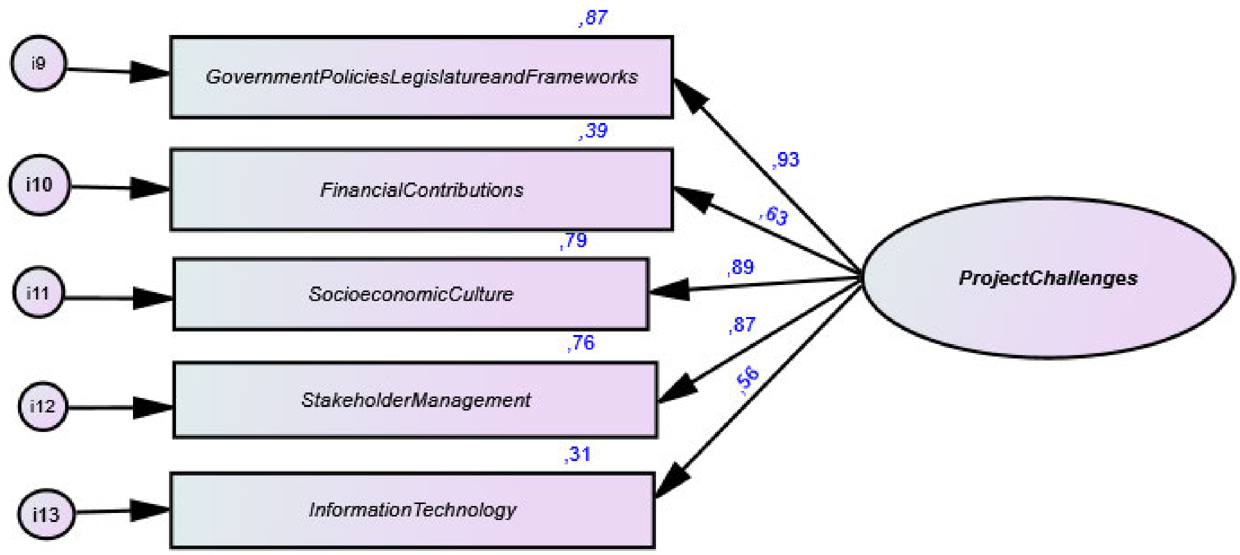

Figure 30: Measurement Model for Construct Three: Project Challenges

Legend: **i9, i10, i11, i12, i13** – error terms

Table 51 reflects the Goodness-of-Fit test which was conducted for Project Challenges. The Absolute Fit Indices; CMIN/df value = 0.000 and the RMSEA value = 0.239 indicate that the theoretical model of project challenges illustrates a good fit for the empirical data. The Incremental Fit Indices; CFI (0.859), IFI (0.861), NFI (0.844) and TLI (0.765) were indicative of a mediocre to acceptable fit. In an effort to attain an improved fit, measurement model re-specification and refinement was conducted.

Table 51: Goodness-of-Fit for Construct Three: Project Challenges Sub-Model

Construct Three: Project Challenges			
Model Fit Index	***Threshold***	***First SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.000	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.239	Poor fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.859	Mediocre fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.861	Mediocre fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.844	Mediocre fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.765	Poor fit

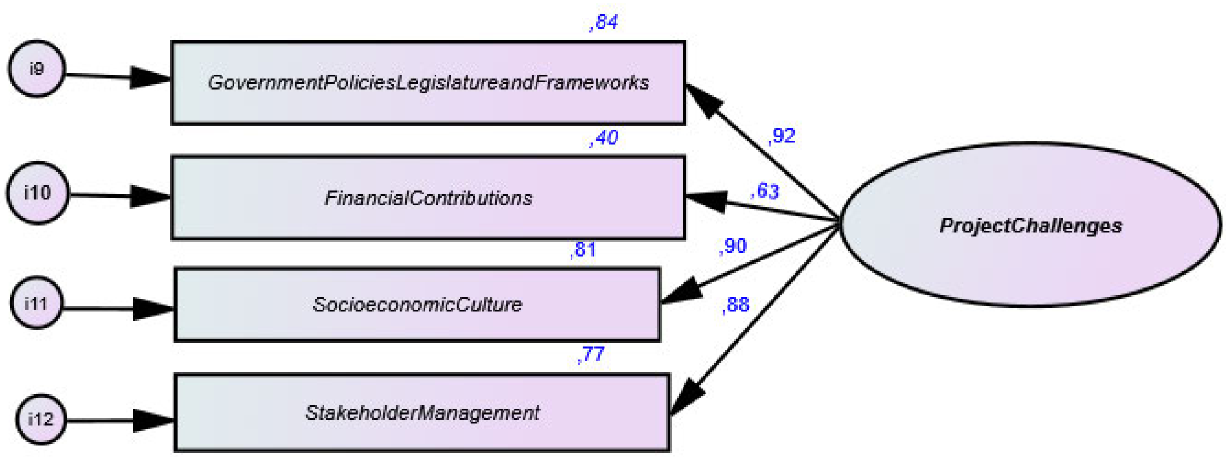

Figure 31: Refined Measurement Model for Construct Three: Project Challenges

Legend: **i9, i10, i11, i12** – error terms

Figure 31 reflects the model re-specification according to the modification indices provided by the data analysis process of SEM. The indicator metrics that reflected the highest residual correlations were identified along with the error terms within the factor. The variable "*information technology*" was removed in order to attain an improved model fit. The model was re-tested after it was refined, with the results illustrated in table 52. The results show that the model fit indices improved with the Absolute Fit Indices; CMIN/df = 3.486 and the RMSEA value = 0.029 indicating that the theoretical model of the construct, project challenges fitting the empirical data acceptably good. The Incremental Fit Indices; CFI (0.981), IFI (0.982), NFI (0.974) and TLI (0.944) were indicative of a good fit and as a result suggests an acceptable refined model fit.

Table 52: Goodness-of-Fit for Construct Three: Project Challenges Sub-Model

Construct Three: Project Challenges			
Model Fit Index	***Threshold***	***Refined SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	3.486	Not acceptable
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.029	Good fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.981	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.982	Good fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.974	Good fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.944	Good fit

7.2.4. Socio-Economic Factors Measurement Model

The confirmatory factor analysis for the *Socio-Economic Factors* latent variable is presented in the figure 32, including the standardized factor loadings. The standard factor loadings of the latent variables range from 0.44 to 1.01 and were all statistically significant indicating convergent validity. The model did not include any cross loadings; therefore, the standardized factor loadings were interpreted as the correlation between the observed variable and the construct it loaded on to.

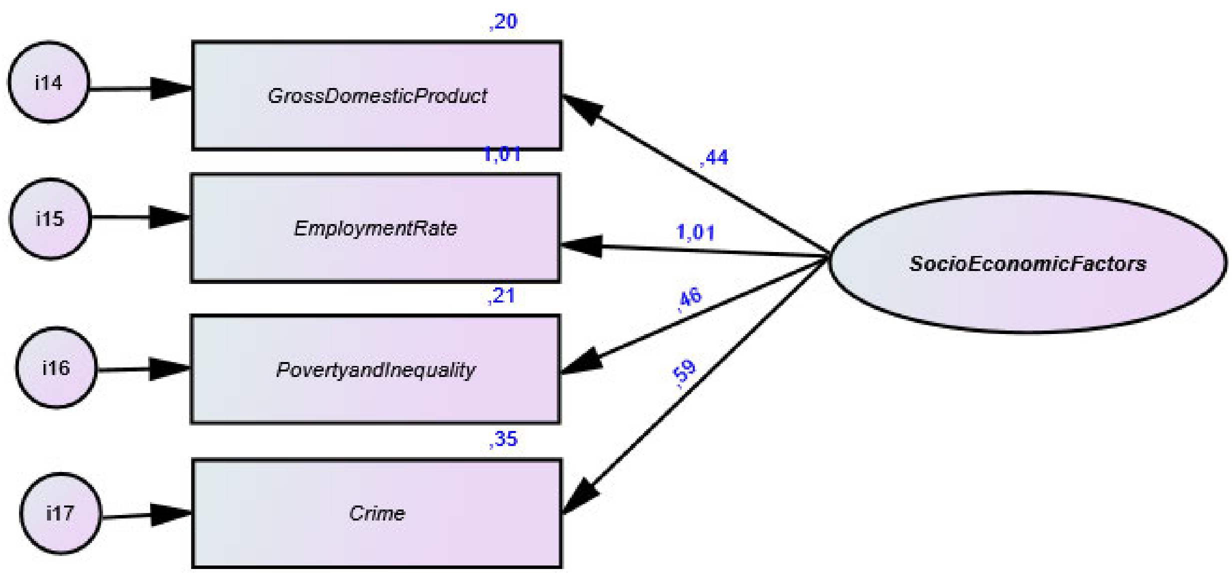

Figure 32: Measurement Model for Construct Four: Socio-Economic Factors

Legend: **i14, i15, i16, i17** – error terms.

Table 53 reflects the Goodness-of-Fit test which was conducted for Socio-Economic Factors. The Absolute Fit Indices; CMIN/df value = 0.066 and the RMSEA value = 0.057 indicate that the theoretical model of project challenges illustrates a good fit for the empirical data. The Incremental Fit Indices; CFI (0.960), IFI (0.961), NFI (0.940) and TLI (0.879) were indicative of a mediocre to acceptable fit. In an effort to attain an improved fit, measurement model re-specification and refinement was conducted.

Table 53: Goodness-of-Fit for Construct Four: Socio-Economic Factors Sub-Model

Construct Four: Socio-Economic Factors			
Model Fit Index	***Threshold***	***First SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.066	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.057	Acceptable fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.960	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.961	Good fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.940	Acceptable fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	0.879	Mediocre fit

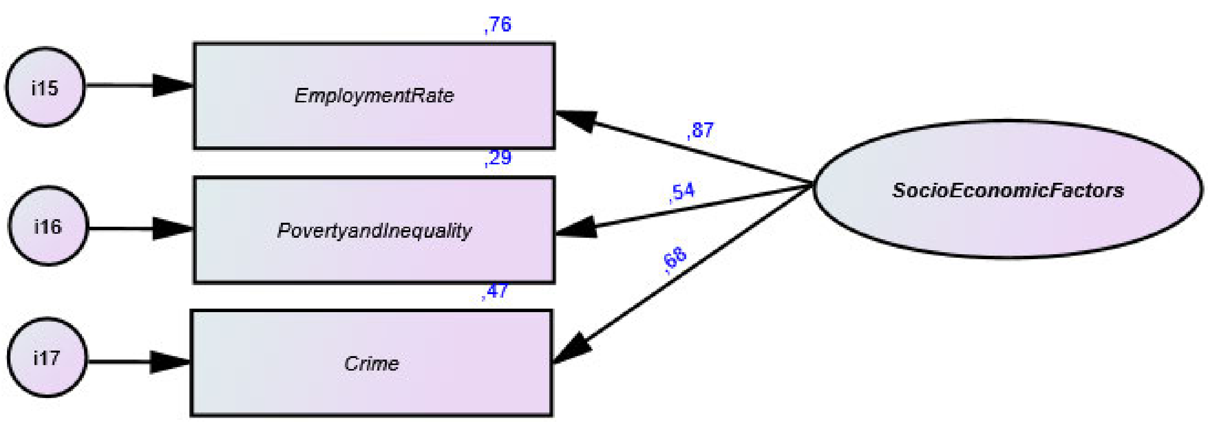

Figure 33: Refined Measurement Model for Construct Four: Socio-Economic Factors

Legend: **i15, i16, i17** – error terms

Figure 33 reflects the model re-specification according to the modification indices provided by the data analysis process of SEM. The indicator metrics that reflected the highest residual correlations were identified along with the error terms within the factor. The variable "*gross domestic product*" was removed in order to attain an improved model fit. The model was re-tested after it was refined, with the results illustrated in table 54. The results show that the model fit indices improved with the Absolute Fit Indices; CMIN/df = 0.000 and the RMSEA value = 0.000 indicating that the theoretical model of the construct, project challenges fitting the empirical data acceptably good. The Incremental Fit Indices; CFI (1.000), IFI (1.000), NFI (1.000) and TLI (-) were indicative of a good fit and as a result suggests an acceptable refined model fit.

Table 54: Goodness-of-Fit for Construct Four: Socio-Economic Factors Sub-Model

Construct Four: Socio-Economic Factors			
Model Fit Index	***Threshold***	***Refined SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.000	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.000	Good fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	-	-

7.2.5. Statutory Frameworks and Legislation Factors Measurement Model

The confirmatory factor analysis for the *Statutory Frameworks and Legislation Factors* latent variable is presented in the figure 34, including the standardized factor loadings. The standard factor loadings of the latent variables range from 0.82 to 0.99 and were all statistically significant indicating convergent validity. The model did not include any cross loadings; therefore, the standardized factor loadings were interpreted as the correlation between the observed variable and the construct it loaded on to.

