# Quality of project documentation as a major risk source in infrastructure projects in South Africa

by
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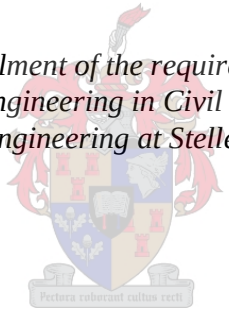


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# Declaration

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## Abstract

It is a common occurrence for infrastructure projects to exceed the planned project cost and time and clients very often provide a contingency amount to counter the effects of such eventualities. The decision to mitigate project cost escalation and time overruns through contingency allocations is often arbitrary. Furthermore, poor quality is observed in some constructed assets.

The research objective was therefore to explore the influence of quality of project documentation in the delivery of infrastructure projects in South Africa. The strategy used in the research was a literature review and two rounds of questionnaire surveys. Experts consulted in the study included clients, consultants and contractors. Overall mean scores were used to measure and rank the influencing factors.

The study explored the factors that influence project key performance indicators which lead to failure to achieve project objectives within agreed time frames, cost and quality. Respondents agree that low or inadequate professional fees is the major driving factor that limit the performance of the consultant. The research findings suggest that low professional fees have resulted in consulting engineers missing effective project management methodologies in the delivery of infrastructure projects. On account of inadequate professional fees, the findings demonstrate that this is directly linked to personnel skills, leading to failure by consultants to practice value engineering. This has led to incomplete designs, design errors, bad specifications, as well as poor constructability through poor quality of project documentation. These deficiencies have the potential of increasing project cost, time and affect the quality, and in some instances, result in structural failure and accidents. Disputes have also been recorded in the delivery of some infrastructure projects.

The quality of project documentation is therefore a major source of risk in the delivery of infrastructure projects in South Africa. Respondents support the proposals for the client organisations to limit the practice of professional fees discounting. The research further recommends a review of procurement strategies with respect to consultancy services to promote innovation in the delivery of consultancy services.

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# Opsomming

*Dit kom algemeen voor dat infrastruktuur projekte die vooraf beplande koste en tyd vir 'n bepaalde projek oorskry. Kliënte maak dikwels voorsorg hiervoor deur 'n gebeurlikheidsbedrag by die projek koste te sit. Die manier waarop die bedrag bepaal word is meeste van die tyd arbitrêr. Verder word daar in sommige gevalle swak kwaliteit waargeneem tydents projekte.*

*Die doel van die navorsing