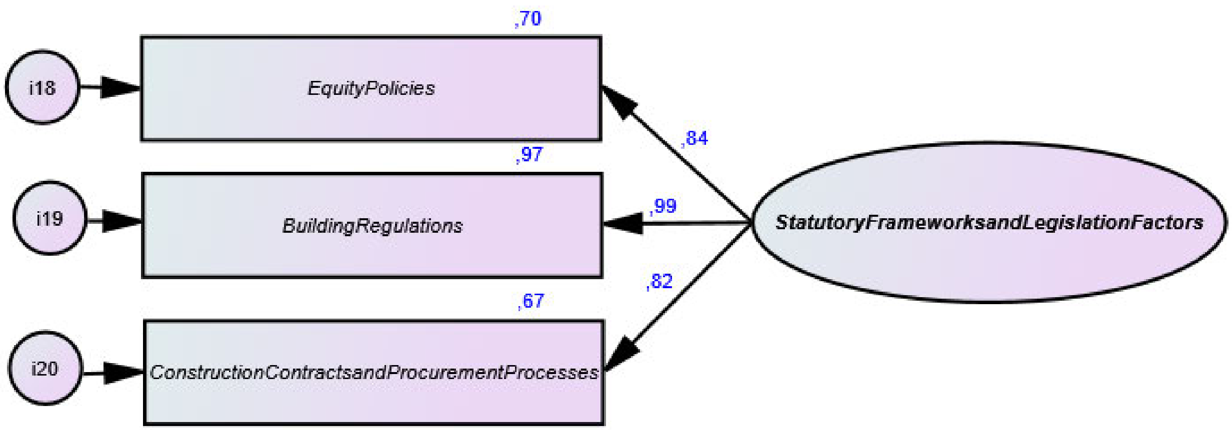

Figure 34: Measurement Model for Construct Five: Statutory Frameworks and Legislation Factors

Legend: **i18, i19, i20** – error terms

The Goodness-of-Fit test was conducted for Statutory Frameworks and Legislation Factors, with the results reflected in table 55. The Absolute Fit Indices; CMIN/df = 0.000 and the RMSEA value = 0.000 indicate that the theoretical model of statutory frameworks and legislation factors fits the empirical data relatively good. The Incremental Fit Indices; CFI (1.000), IFI (1.000), NFI (1.000) and TLI (1.000) were indicative of a good fit and as a result suggests an acceptable model fit.

Table 55: Goodness-of-Fit for Construct Five: Statutory Frameworks and Legislation Factors Sub-Model

Construct Five: Statutory Frameworks and Legislation Factors			
Model Fit Index	***Threshold***	***First SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.000	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.000	Good fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit

7.2.6. National and Global Dynamic Factors Measurement Model

The confirmatory factor analysis for the *National and Global Dynamic Factors* latent variable is presented in the figure 35, including the standardized factor loadings. The standard factor loadings of the latent variables range from 0.59 to 1.11 and were all statistically significant indicating convergent validity. The model did not include any cross loadings; therefore, the standardized factor loadings were interpreted as the correlation between the observed variable and the construct it loaded on to.

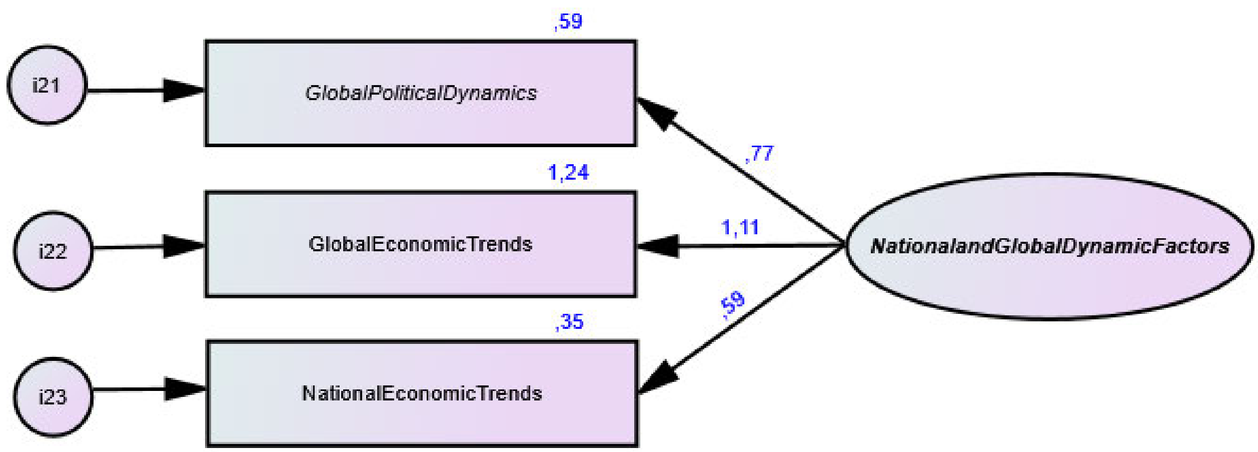

Figure 35: Measurement Model for Construct Six: National and Global Dynamic Factors

Legend: **i21, i22, i23** – error terms.

The Goodness-of-Fit test was conducted for National and Global Dynamic Factors, with the results reflected in table 56. The Absolute Fit Indices; CMIN/df = 0.000 and the RMSEA value = 0.000 indicate that the theoretical model of statutory frameworks and legislation factors fits the empirical data relatively good. The Incremental Fit Indices; CFI (1.000), IFI (1.000), NFI (1.000) and TLI (1.000) were indicative of a good fit and as a result suggests an acceptable model fit.

Table 56: Goodness-of-Fit for Construct Six: National and Global Dynamic Factors Sub-Model

Construct Six: National and Global Dynamic Factors			
Model Fit Index	***Threshold***	***First SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.000	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.000	Good fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Normed Fit Index (NFI)	Value ≥ 0.95	1.000	Good fit

	Value is 0.90 - 0.95		
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit

The model fit indices across all six constructs for the refined model met the acceptable threshold limits. The absolute fit assessment indices were used to assess the goodness-of-fit of the conceptual model, using the relative normed Chi-square and the Root Mean Square Error of Approximation. The root mean square error of approximation is used to measure the square root of the residual data that forms the difference between the collected data and model prediction, with the value smaller than the limit value of 0.08 perceived as an acceptable fit (Kline, 2011 and Anderson and Gerbing, 1984).

The CMIN/df and RMSEA for this research study met the recommended acceptable limits with the relative normed Chi-square being less than the recommended 2.00 and the root mean square error of approximation being less than 0.05 (Fidell, et al., 2013; and Hu and Bentler, 1999). Incremental indices such as the CFI, IFI, NFI, and the TLI were assessed. Three of the four incremental fit indices that were assessed fell above the acceptable threshold to provide support for acceptable model fit and therefore the model has an acceptable incremental fit.

7.3. Model Refinement

As recommended by Hooper *et al*. (2008), the model was further refined by eliminating obstinate constructs and observed variables. In this research study, the composite reliability and discriminant validity of the initial conceptual model was tested, after which, one latent construct was eliminated, namely; *Socio Economic Factors* as well as two variables; *Employment Rate and Poverty and Inequality*.

The composite reliability was used to measure the manner in which all the measurement indicators consistently represent the corresponding latent construct (Hair et al., 2013). Table 57 reflects the composite reliability of all six constructs greater than 0.7, highlighting that the initial conceptual model has achieved composite reliability. However, the initial conceptual structural model highlighted the poor discriminant validity between *Construct One: Project Stakeholder Influence* and *Construct Four: Socio Economic Factors;* with the average variance of *Construct Four: Socio Economic Factors* being less than 0.5. As a result, *Construct Four: Socio Economic Factors* was removed in an effort to improve an overall discriminant validity of the Structural Model with *Socio-Economic Culture* being considered in *Construct Three: Project Challenges*. Furthermore, *Construct Three: Project Challenges* was amended, with *"stakeholder management"* being removed in order to attain composite reliability and discriminant validity of the structural research model.

Table 57: Composite Reliability and Discriminant Validity of the Initial Conceptual Structural Model

	CR	***AVE***	***Project Stakeholder Influence***	***Project Characteristics***	***Project Challenges***	***Socio Economic Factors***	***National and Global Dynamic Factors***	***Statutory Framework and Legislation Factors***
Project Stakeholder Influence	0.893	0.678	**0.824**					
Project Characteristics	0.848	0.659	0.781	**0.812**				
Project Challenges	0.892	0.681	0.203	0.600	**0.825**			
Socio Economic Factors	0.738	0.486	0.986	0.780	0.518	**0.697**		
National and Global Dynamic Factors	0.876	0.707	0.298	0.035	-0.251	0.211	**0.841**	
Statutory Framework and Legislation Factors	0.911	0.774	-0.045	0.244	0.378	-0.169	0.433	**0.880**

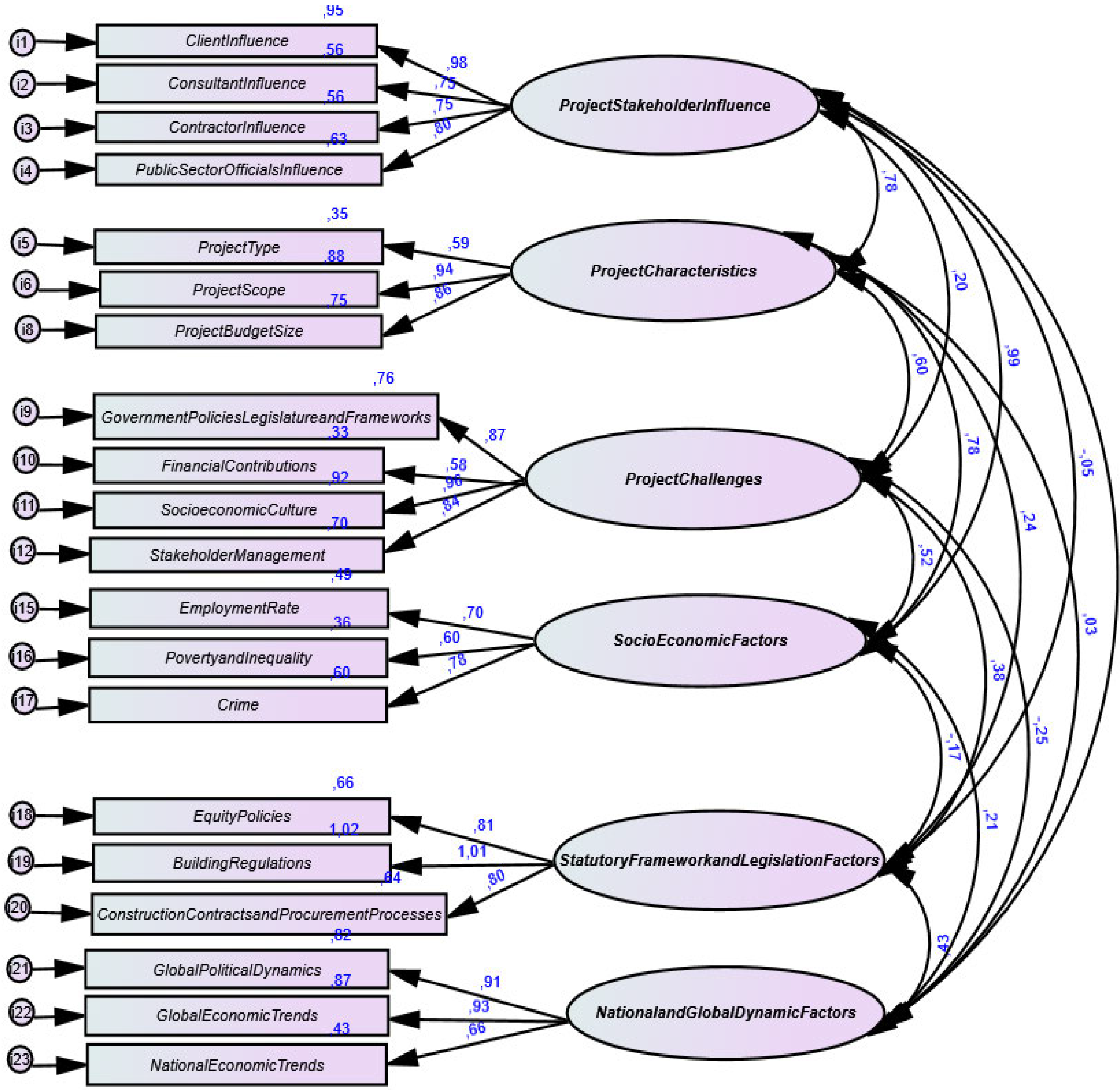

Figure 36: Initial Conceptual Structural Model

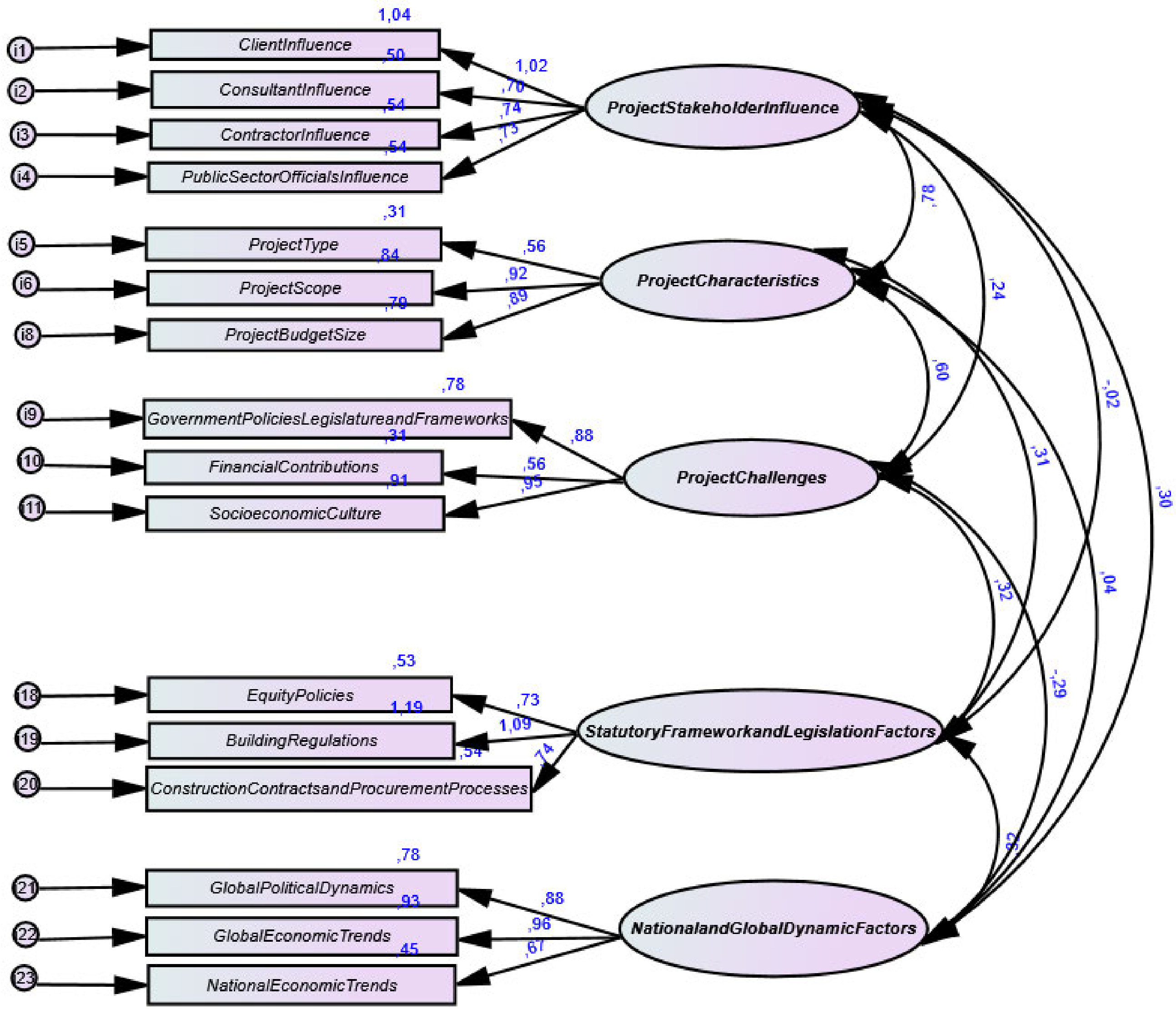

Figure 37: Hypothesized Structural Model

7.4. Structural Model Validation

7.4.1. Assessment of Normality

A critical assumption of an SEM approach, is that the presented data is of multivariate normality which is based on the analysis of covariance structures (Arbuckle, 2015). Furthermore, the skewness of the data affects the mean and kurtosis impacts the variances and covariances of the research study. According to Zhao (2017) and Hoyle (1995); and a kurtosis value greater than or equal to seven is an indication of a violation of normality. It is therefore necessary to evaluate the criterion for the structural model (Zhao, 2017 and DeCarlo, 1997).

Table 58: Assessment of Structural Model Normality

Observed Variables	*Skewness*	*Std Error*	*Kurtosis*	*Std Error*
Client Influence	-.880	.246	-.603	.488
Consultant Influence	-1.208	.246	.610	.488
Contractor Influence	-1.786	.246	1.877	.488
Public Sector Officials Influence	-.321	.246	-1.195	.488
Project Type	-.345	.246	-1.433	.488
Project Scope	-.485	.246	-1.020	.488
Project Budget Size	-1.958	.246	3.477	.488
Government Policies, Legislature and Frameworks	-.098	.246	-.999	.488
Financial Contributions	-1.246	.246	1.027	.488
Socio-Economic Culture	-.084	.246	-1.235	.488
Equity Policies	.189	.246	-1.117	.488
Building Regulations	-.336	.246	-1.224	.488
Construction Contracts and Procurement Processes	-.766	.246	-.551	.488
Global Political Dynamics	-.386	.246	-.732	.488
Global Economic Trends	-.435	.246	-.570	.488
National Economic Trends	-.622	.246	-.759	.488

The findings reflected in the table 58 illustrate that all five constructs and their associated variables in the structural model have achieved normality with kurtosis values less than 7.

7.4.3. Multi-Collinearity

Multicollinearity, is referred to as a statistical phenomenon where two or more predictor variables in a multiple regression model are highly correlated with each other (Lauridsen and Mur, 2006; Zhao, 2017). If no linear relationship exists between predictor variables, the variables are regarded to be orthogonal (Ramirez et al., 2012). Multicollinearity identifies the high correlation among constructs and influences the standard errors and parameter estimates. It also affects the significant values of the hypotheses testing process of the structural model (Hwang, 2009; Zhao, 2017). In an effort to defend a research model, a research study should adequately evaluate the model's multicollinearity to avoid unsuitable and spurious conclusions.

Bryman and Cramer, (2005) mention that correlations in a study indicate the direction and strength of the relationships that exist between a pair of variables which range between -1 to +1 (Bryman and Cramer, 2005). According to Pallant (2020 and 2010) correlation coefficients should be assessed through a rigorous process with coefficients reflecting values greater than 0.30. Values greater than 0.30 indicate a convergent validity being achieved (Robinson et al., 2015). Kline (2011) further highlights that correlations values, less than 0.90 are indicative of discriminant validity.

Table 59: Correlation Results for Construct One: Project Stakeholder Influence – Structural Model

	B1.1	***B1.2***	***B1.3***	***B1.4***
B1.1	1.000			
B1.2	.722	1.000		
B1.3	.753	.668	1.000	
B1.4	.758	.622	.639	1.000

Legend: B1.1 - Client Influence; **B1.2** – Consultant Influence; **B1.3** – Contractor Influence; **B1.4** – Public Sector Officials Influence

Table 59 highlights the inter-item correlation matrices for construct one: project stakeholder influence. It reflects the inter-correlations that were < 0.90, which implies no multicollinearity present in the construct. The results confirm that project stakeholder influence had attained discriminant validity and that the construct was adequately measured. This finding reflects that the variables are relatively good indictors of the latent variable.

Table 60: Correlation Results for Construct Two: Project Characteristics – Structural Model

	B2.1	***B2.2***	***B2.3***
B2.1	1.000		
B2.2	0.574	1.000	
B2.3	0.567	0.798	1.000

Legend: B2.1 - Project Type; **B2.2** – Project Scope; **B2.3** - Project Budget Size

Table 60 highlights the inter-item correlation matrices for construct two: project characteristics. It reflects the inter-correlations of all three variables that were < 0.90, which implies no multicollinearity present in the construct. The results confirm that project characteristics had attained discriminant validity and that the construct was adequately measured. This finding reflects that the variables are relatively good indictors of the latent variable.

Table 61: Correlation Results for Construct Three: Project Challenges – Structural Model

	B3.1	***B3.2***	***B3.3***
B3.1	1.000		
B3.2	.564	1.000	
B3.3	.836	.518	1.000

Legend: **B3.1** - Government Policies, Legislatures and Frameworks; **B3.2** – Financial Contributions; **B3.3** – Socio-Economic Culture

Table 61 highlights the inter-item correlation matrices for construct three: project challenges. It reflects the inter-correlations of all five variables that were < 0.90, which implies no multicollinearity present in the construct. The results confirm that project challenges had attained discriminant validity and that the construct was adequately measured. This finding reflects that the variables are relatively good indictors of the latent variable.

Table 62: Correlation Results for Construct Four: Statutory Frameworks and Legislation Factors – Structural Model

	B4.1	***B4.2***	***B4.3***
B4.1	1.000		
B4.2	.825	1.000	
B4.3	.684	.808	1.000

Legend: **B5.1** - Equity Policies; **B5.2** – Building Regulations; **B5.3** – Construction Contracts and Procurement Processes

Table 62 highlights the inter-item correlation matrices for construct four: statutory frameworks and legislation factors. It reflects the inter-correlations of all three variables that were < 0.90, which implies no multicollinearity present in the construct. The results confirm that statutory frameworks and legislation factors had attained discriminant validity and that the construct was adequately measured. This finding reflects that the variables are relatively good indictors of the latent variable.

Table 63: Correlation Results for Construct Five: National and Global Dynamic Factors – Structural Model

	B5.1	***B5.2***	***B5.3***
B5.1	1.000		
B5.2	.857	1.000	
B5.3	.456	.658	1.000

Legend: **B6.1** - Global Political Dynamics; **B6.2** – Global Economic Trends; **B6.3** – National Economic Trends

Table 63 highlights the inter-item correlation matrices for construct five: national and global dynamic factors. It reflects the inter-correlations of all three variables that were < 0.90, which implies no multicollinearity present in the construct. The results confirm that national and global dynamic factors had attained discriminant validity and that the construct was adequately measured. This finding reflects that the variables are relatively good indictors of the latent variable.

7.4.4. Reliability and Validity

The internal reliability and validity of a research model should be satisfactorily evaluated based on the empirical data analysed of the SEM. The composite reliability and discriminant validity of the structural research model was analysed and reflected in table 68 below. Composite reliability measures how well the various measurement indicators reflect the corresponding latent construct (Hair et al., 2013). Composite reliability of a research study is calculated using the following equation:

$$CR = \sum \varphi_i^2 / (\sum \varphi_i^2 + \sum \delta_i^2)$$

Where
φi is the regression factor loading for corresponding measurement indicator
δi is the measurement error of the corresponding measurement indicator
$\delta = (1-\varphi)$

Composite reliability of a research model is achieved when the values are greater than 0.70.

The process of measuring discriminant validity is based on the assumption that variables of a construct should correlate with other variables from other constructs that are theoretically not meant correlate. Various methods may be employed for the testing of discriminant validity using one of the following methods, namely, Chi-square difference test, Q-sorting and the Average Variance Extracted analysis (Zait and Bertea, 2011).

The Q-sorting test for discriminant validity is employed during the exploratory phase of the research study while the AVE Analysis and Chi-square difference test is administered in the confirmatory stage of the research study. Discriminant validity of a research study is calculated with following equation:

$$AVE = \sum \varphi_i^2 / n$$

Where
φi is the regression factor loading for corresponding measurement indicator
n is the number of measurement indicators of the corresponding construct

Discriminant validity of a research study is achieved when the Average Variance Extracted (AVE) is greater than 0.5.

As recommended by Anderson and Gerbing (1988), table 64 illustrates that the factor loading of each variable was above the threshold limit of 0.50. The composite reliability index ranged from 0.843 to 0.897 for the five latent constructs which signifies that the final structural model has attained composite reliability, adequacy and appropriateness. The average variance extracted value of the model measures the level of variance of a construct in respect to the measurement error of the structural model. The constructs illustrate that the model has achieved the average variance extracted value which ranged between 0.651 to 0.752. The structural model further illustrates an internal reliability above 0.7, ranging between 0.819 to 0.911.

Table 64: Reliability and Validity of the Structural Model

	Observed Variable	***Factor Loading***	***CR***	***AVE***	***Cronbach's Alpha***
Project Stakeholder Influence	PSI1	0.929	0.881	0.654	0.896
	PSI2	0.785			
	PSI3	0.814			
	PSI4	0.806			
Project Characteristics	PCHF1	0.639	0.843	0.651	0.823
	PCHF2	0.899			
	PCHF5	0.888			
Project Challenges	PCF1	0.954	0.850	0.665	0.819
	PCF2	0.592			
	PCF4	0.876			
Statutory Framework and Legislation Factors	SFLF3	0.682	0.897	0.752	0.911
	SFLF4	0.792			
	SFLF5	0.653			
National and Global Dynamic Factors	NGD1	0.857	0.882	0.718	0.825
	NGD2	1.000			
	NGD3	0.658			

7.5. Final Structural Model

Structural equation modelling has been used to develop a structural model to measure how well the collected data fits the hypothesized conceptual model in this research study. The path diagram highlighted below in figure 38, describes the various hypothesised relationships among the five latent constructs based on the results collected from construction and engineering industry stakeholders. The structural model had one independent and five intervening variables, with the five intervening variables having 16 measuring variables. In an attempt to measure the five dependent variables, a second order factor analysis was conducted. According to Kline (2011), in second-order factor analysis, second-order factors are measured indirectly through the indicators of the first-order factors.

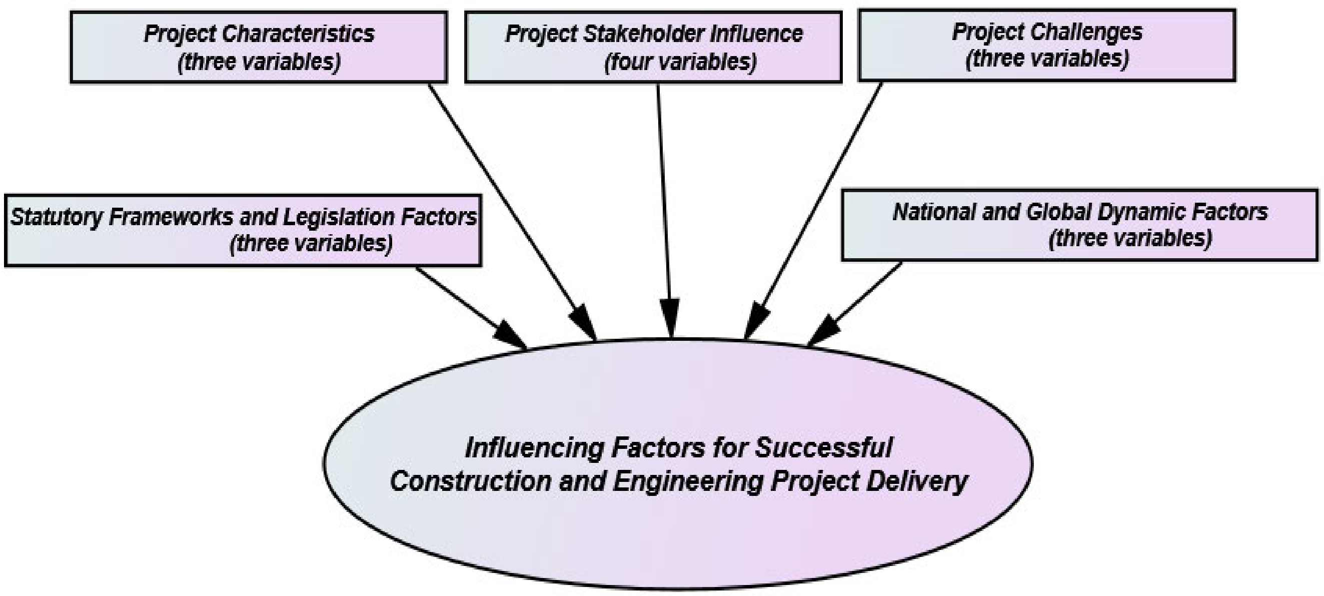

Figure 38: Final Structural Model

In this research study, factor loadings were used to determine model parameters. The overall association between the 16 observed variables and five latent constructs, as well as the extent of the statements may be determined by employing standardized and unstandardized factor loadings. According to Diamantopoulos and Siguaw (2000), unstandardized factor loadings are an indicator of the various relationships that exist between manifest variables and latent variables. Schumacker and Lomax (2004) further state that standardized factor loadings are an indicator of the importance between one variable and another. These are perceived as easier to interpret. This research study investigates standardized factor loadings greater than 0.50 as they indicate a reasonably good construct and convergent validity of the structural model (Hair et al., 2013).

Standardized regression weights are also used to accept or reject the hypotheses from the structural model. According to Hair et al. (2013); Lattin et al. (2011) and Hung and Liu (2008), a hypothesis with a standardized regression weight less than 0.1 should be rejected. The five hypothesized latent constructs of this research study were supported at the five percent level of significance.

Table 65: Structural Model Hypothesis Testing

Latent Constructs	*Estimate*	*S.E.*	*C.R*	*p-Value*	*Conclusion*
Project Stakeholder Influence	0.745	0.063	10.326	***	Cannot be rejected
Project Characteristics	1.136	0.196	6.120	***	Cannot be rejected
Project Challenges	0.997	0.119	9.060	***	Cannot be rejected
Statutory Frameworks and Legislation Factors	0.887	0.140	9.362	***	Cannot be rejected
National and Global Dynamic Factors	0.968	0.096	10.824	***	Cannot be rejected

Note: *** Sig (p) value is infinitesimally small (close to 0) hence cannot be reported

Table 65 highlights the standardized regression weights of the five latent constructs of the structural model that were all above the threshold limit of 0.1 with the highest value Project Characteristics (1.136). The overall standardized regression weights were in the range between 0.745 and 1.136. The standard errors of the model do not present extremely small or large values. The hypothesized relationships of the five latent constructs present a CR value between 10.824 and 6.120 that positively support the hypothesized relationships. The research analysis results positively indicate that the participants of the research study consider the five latent constructs as essential factors that influence project delays and disruptions in the construction and engineering sector.

H1: A positive relationship is predicted between Project Stakeholder Influence and Client Influence

H2: A positive relationship is predicted between Project Stakeholder Influence and Consultant Influence

H3: A positive relationship is predicted between Project Stakeholder Influence and Contractor Influence

H4: A positive relationship is predicted between Project Stakeholder Influence and Public Sector Officials Influence

H5: A positive relationship is predicted between Project Characteristics and Project Type

H6: A positive relationship is predicted between Project Characteristics and Project Scope

H7: A positive relationship is predicted between Project Characteristics and Project Budget Size

H8: A positive relationship is predicted between Project Challenges and Government Policies, Legislature and Frameworks

H9: A positive relationship is predicted between Project Challenges and Financial Contributions

H10: A positive relationship is predicted between Project Challenges and Socio-Economic Culture

H11: A positive relationship is predicted between Statutory Frameworks and Legislation Factors and Equity Policies

H12: A positive relationship is predicted between Statutory Frameworks and Legislation Factors and Building Regulations

H13: A positive relationship is predicted between Statutory Frameworks and Legislation Factors and Construction Contracts and Procurement Processes

H14: A positive relationship is predicted between National and Global Dynamic Factors and Global Political Dynamics

H15: A positive relationship is predicted between National and Global Dynamic Factors and Global Economic Trends

H16: A positive relationship is predicted between National and Global Dynamic Factors and National Economic Trends

One latent construct and four observed variables were eliminated during the model refinement process in order to achieve the best fit of the final structural model. The goodness-of-fit test was conducted on the final structural model with the findings illustrated in Table 67. The findings indicate that the structural model is valid and reliable; with the absolute and incremental fit indices indicating an overall good model fit.

Table 66: Structural Model Statistics

Proposed Hypothesis						*Regression Estimate*	*P Level*	*Rejected/ Supported*
Construct One: Project Stakeholder Influence								
1	PSI1	←	PSI	H1	Positive Significant	0.929	***	Supported
2	PSI2	←	PSI	H2	Positive Significant	0.785	***	Supported
3	PSI3	←	PSI	H3	Positive Significant	0.814	***	Supported
4	PSI4	←	PSI	H4	Positive Significant	0.806	***	Supported
Construct Two: Project Characteristics								
1	PCHF1	←	PCHF	H5	Positive Significant	0.639	***	Supported

2	PCHF2	←	PCHF	H6	Positive Significant	0.899	***	Supported
3	PCHF5	←	PCHF	H7	Positive Significant	0.888	***	Supported
Construct Three: Project Challenges								
1	PCF1	←	PCF	H8	Positive Significant	0.910	***	Supported
2	PCF4	←	PCF	H9	Positive Significant	0.768	***	Supported
3	PCF2	←	PCF	H10	Positive Significant	0.350	***	Supported
Construct Four: Statutory Frameworks and Legislation Factors								
1	SFLF3	←	SFL	H11	Positive Significant	0.836	***	Supported
2	SFLF4	←	SFL	H12	Positive Significant	0.987	***	Supported
3	SFLF5	←	SFL	H13	Positive Significant	0.818	***	Supported
Construct Five: National and Global Dynamic Factors								
1	NGD1	←	NGD	H14	Positive Significant	0.771	***	Supported
2	NGD2	←	NGD	H15	Positive Significant	1.112	***	Supported
3	NGD3	←	NGD	H16	Positive Significant	0.592	***	Supported

Table 67: Structural Model Goodness-of-Fit Testing

Structural Model			
Model Fit Index	***Threshold***	***First SEM***	***Acceptability***
Absolute Fit Indices			
CMIN/df	< 2	0.115	Good fit
Root Mean Square Error of Approximation	Value < 0.05 Value is 0.06 - 0.08	0.002	Good fit
Incremental Fit Indices			
Bentler Comparative Fit Index (CFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Incremental Fit Index (IFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Normed Fit Index (NFI)	Value ≥ 0.95 Value is 0.90 - 0.95	1.000	Good fit
Tucker - Lewis Index (TLI)	Value ≥ 0.95 Value is 0.90 - 0.95	-	-

Parsimonious Fit Indices			
Parsimony Adjusted Normed Fit Index (PNFI)	Value ≥ 0.90 Value is 0.90 - 0.95	-	Not met
Parsimony Adjusted Comparative Fit Index (PCFI	Value ≥ 0.90 Value is 0.90 - 0.95	-	Not met

7.6. Discussions of the Findings

The research study focused on a primary research objective, seven theoretical objectives and one empirical objective. The primary research objective was to identify the factors that affect public sector project delivery in the South African construction and engineering sector. IBM SPSS version 26 and the AMOS version 27 add-on for SEM was used to test the relationships between the various constructs and components of the model. Six latent constructs and 38 observed variables were analysed. Through critical principal component analysis (PCA) and structural equation modelling, (SEM) six latent constructs, namely: Project Stakeholder Influence; Project Characteristics; Project Challenges; Socio-economic Factors; Statutory Frameworks and Legislation Factors and National and Global Dynamic Factors were reduced to five by eliminating Socio-economic Factors. Furthermore, 38 observed variables were reduced to sixteen as the model was refined in order to achieve best fit, by eliminating obstinate constructs. SEM techniques were used to develop a best fit model for the research study. These advanced methodologies were employed to test the statistical adequacy of the proposed research model in an effort to confirm or reject the hypothesised relationships between the latent constructs. The critical analysis statistically proved the five latent constructs, *Construct One: Project Stakeholder Influence; Construct Two: Project Characteristic; Construct Three: Project Challenges; Construct Fours: Statutory Frameworks and Legislation Factors* and *Construct Five: National and Global Dynamic Factors.*

Cognitive mapping and critical path models were used to accurately explicate the observed variables and latent constructs, highlighting the statistical significance of the path coefficients. *The construct Socio-Economic Factors* along with its 12 observed variables was eliminated from the critical path model in an effort to refine the structural model with the observed variable *socio-economic culture* being instead included in *Project Challenges Construct*. The reliability and validity of the five remaining latent constructs, were considered to be statistically adequate. Furthermore, the goodness-of-fit indices of the structural research model were deemed to be satisfactory. The critical path model analysis illustrated that all the hypothesized relationships were found to be significant.

The reliability of the model was evaluated with Cronbach's alpha, Average variance, Item-total correlations and Composite Reliability testing, highlighted in table 68, with all items meeting the minimum threshold of 0.30 for item-total correlation as recommended by (Brzoska and Razum, 2010; Hair et al., 2007).

Table 68: Findings on the Reliability and Validity of the Final Structural Model

Constructs	***CR***	***AVE***	***Cronbach's Alpha***
Project Stakeholder Influence	0.881	0.654	0.896
Project Characteristics	0.843	0.651	0.823
Project Challenges	0.850	0.665	0.819
Statutory Framework and Legislation Factors	0.897	0.752	0.911
National and Global Dynamic Factors	0.882	0.718	0.825

The following sections highlight the detailed research findings and the dissemination of the latent constructs, observed variables and the relationships that exist between them.

7.6.1. Project Stakeholder Influence

It is evident that the findings reported in table 69 highlight the four key project stakeholder influences in the construct.

Table 69: Project Stakeholder Influence

Project Stakeholder Influence	***Mean***	***Std. Deviation***	***Ranking***
Consultant Influence	8.322	2.129	1
Contractor Influence	8.270	2.751	2
Client Influence	7.531	2.850	3
Public Sector Officials Influence	6.000	3.012	4

A positive relationship was predicted between project stakeholder influence and consultant influence, contractor influence, client influence and public sector officials influence. It is clear from the table above that *consultant influence* with a mean of 8.322 ranked highest out of the four factors presented to the respondents. *Contractor influence* ranked second highest with a mean of 8.270, *client influence* ranked third and *public sector officials influence* ranked fourth with means of 7.531 and 6.000 respectively within the *Construct One: Project Stakeholder Influence*. The research further highlights that the influence of *consultants* in the construction and engineering industry is a key factor that significantly impacts the successful delivery of construction and engineering projects in the South African public sector. Construction and engineering industry project stakeholders are required to function effectively on a daily basis in order to ensure a positive constructive impact on the overall quality and performance of industry projects (Pinto, 2000; Bleout, 1998; Pinto and Kharbanda, 1995a,1995b). According to Pinto and Slevin (1988), in order to attain successful project performance, industry stakeholders are required to be encouraged and nurtured. Any hinderance by the industry stakeholders may result in the poor team dynamics and overall project performance (Dadzie, Abdul-Aziz and Kwame, 2012; Nicolini, 2002).

7.6.2. Project Characteristics

Table 70 illustrates the responses received by research respondents to *Construct Two: Project Characteristics* and the variable factors that influence construction and engineering project delivery. The findings highlight the four key project characteristics that are ranked below.

Table 70: Project Characteristics Hypotheses Ranking

Project Characteristics	***Mean***	***Std. Deviation***	***Ranking***
Project Budget Size	9.135	1.342	1
Project Scope	8.479	1.628	2
Project Type	7.968	1.997	3

A positive relationship is predicted between project characteristics and project budget size, project scope and project type. It is clear that *project budget size* with a mean of 9.135 ranked highest out of the three factors presented to the respondents. *Project scope* ranked second highest with a mean of 8.479 with *project type* ranked third with a mean of 7.968 within the *Construct Two: Project Characteristics*. The research further highlights that the influence of *project budget size* in the construction and engineering industry is a key factor that significantly impacts the successful delivery of construction and engineering projects in the South African public sector. Modern public sector construction and engineering projects often involve numerous stakeholders across different disciplines. In a complex and highly integrated work environment, the objective of cohesive and multi-disciplinary industry projects is to successfully ensure the success of a project. This includes the management of project specific characteristics such as schedules, budget cost and quality. Traditionally referred to as ‘the iron triangle”. The iron triangle criterion is commonly cited by researchers as measures of project success (Bryde and Robinson, 2005).

According to White and Fortune (2002), industry stakeholders have evolved over the decades to expand the iron triangle and include the scope and nature of a project, dispute resolution management and health and safety to name a few; as their primary manner of defining project performance and success (Tabish and Jha, 2018; Pollack, Helm and Adler, 2018).

7.6.3. Project Challenges

Table 71 illustrates the responses received by research respondents to *Construct Three: Project Challenges* and the variable factors that influence construction and engineering project delivery. The findings highlight the four key project characteristics that are ranked below.

Table 71: Project Challenges Hypotheses Ranking

Project Challenges	***Mean***	***Std. Deviation***	***Ranking***
Financial Contributions	8.041	2.275	1
Socio-Economic Culture	7.479	1.722	2
Government Policies Legislature and Frameworks	7.416	1.658	3

A positive relationship is predicted between project challenges and financial contributions, socio-economic culture and government policies, legislature and frameworks. It is clear that *financial contributions* with a mean of 8.041 ranked highest out of the three factors presented to the respondents. *Socio-economic culture* ranked second highest with a mean of 7.479 with *government policies legislature and frameworks* ranked third with a mean of 7.416 within the *Construct Three: Project Challenges*. The research further highlights that the influence of *financial contributions* in the construction and engineering industry is a key factor that significantly impacts the successful delivery of construction and engineering projects in the South African public sector. The South African construction industry faces immense challenges that are present alongside a general situation of chronic financial and resource shortages, socio-economic stress, institutional weaknesses and an overall incapacity to deal with the key societal issues. Evidence suggest that these challenges have significantly increased in extent and severity in current years and has affected the development and growth of the construction and engineering sector (Windapo and Cattell, 2013; Ofori, 2000).

7.6.4. Statutory Frameworks and Legislation Factors

Table 72 illustrates the responses received by research respondents to *Construct Four: Statutory Frameworks and Legislation Factors* and the variable factors that influence construction and engineering project delivery. The findings highlight the four key project characteristics that are ranked below.

Table 72: Statutory Frameworks and Legislation Factors Hypotheses Ranking

Statutory Frameworks and Legislation Factors	***Mean***	***Std. Deviation***	***Ranking***
Construction Constructs and Procurement Processes	7.750	2.181	1
Building Regulations	7.333	2.360	2
Equity Policies	6.437	2.160	3

A positive relationship is predicted between statutory frameworks and construction contracts and procurement processes, building regulations legislation factors and equity policies. It is clear that *construction constructs and procurement processes* with a mean of 7.750 ranked highest out of the three factors presented to the respondents. *Building regulations* ranked second highest with a mean of 7.333 with *equity policies* ranked third with a mean of 6.437 within the *Construct Four: Statutory Frameworks and Legislation Factors*. The research further highlights that the influence of *construction constructs and procurement processes* in the construction and engineering industry is a key factor that significantly impacts the successful delivery of construction and engineering projects in the South African public sector. According to Munns and Bjeirmi (1996), a successful project is seen as the attainment of specified objectives, which is comprised of a series of tasks, activities and resources that are governed by a set of statutory framework and legislation (Chan and Chan, 2004).

7.6.5. National and Global Dynamic Factors

Table 73 illustrates the responses received by research respondents to *Construct Five: National and Global Dynamic Factors* and the variable factors that influence construction and engineering project delivery. The findings highlight the four key project characteristics that are ranked below.

Table 73: National and Global Dynamic Factors Hypotheses Ranking

National and Global Dynamic Factors	***Mean***	***Std. Deviation***	***Ranking***
National Economic Trends	6.135	2.781	1
Global Economic Trends	5.114	1.929	2
Global Political Dynamics	4.968	2.216	3

A positive relationship is predicted between national and global dynamic factors and national economic trends, global economic trends and global political dynamics. It is clear that *national economic trends* with a mean of 6.135 ranked highest out of the three factors presented to the respondents. *Global economic trends* ranked second highest with a mean of 5.114 with *global political dynamics* ranked third with a mean of 4.968 within the *Construct Five: National and Global Dynamic Factors*. The research further highlights that the influence of *national economic trends* in the construction and engineering industry is a key factor that significantly impacts the successful delivery of construction and engineering projects in the South African public sector.

The South African construction industry plays an indispensable role in the economy, with the activities of the construction and engineering industry being a vital source in the achievement of national socio-economic development, global economic development and global political. According to a report published by the United Nations Industrial Development Organization (1993) insufficient consideration is given by government officials, policy makers and financial planners to the construction industry in developing countries (Anaman and Osei-Amponsah, 2007).

Six latent constructs and 38 observed variables were raised in the survey questionnaire which was delineated to five constructs and 16 observed variables. After extensive statistical analysis, reliability and validity testing; the key influencing factors were highlighted and presented in the structural model and table 74 below.

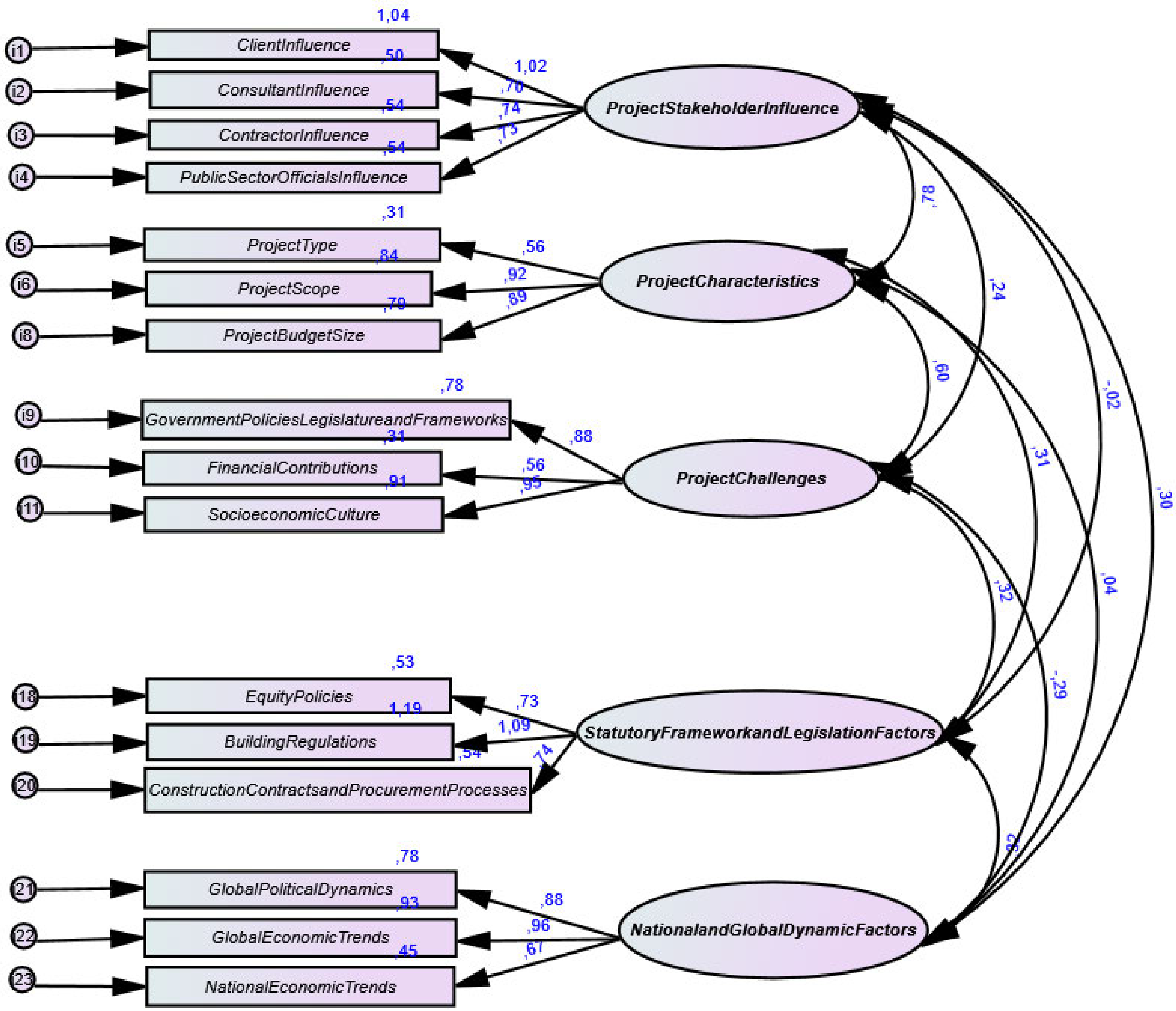

Figure 39: Structural Model for Successful Project Delivery in the South African Public Sector Construction and Engineering Industry

Table 74: Key Influencing Factors for Successful Project Delivery in the South African Public Sector Construction and Engineering Industry

Factors	***Mean***	***Std. Deviation***	***Ranking***
Project Budget Size	9.1354	1.34258	1
Project Scope	8.4792	1.62856	2
Consultant Influence	8.3229	2.12996	3
Contractor Influence	8.2708	2.75100	4
Financial Contributions	8.0417	2.27534	5
Project Type	7.9687	1.99712	6
Construction Contracts and Procurement Processes	7.7500	2.18126	7
Client Influence	7.5313	2.85050	8
Socio-Economic Culture	7.4792	1.72278	9
Government Policies Legislature and Frameworks	7.4167	1.65858	10
Building Regulations	7.3333	2.36049	11
Equity Policies	6.4375	2.16096	12
National Economic Trends	6.1354	2.78197	13
Public Sector Officials Influence	6.0000	3.01226	14
Global Economic Trends	5.1146	1.92966	15
Global Political Dynamics	4.9687	2.21694	16

7.7. Proposed Strategic Infrastructure Delivery Management Model (SIDMM)

The proposed strategic modality based on the findings of this research study is illustrated in figure 40. The proposed modality suggested for implementation by South African public sector institutes comprises of a strategic structural model that incorporates various essential factors. These factors play an essential role in the success of construction and engineering project delivery. The model may be used singularly or integrated into existing infrastructure delivery management systems focusing predominantly on the implementation and successful management of project stakeholders (consultants, contractors, clients, public sector officials); project characteristics (project budget, size, project scope, project type); project challenges (financial contributions, socio-economic culture, government policies legislature and frameworks), statutory frameworks and legislations (construction constructs and procurement processes, building regulations, equity policies) and national and global dynamic factors (global political dynamics, global economic trends, national economic trends).

Public sector institutions and key industry stakeholders are advised to work in tandem to plan, project and manage the above factors. The unilateral use of an advanced technological software program, highlighting the above constructs and factors, among public sector institutions and key industry stakeholders are advised as a strategic tool in an attempt to successfully achieve project delivery in the South African public sector environment.

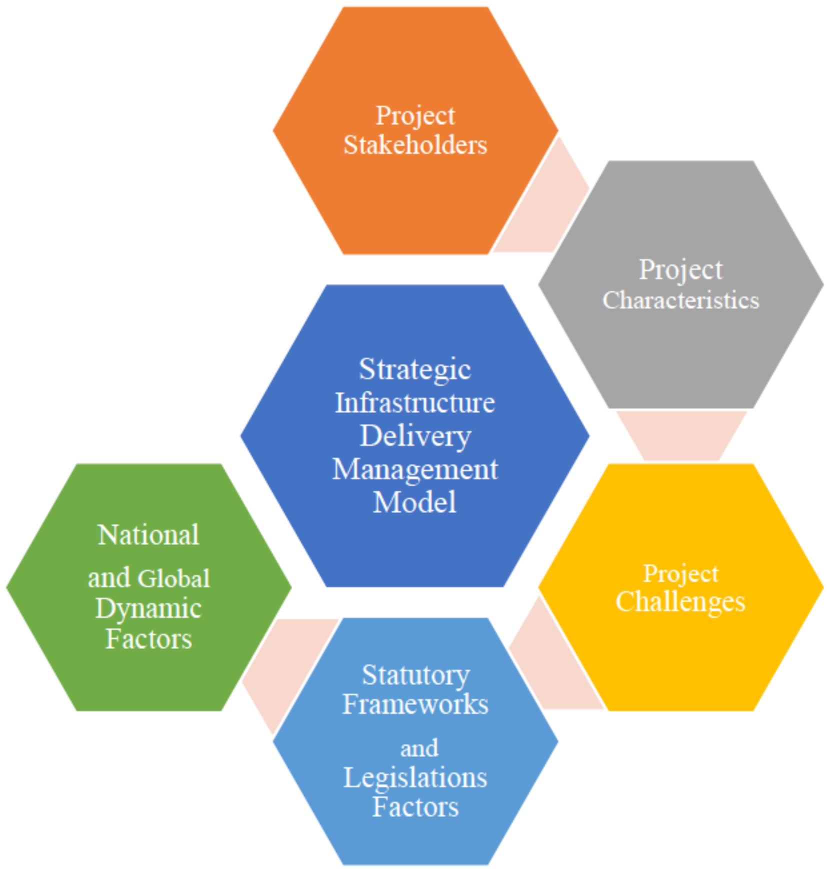

Figure 40: Proposed Strategic Infrastructure Delivery Management Model (Proposed SIDMM)

7.8. Chapter Summary

This chapter further evaluated the final structural research model with descriptive statistics and its corresponding reliability and validity test being conducted. Exploratory and confirmatory factor analyses processes were conducted with the refinement and measurement of the structural model. Internal reliability and validity tests were conducted through model fitness tests. The structural model was further developed and tested to measure the extent to which the collected data fits into the hypothesized conceptual research model. Normal distribution, multicollinearity, standard factor loadings and their statistical significance were used to assess and test the research hypotheses. The chapter actively discusses the research findings based on the positive results from the data analysis.

The data collected was screened to detect responses that presented missing, abnormal and patterned data that reflected outliers. The biographical data of the industry survey respondents; including the factors that influence successful construction and engineering project delivery in the South African public sector was further analyzed.

The findings of the exploratory factor analysis, principal component analysis and structural equation modelling was developed, refined and validated were discussed. Reliability and validity scales which were unsuccessful and illustrated poor reliability and validity were omitted from the structural equation model. The Structural Equation Model was further refined, with confirmatory factor analysis indicating that the conceptual model was a good fit based on the empirical data. The structural model illustrated that five constructs, namely; Project Stakeholder Influence; Project Characteristic; Project Challenges; Statutory Frameworks and Legislation Factors and National and Global Dynamic Factors were the main factors, with 16 sub factors; that had an influence on successful construction and engineering project delivery in the South African public sector. The findings illustrated that the data presented were reliable, valid and statistically significant; with a proposed strategic infrastructure delivery management model presented for implementation and/or integration into existing infrastructure delivery management systems in the South African public sector construction and engineering industry.

CHAPTER EIGHT:
CONCLUSION AND RECOMMENDATIONS

8. Introduction

This study adopted a pragmatic research paradigm in an attempt to achieve the research objectives. This was conducted through a mixed methodological approach that included an extensive literature review, exploratory pilot survey and a survey questionnaire; that were issued, collected and critically analyzed via SPSS version 26 and AMOS version 27 using structural equation modelling.

This research study sought to identify factors that influence construction project delivery of construction and engineering projects in the South African public sector. The study further seeks to establish a modality that highlights significant factors and proposes a strategy in which these factors are managed in order to promote successful construction and engineering project delivery in the South African public sector. This modality is recommended for use by government and municipal stakeholders in an effort to inhibit delays and disruptions on construction and engineering projects that are prevalent in the current climate of the South African public sector. In an effort to attain this objective, the research recognized six key factors expressed by industry professionals and experts; that impacted delays and disruptions on construction and engineering projects in the public sector. Through the use of empirical based evidence, the research study was refined and established the five most important factors that impacted project delivery in the promotion of delays and disruptions. The five factors and its 16 associated sub-factors will be incorporated into a recommended strategic model for successful construction and engineering project delivery that is unique to the South African public sector environment. The strategic model will be shaped on the findings highlighted throughout the extensive literature review. Findings from the empirical study further shape the strategic model in its refinement with the modality illustrating its use within existing Infrastructure Delivery Management Systems evident in the current South African public sector.

The final chapter reflects on the overall findings of the research study and seeks to present conclusions that are found based on the research outcomes. The key findings highlight the individual theoretical objectives of the study, contribution and value of the study, limitations, recommendations and conclusions of the study are presented and outlined in an effort to assist public sector project stakeholders, that are involved with successful construction and engineering project delivery.

8.1. Research Questions, Objectives and Aim

The research study sought to address the central question of "What are the factors that influence poor public sector project delivery in the South African construction and engineering sector." The various research questions and objectives arising from this central question was to identify and establish a strategic modality for successful construction and engineering project delivery, that could be implemented within existing infrastructure delivery management systems within the South African public sector environment. As a result, the main objective in achieving this aim was to identify and highlight the key factors that influence successful construction and engineering project delivery.

The research questions adopted for this research study were:

1. How to enhance the successful delivery of public sector construction and engineering projects in Kwazulu-Natal?
   a. What are the key factors, roles and influence of public sector project stakeholders and project characteristics that influence successful construction and engineering project delivery in Kwazulu-Natal?
   b. What are the key challenges; such as delays and disruptions that influence successful public sector construction and engineering project delivery in Kwazulu-Natal?
   c. What are the key socio-economic factors that influence successful public sector construction and engineering project delivery in Kwazulu-Natal?
   d. What are the frameworks and legislations that are related to the management of construction and engineering project performance in the public sector construction and engineering industry in Kwazulu-Natal?
   e. What are the national and global dynamic factors that influence project performance and development in the public sector construction and engineering industry in Kwazulu-Natal?
   f. What are the infrastructure delivery modalities that contribute to poor project delivery in the South African public sector construction and engineering industry?

8.2. Key Research Findings and Conclusions

8.2.1. Research Question

"How to enhance the successful delivery of public sector construction and engineering projects in Kwazulu-Natal?"

The main research objective was to identify factors enhance the successful delivery of construction and engineering projects in the Kwazulu-Natal public sector. An extensive literature review was conducted, accompanied by a quantitative research methodology, in an attempt to meet the objectives of the research study. Findings based on the literature review and a quantitative study by leading industry stakeholders, identified six constructs and 38 factors.

These constructs included:

1. Project Stakeholder Influence
    a. Consultants
    b. Contractors
    c. Clients
    d. Public Sector Officials
2. Project Characteristics
    a. Project Type
    b. Project Scope
    c. Project Size
    d. Project Complexity
    e. Project Budget Size
3. Project Challenges
    a. Government Policies, Legislatures and Frameworks
    b. Financial Contributions
    c. Skills Capacity
    d. Socio-Economic Culture
    e. Stakeholder Management
    f. Information Technology
    g. Sustainability
    h. Industry Development
    i. Force Majeure Events
4. Socio-Economic Factors
    a. Gross Domestic Product
    b. Consumer Price Index
    c. Gross Fixed Capital Formation
    d. Employment Rate
    e. Skills Shortage

f. Poverty and Inequality
g. Crime
h. Social Services
i. Monetary Policies
j. Investor Confidence
k. Fiscal Policies
l. Transformation Policies

5. Statutory Framework and Legislation Factors
   a. Political Policies
   b. Public Sector Policies and Management Systems
   c. Equity Policies
   d. Building Regulations
   e. Construction Contracts and Procurement Processes
6. National and Global Dynamic Factors
   a. Global Political Dynamics
   b. Global Economic Trends
   c. National Economic Trends

After extensive research analysis using Structural Equation Modeling, Confirmatory Factor Analysis, Reliability and Validity testing, the conceptual model was refined to include five constructs with 16 associated factors. Findings illustrated that no factors were excluded from *construct one: project stakeholder influence* and *construct six: national and global economic trends.* Two factors were excluded from *construct two: project characteristics*; six factors were excluded from *construct three: project challenges*, two factors were excluded from *factor five: statutory framework and legislation factors;* with construct four: socio-economic factors being completely excluded.

The constructs and associated factors represented in the conceptual model highlighted three types of variables; with the final SEM model reflecting one independent variable, five dependent variables and sixteen intervening variables. The research objectives were achieved and the following research sub-questions were answered.

8.2.1.1. Sub Research Question One: The Influence of Key Factors, Project Stakeholders and Project Characteristics

"What are the key factors, roles and influence of public sector project stakeholders and project characteristics that influence successful construction and engineering project delivery in Kwazulu-Natal?"

Sub research question one sought to establish the key factors, various roles played by project stakeholders and the project characteristics that exist within construction and engineering projects, based on findings from theoretical backgrounds. The question was further answered through an extensive review of literature and exploratory survey analysis that highlighted six constructs that were later refined to five through confirmatory factor analysis; however, it did not provide a direct list of essential roles that are required for successful construction and engineering project delivery that re unique to the South African public sector environment. As a result, an empirical evaluation was conducted to determine the significant roles project stakeholders play in determining successful construction and engineering project delivery.

Findings based on extant literature and an empirical study highlight key public sector project stakeholders that have a significant influence on construction and engineering projects includes:

1. Consultants
2. Contractors
3. Clients
4. Public Sector Officials

Furthermore, findings based on the Final SEM Model illustrate that Construct One: Project Stakeholder Influence reflected a CR of 0.881, an AVE of 0.654 and Cronbach's Alpha of 0.896 which illustrated that the findings are valid and reliable. This demonstrates that the critical thought processes, expertise, experience, decision making and problem-solving skills of key project stakeholders, such as; consultants, contractors, clients and public sector officials play an essential role in the successful delivery of construction and engineering projects in the South African public sector.

According to The Project Management Institute (2001) project stakeholders are organizations and individuals that are actively involved in a construction project. They may be internal or external stakeholders whose interests may result in a project being positively or negatively affected and as a result may or may not attain successful project completion. Construction and engineering sector project stakeholders are vital to the success of any project. Together they promote the success of a project through the provision of expertise, by reducing and uncovering risks and in ensuring a positive project outcome. Key project stakeholders are aware of project delivery expectations, associated risks and the manner in which these risks are mitigated. Successful stakeholder management is essential to the success project delivery. As a result, the research objective was attained, with the research sub-question being answered.

The sub research question further sought to establish the project characteristics that are present in construction and engineering projects. It further seeks to identify those characteristics that are unique to the South African public sector and its impact on successful project delivery. The research sub question was answered using extensive literature; however, it did not provide a direct list of project characteristics that were unique to the South African public sector environment with respect to construction and engineering projects. As a result, a detailed critique and empirical evaluation of the project characteristics was necessary in order to identify and determine its impact on successful construction and engineering project delivery.

Findings based on extant literature highlight *Project Type, Project Scope, Project Size, Project Complexity* and *Project Budget Size* as project characteristics on construction and engineering sector projects. However, after an extensive empirical study and SEM; the key project characteristics that have a substantial influence on the successful delivery of construction and engineering projects include; in order of importance:

1. Project Budget Size
2. Project Scope
3. Project Type

Furthermore, findings based on the Final SEM Model illustrate that Construct Two: Project Characteristics reflected a CR of 0.843, an AVE of 0.651 and Cronbach’s Alpha of 0.823 which illustrated that the findings are valid and reliable. This demonstrates that the traditional *“iron triangle*” of cost, quality and time; that is responsible for successful project delivery should be amended to include *Project Type* as a key project characteristic which impacts delays and disruptions, project performance and the successful delivery of construction and engineering projects in the South African public sector.

Construction project success is the singular most important goal of industry and project stakeholders. Project characteristics often affect project performance as they contain unique characteristics which determines the selection process of the project team, the selection and appointment of the contractor, procurement methods employed, management processes and the overall success of the project. As a result, in an effort to achieve project success, public sector organizations and municipal entities have developed various infrastructure delivery management systems and modalities that consider a range of project characteristics, unique to the construction and engineering sector. As a result, the research objective was attained, with the research sub-question being answered.

8.2.1.2. Sub Research Question Two: The Influence of Key Project Challenges

"What are the key challenges; such as delays and disruptions that influence successful public sector construction and engineering project delivery in Kwazulu-Natal?"

Sub research question three sought to establish the key challenges that are faced during the delivery period of construction and engineering projects. The sub question further seeks to identify those challenges that are unique to the South African public sector and its impact on successful project delivery. The research sub question was answered using extensive literature; however, it did not provide a direct list of project challenges that were unique to the South African public sector environment with respect to construction and engineering projects. As a result, a detailed critique and empirical analysis was conducted of the project challenges in order to ascertain its impact on successful construction and engineering project delivery.

Findings based on extant literature highlighted *Government Policies, Legislatures and Frameworks; Financial Contributions; Skills Capacity; Socio-Economic Culture; Stakeholder Management; Information Technology; Sustainability; Industry Development* and *Force Majeure* as project challenges that impact construction and engineering projects. However, after an extensive empirical study and SEM, the key project challenges that have a substantial influence on the successful delivery of construction and engineering projects were reduced to include:

1. Financial Contributions
2. Socio-Economic Culture
3. Government Policies Legislature and Frameworks

Furthermore, findings based on the Final SEM Model illustrate that Construct Three: Project Challenges reflected a CR of 0.850, an AVE of 0.665 and Cronbach's Alpha of 0.819 which illustrated that the findings are valid and reliable. This demonstrates that of the numerous challenges plagued by the South African construction industry in a post democratic era, "*financial contributions*" by the government, the *"socio-economic culture"* of South Africans and *"government policies legislature and frameworks"* are deemed to be the most significant challenges that impact public sector infrastructure delivery management processes, project delays and disruptions, project performance and the successful delivery of construction and engineering projects in the South African public sector.

By nature, the construction and engineering sector is diverse and complex. The sector faces numerous unique challenges that often impact project success over the lifespan of the development. It is therefore essential that effective measures are taken to successfully identify contributing factors and improve the overall performance of the sector at various levels of management and development. Factors that have been highlighted through detailed SEM analysis, include financial contributions made by government, the socio-economic culture of society and institutes and the policies, legislature and frameworks implemented by governmental bodies. Successful management of these challenges are essential to the success of public sector project delivery. As a result, the research objective was attained, with the research sub-question being answered.

The sub research question further sought to establish the project delays and disruptions as a key challenge that is ever present in South African construction and engineering projects. The sub question further seeks to identify the delays and disruptions that are unique to the South African public sector and its impact on successful project delivery. The research sub question was answered using extensive literature; however, it did not provide a direct list of project delays and disruptions that were unique to the South African public sector environment with respect to construction and engineering projects. As a result, a detailed critique and empirical evaluation of the project delays and disruptions that was necessary in order to identify and determine its impact on successful construction and engineering project delivery.

Findings based on extant literature, an empirical study and SEM analysis; highlight that the key project characteristics and key project challenges have a substantial influence on the successful delivery of construction and engineering projects.

These include:

1. Project Budget Size
2. Project Scope
3. Project Type
4. Financial Contributions
5. Socio-Economic Culture
6. Government Policies Legislature and Frameworks

Furthermore, findings demonstrate that the above characteristics and challenges of public sector construction projects; often result in construction project delays and disruptions that negatively impact public sector infrastructure delivery management processes, project performance and the successful delivery of construction and engineering projects in the South African public sector. As a result, the research objective was attained, with the research sub-question being answered.

8.2.1.3. Sub Research Question Three: The Influence of Frameworks and Legislations

"What are the frameworks and legislations that are related to the management of construction and engineering project performance in the public sector construction and engineering industry in Kwazulu-Natal?"

Sub research question six sought to establish the frameworks and legislations related to the management of construction and engineering project performance that are present in construction and engineering projects. The sub question further seeks to identify the frameworks and legislations that are present in current public sector environment and its impact on successful project delivery. The research sub question was answered using extensive literature; however, it did not provide a direct list of frameworks and legislations related to the management of construction and engineering project performance that were unique to the South African public sector environment with respect to construction and engineering projects. As a result, a detailed critique and empirical analysis of the frameworks and legislations was necessary in order to identify and determine its impact on successful construction and engineering project delivery.

Findings based on extant literature highlighted *Political Policies; Public Sector Policies and Management Systems; Equity Policies; Building Regulation* and *Construction Contracts and Procurement Processes* as statutory framework and legislation factors that impact construction and engineering projects. However, after an extensive empirical study and SEM, the key statutory framework and legislation factors that have a substantial influence on the successful delivery of construction and engineering projects were reduced to include:

1. Construction Constructs and Procurement Processes
2. Building Regulations
3. Equity Policies

Furthermore, findings based on the Final SEM Model illustrate that Construct Four: Statutory Framework and Legislation Factors reflected a CR of 0.897, an AVE of 0.752 and Cronbach's Alpha of 0.911 which illustrated that the findings are valid and reliable. This demonstrates that of the numerous statutory framework and legislation factors implemented in a post democratic era by the government, "*Construction Constructs and Procurement Processes", "Building Regulations*" and "*Equity Policies"* are deemed to be the most significant statutory framework and legislation factors that impact public sector infrastructure delivery management processes, project delays and disruptions, project performance and the successful delivery of construction and engineering projects in the South African public sector. The South African government has a vision to develop opportunities for economic and socio-economic development through extensive infrastructure investment. In a post-apartheid era, various reviews of provincial services and delivery systems were conducted by The National Treasury, with an intent to improve public sector infrastructure delivery. Findings from the reviews and detailed SEM analysis suggest development and implementation of statutory frameworks and legislations; that include construction constructs and procurement processes, building regulations and equity policies, in an attempt to effectively direct stakeholders and structure the management process that promote efficient infrastructure delivery. As a result, the research objective was attained, with the research sub-question being answered.

8.2.1.4. Sub Research Question Four: The Influence of National and Global Dynamic Factors

"What are the national and global dynamic factors that influence project performance and development in the public sector construction and engineering industry in Kwazulu-Natal?"

Sub research question seven sought to establish the national and global dynamic factors that are present in the construction and engineering sector. It further seeks to identify the factors that are unique to the South African public sector and the manner in which it impacts successful project delivery. The research sub question was answered using extensive literature; however, it did not provide a direct list of national and global dynamic factors that were unique to the South African public sector environment with respect to construction and engineering projects.
As a result, a detailed critique and empirical analysis of the national and global dynamic factors was necessary in order to identify and determine its impact on successful construction and engineering project delivery in the South African public sector.

Findings based on extant literature highlighted Global Political Dynamics; Global Economic Trends and National Economic Trends as national and global dynamic factors that impact construction and engineering projects. However, after an extensive empirical study and SEM, the key national and global dynamic factors that have a substantial impact on the successful delivery of construction and engineering projects included:

1. Global Political Dynamics
2. Global Economic Trends
3. National Economic Trends

Furthermore, findings based on the Final SEM Model illustrate that Construct Five: National and Global Dynamic Factors reflected a CR of 0.882, an AVE of 0.718 and Cronbach's Alpha of 0.825 which illustrated that the findings are valid and reliable. This demonstrates that of the all the national and global dynamic factors that were identified and which play an active role in the South African economy have a significant effect on public sector infrastructure delivery management processes, project delays and disruptions, project performance and the successful delivery of construction and engineering projects in the South African public sector. The South African construction industry contributes significantly to countries GDP, Gross Domestic Capital Formation and employment rate as it is a sizeable sector in its own right. Both nationally and globally, the construction industry is accountable for 3% to 10% of GDP. However, due to its sizeable nature, changes in national economic trends, global economic trends and global political dynamics have a substantial influence on the success of public sector infrastructure and socio-economic development. Therefore, the effective monitoring and management are key to the success of public sector project delivery. As a result, the research objective was attained, with the research sub-question being answered.

8.2.1.5. Sub Research Question Five: Infrastructure Delivery Modalities

"What are the infrastructure delivery modalities that contribute to poor project delivery in the South African public sector construction and engineering industry?"

Sub research question eight sought to identify existing infrastructure delivery modalities that are present in the South African public sector environment. It further seeks to identify the infrastructure delivery modalities that are unique to the South African public sector and its impact of successful project delivery. The research sub question was answered using extensive literature.

Findings illustrated that the Municipal Infrastructure Delivery Management System was the leading modality implemented by the South African public sector and deemed to be a tool for the successful delivery of construction and engineering projects. However, findings also highlighted the inefficiencies that exist within the public sector in the implementation and management process of such modality. Furthermore, project stakeholders; project characteristics, project challenges; statutory frameworks and legislations and national and global dynamic factors; have a substantial influence on the implementation and management of the Municipal Infrastructure Delivery Management System which in return affects the successful delivery of public sector construction and engineering project.

8.3. Contribution and Value of The Research Study

The findings of this research study meaningfully contribute practically and theoretically to the prevailing body of knowledge in the area of successful construction and engineering project delivery in a uniquely South African context. The theoretical contributions of the research study lend itself towards the existent literature on the South African construction and engineering sector, the nature of the industry which includes the characteristics, challenges, socio-economic factors, statutory and legislations implemented by the government and governing bodies, and the national and global trends that affect the industry over a period of time. Previous studies have highlighted the nature of the construction and engineering sector in developing countries and the factors that contribute to delays and disruptions, however this research study focuses on the unique nature of the construction and engineering sector in South Africa, and the prevalent factors that contribute to poor project delivery as a result delays and disruptions in the South African public sector.

The findings further serve as a basis for further research into infrastructure delivery and management systems in the context of developing countries, more specifically, it provides the basis for research into the efficacy and appropriateness of infrastructure delivery management systems as a successful tool for infrastructure delivery management in the South African public sector environment.

The practical implications of the study, is the development of a strategic infrastructure delivery management model that considers the 5 key constructs; *project stakeholder influence, project challenges, project characteristics, statutory framework and legislations and national and global economic trends;* and 16 associated factors; *project budget size, project scope, consultant influence, contractor influence, financial contributions, project type, construction contracts and procurement processes, client influence, socio-economic culture, government policies legislature and frameworks, building regulations, equity policies, national economic trends, public sector officials influence, global economic trends and global political dynamics;* based on an extensive SEM analysis from leading industry stakeholders. The strategic model highlighted project budget size as the dominant influencing factor of successful project delivery.

The implication of this model is for it to be used by public sector institutions and key industry stakeholders as a strategic tool in the effective planning, implementation and management of project stakeholders, project characteristics, project challenges, statutory frameworks and legislations, and national and global dynamics; as an attempt to successfully achieve project delivery in the South African public sector environment. The research study further illustrated that these five constructs need to work cohesively with one another in order to achieve success. The strategic model shall serve as a strategic guide and be used in tandem by public sector institutions and key industry stakeholders, in order to achieve synergy among the various project processes and delivery management systems to ensure successful project delivery.

Based on the above research findings and conclusions, the research study proposed a *Strategic Infrastructure Delivery Management Model* for implementation by public sector institutions and key industry stakeholders, through the integrated of advanced technological software programs that reflect the five essential constructs and associated factors identified through extensive structural equation modeling.

8.4. Limitations of The Research Study

According to Naoum (2012 and 2007), the limitations of a research study highlight the various points of difficulties faced during the research study. The limitations faced in this research study is as follows:

a. The survey questionnaire conducted in this research study only targeted CIDB grade 6 and above industry professionals. Possible inclusion of other industry stakeholders, statutory organs, government bodies and end users could offer a more complete picture;
b. The data collection process followed a non-probabilistic convenience sampling technique which resulted in a poor response rate. This was a result of responses being received from those individuals who were accessible and enthusiastic to participate in the research study.
c. Poor response rates were compounded by the lethargic and apathetic views of a select individuals actively involved in the construction and engineering sector, with individuals stating their disinterest in participating in the research study. This apathy was intensified by the Covid-19 pandemic as the sector faced a shutdown period, with individuals being difficult to contact. The researcher further faced time constraints in the completion of the research study. As a result, a small sample size of 96 was used;
d. The research study employed a structured survey questionnaire in order to collect scaled responses from participants using subjective measured variables. As a result, the responses received could be exposed to bias;
e. The construction and engineering sector were viewed as a collective with responses from both construction and engineering industry professionals being considered. Various industries may have their own particularities pertaining to its nature, characteristics., challenges, statutory frameworks, legislations and development techniques. This research study combined responses pertaining to both industries and viewed it as a collective with no differentiation being made to account for the minute disparities that may exist;
f. The conceptual research model was tested for its reliability and validity using the data obtained from industry professionals in South Africa. A comparison between findings from developing countries was not conducted;
g. The research findings expressed in this study were dependent on the opinions highlighted by select industry professionals through the semi-structured interviews and the data collected from CIDB registered industry professionals. The research made no attempt to conduct various other research methods in order to evaluate the factors that influence poor public sector project delivery in the South African construction and engineering sector.

8.5. Recommendations for Further Research

This research study has contributed to the existing body of knowledge in the focus areas pertaining to public sector infrastructure development and the influences that impact successful infrastructure delivery in the South African public sector environment. However, based on the research limitations, delimitations and research findings of this research study, the following areas are recommended for further research:

a. Further research studies should be more inclusive of industry professionals, statutory organs, government bodies and end users.
b. Further research studies shall adopt a probabilistic random sampling to ensure greater generalizability
c. Further research studies can reproduce this study with a greater sample size and with various other research instruments and research methodologies which have deemed to be validated.
d. Further research studies may use the model established in this research study as a basis for further development.
e. Further research studies may illustrate methodologies on the manner in which public sector institutions and industry stakeholders effectively work in unison using technological software programs, as a tool to ensure successful project delivery.
f. Further research studies may very well develop a structured framework detailing the practical implementation process of the model developed in this research study, and may seek to validate the existing relationships between measured variables.

8.6. Chapter Summary

The final chapter reflects a conclusion of the summarised findings of the research study, the detailed research contributions to the existing body of knowledge and a finalised structural modality for the successful completion of public sector construction and engineering projects in South Africa. This includes a proposed progression strategy for acceptance and implementation in the South African public sector construction and engineering industry. Limitations of the research study was expressed and recommendations to the public sector industry shall be articulated for implementation and for further research recommendations.

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UKZN HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE (HSSREC)

LETTER OF INFORMATION

Date:

12th May 2020

Dear Sir/Madam

My name is Zakheeya Armoed; enrolled at the University of Kwazulu-Natal, College of Agriculture, Engineering and Science, School of Engineering; and I am currently reading towards a PhD in Engineering: Construction Management. You are invited to participate in the research study below which focuses on the successful completion of public sector construction projects in South Africa.

Title of the research study:

A Model for the Successful Completion of Public Sector Construction and Engineering Projects in South Africa

Principal researcher:

Zakheeya Armoed

(MSc. Construction Management; BSc. Honors. Quantity Surveying; BSc. Property Development)

Brief introduction and purpose of the study:

The South African public sector construction industry plays a vital role in South Africa's socio-economic development and is a significant contributor to the country's economic growth. However, several challenges, delays and disruptions have been identified as confronting and influencing the performance, development and growth of the South African construction industry. As a result, the public sector construction industry is perceived to be unsuccessful in producing projects that are within the conventional measures of project time, cost and quality. In recent years it also fails to comply with measures such as customer and stakeholder satisfaction, health and safety parameters, quality control and overall project sustainability. The purpose of this study is to investigate challenges assumed to influence the project performance, development and growth of the South African construction industry. The outcome of the study will be to develop and implement a model and strategy to improve successful construction and engineering project delivery in South Africa.

Outline of the procedures:

Select key public sector stakeholders actively involved in construction and engineering projects will be invited to participant in a semi structured interview. Findings from the interview will be used to develop a survey questionnaire, where selected public sector industry stakeholders will be requested to participate in an online questionnaire survey on google forms, where they will be requested to complete one electronic copy of the survey questionnaire. They will be requested to complete the questionnaire honestly and completely. The data gathered in the questionnaire will be analyzed by researcher at the University of Kwazulu-Natal. Findings from the semi structured interviews will be used to validate the overall research outcomes. The research study along with its findings will provided to the participant upon request. Please note that participation in this study is voluntary and participants are free to decline if they wish to do so. However, participation in this research will play a critical role in the outcome of this study.

Risks or discomforts to the participant:

You will not be subject to any risk or discomfort during the course of this investigation.

Benefits:

The results of this study may benefit the public sector construction and engineering projects, in terms of successful construction and engineering project delivery. However, there are no direct benefits to you personally from your participation. The researcher and UKZN may also benefit through the publication of papers pertaining to the results of the study.

Reasons why the participant may be withdrawn from the study:

Participants are free to withdraw from the interview process or survey questionnaire should they so choose to do so. There will be no adverse consequences for the participant.

Remuneration:

You will not receive any type of remuneration for your participation in this study.

Costs of the study:

The costs of the study will be covered by the researcher's budget.

Confidentiality:

You will not be required to provide your personal details during the interview process or in the process of completing the survey questionnaire. A consent letter will be provided prior to you participating in this research study. You will need to agree to participate in order to conduct interviews or for the survey questionnaire to be activated on the online platform. The information that you will provide will be handled by the researcher responsible for this study. The researchers will ensure that all details on the consent letter are completely confidential. The data gathered during the interview process and in the questionnaire will be anonymous and stored for a period of 5years. All data published will not being traceable to any individual participant.

Research-related injury:

None

Ethically reviewed:

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee: Approval number – HSSREC/00002122/2020

Persons to contact in the event of any problems or queries:

Please contact the researcher at **zakheeya.armoed@gmail.com** or the research supervisor Prof. Theodore Conrad Haupt at **haupt@ukzn.ac.za**.

Complaints may be forwarded to:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban, 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

General:

Potential participants are assured that participation in this research study is voluntary and that participants may withdraw from participation at any point. However, a participant may be terminated from the study if they provide false information that may impact the legitimacy of the study. A total number of 750 participants invited to participate in the survey questionnaire with a further 20 participants are invited to participate in the interview process. A copy of the information and consent letter should will be issued to all active participants. The information letter and consent form, if needed may be translated and provided in the primary spoken language of the participant e.g. isiZulu.

UKZN HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE (HSSREC)

INFORMED CONSENT LETTER

Statement of Agreement to Participate in the Research Study:

- I,____ hereby confirm that I have been informed by the researcher, Zakheeya Armoed, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _______________________,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the purpose and procedure of the study.
- I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.
- I hereby provide consent to: Audio-record my interview **YES / NO**
- If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
Kwazulu-Natal, South Africa
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

_______________________ ___________ ______ ________________

Full Name of Participant **Date** **Time** **Signature/Right Thumbprint**

I, **Zakheeya Armoed** herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____________________ _____________________ _____________________

Full Name of Researcher **Date** **Signature**

_____________________ _____________________ _____________________

Full Name of Witness (If applicable) **Date** **Signature**

_____________________ _____________________ _____________________

Full Name of Translator (If applicable) **Date** **Signature**

RESEARCHER
Full Name: Zakheeya Armoed
University: The University of Kwazulu-Natal
School: School of Engineering, Prop. Dev.
College: Agriculture, Engineering and Science
Campus: Howard College
Proposed Qualification: PhD. Engineering: Construction Management
Contact: 074 589 2244
Email: zakheeya.armoed@gmail.com

SUPERVISOR
Full Name: Prof. Theodore. C. Haupt
University: The University of Kwazulu-Natal
School: School of Engineering, Construction Studies
College: Agriculture, Engineering and Science
Campus: Howard College
Contact: 031 260 2712
Email: haupt@ukzn.ac.za

UKZN HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE (HSSREC)

INTERVIEW QUESTIONS

Section A: Demographical Information

1. **Name:** ______________________________
2. **Age:** ______________________________
3. **Race:** ______________________________
4. **City:** ______________________________
5. **Sector:** ______________________________
6. **Institution:** ______________________________
7. **Position:** ______________________________
8. **Length of experience:** ______________________________

Section B: Interview Questions

	Main Question
1	In your opinion, what are the key factors influencing project delays and disruptions of construction and engineering projects in the South African public sector?
	Sub Questions
2	What are the key influences that project stakeholders have on successful construction project completion and delivery?
3	What are the key project characteristics that have a significant impact on successful construction project completion and delivery?
4	What are the key project challenges experienced in the public sector that affect successful construction project completion and delivery?
5	Please highlight the key socio-economic factors that have a significant impact on successful construction project completion and delivery?
6	What are the key statutory frameworks and legislation factors that have a significant impact on successful construction project completion and delivery?
7	Please highlight the impact delays and disruptions have on the national and global dynamic environment.
8	In your opinion, how successful is the IDMS and do the above delays and disruptions have a significant impact the IDMS in the public sector construction industry?
9	**General Comments**

UKZN HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE (HSSREC)

SURVEY QUESTIONNAIRE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Title:

A Model for the Successful Completion of Public Sector Construction Projects in South Africa

This survey questionnaire comprises of 2 sections.

- Section 1 focuses on the biographical profiles of respondents which assists in the comparison of the research respondents' ratings across all biographical profiles.
- Section 2 of the survey questionnaire focuses on the factors that influence successful construction and engineering project delivery in the South African public sector.

Section 1: Biographical Profile

1. **Name:**	____________________				
2. **Age:**	____________________				
3. **Race:**	Indian	☐	White	☐	
	Colored	☐	African	☐	
	Other	☐			
4. **Gender:**	Male	☐	Female	☐	
5. **City:**	____________________				
6. **Primary Sector:**	Public	☐	Private	☐	
7. **Institution:**	____________________				
8. **Job Category:**	Developer	☐	Main Contractor	☐	
	Engineer	☐	Project Manager	☐	
	Architect	☐	Quantity Surveyor	☐	
	Other	____________________			

9. Position:

CEO	☐	Senior Manager	☐
Manager	☐	Supervisor	☐
Employee	☐	Trainee	☐
Other	________________________________		

10. Length of experience: ____

Section 2: Questions/Constructs

The following main and sub factors/latent constructs have been identified as key influencing factors that promote delays and disruptions in the construction industry. These affect the successful completion and delivery of construction and engineering projects in the South African public sector. You are required to rate the level of influence that each of the factors have on successful project delivery by using a **10-point Likert Scale** ranging from: **1 = 10% to 10 = 100%.** If you identify factors that are not listed below, please feel free them to the text box provided below.

	FACTORS INFLUENCING PROJECT DELAYS AND DISRUPTIONS OF CONSTRUCTION AND ENGINEERING PROJECTS IN THE SOUTH AFRICAN PUBLIC SECTOR	**Likert Scale - % Level of Influence**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	**Project Stakeholder Influence**										
1.1	Client Influence										
1.2	Consultant Influence										
1.3	Contractor Influence										
1.4	Public Sector Officials Influence										
2	Project Characteristics										
2.1	Project Type										
2.2	Project Scope										
2.3	Project Size										
2.4	Project Complexity										
2.5	Project Budget Size										

	FACTORS INFLUENCING PROJECT DELAYS AND DISRUPTIONS OF CONSTRUCTION AND ENGINEERING PROJECTS IN THE SOUTH AFRICAN PUBLIC SECTOR	Likert Scale - % Level of Influence									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3	**Project Challenges**										
3.1	Government Policies, Legislatures and Frameworks										
3.2	Financial Contributions										
3.3	Skills Capacity										
3.4	Socio-Economic Culture										
3.5	Stakeholder Management										
3.6	Information Technology										
3.7	Sustainability										
3.8	Industry Development										
3.9	Force Majeure										
4	**Socio-Economic Factors**										
4.1	Gross Domestic Product										
4.2	Consumer Price Index										
4.3	Gross Fixed Capital Formation										
4.4	Employment Rate										
4.5	Skills Shortage										
4.6	Poverty and Inequality										
4.7	Crime										
4.8	Social Services										
4.9	Monetary Policies										
4.10	Investor Confidence										
4.11	Fiscal Policies										
4.12	Transformation Policies										

	FACTORS INFLUENCING PROJECT DELAYS AND DISRUPTIONS OF CONSTRUCTION AND ENGINEERING PROJECTS IN THE SOUTH AFRICAN PUBLIC SECTOR	Likert Scale - % Level of Influence									
		1	2	3	4	5	6	7	8	9	10
5	**Statutory Frameworks and Legislation Factors**										
5.1	Political Policies										
5.2	Public Sector Policies and Management Systems										
5.3	Equity Policies										
5.4	Building Regulations										
5.5	Construction Contracts and Procurement Processes										
6	**National and Global Dynamic Factors**										
6.1	Global Political Dynamics										
6.2	Global Economic Trends										
6.3	National Economic Trends										
7	**Other (please specify)**										
7.1											
7.2											
8	**SUMMARY OF KEY FINDINGS**										
	Should you wish to receive a summary of the key findings of this survey questionnaire, please provide										
	your email address below:										
9	**ADDITIONAL FEEDBACK/COMMENTS**										

08 December 2020

Miss Zakheeya Armoed (208512825)
School Of Engineering
Howard College

Dear Miss Armoed,

Protocol reference number: HSSREC/00002122/2020
Project title: A model for the successful completion of public sector construction and engineering projects in South Africa
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 07 October 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL** on the following condition:

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 08 December 2021.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
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BIOGRAPHICAL SKETCH

Mrs. Zakheeya Armoed was born on May 29, 1990, in Durban, South Africa. In 2007 she matriculated with a Merit Exemption from Crossmoor Secondary School in the suburb of Chatsworth, Durban. She later went on to attend the University of Kwazulu-Natal where she completed a Bachelor of Science Honours degree in Quantity Surveying from the Department of Engineering, Agriculture and Science. In 2013, she was employed at the City of uMhlathuze and eQS Consultants as a Quantity Surveyor working with both private and public entities. This included the Department of Health, the Department of Education, AECOM, Grinaker Lta etc., to name a few. In 2017. Mrs. Armoed joined the Durban University of Technology as a Lecturer in the Faculty of Engineering and the Built Environment: Department of Construction Management and Quantity Surveying. She is actively involved in curriculum development and is a part of an international initiative known as PEESA III (Personalised Engineering Education of Southern Africa), to promote a standard of education that is in line with Industry 4.0. She has published numerous conference proceedings and is embarking on expanding her research capacity at the Durban University of Technology. Mrs. Armoed's research interests includes South African construction education and the state of the public sector construction and engineering industry. She aims to develop her academic career by publishing numerous journal papers and in improving the current state of construction education at higher education institutes.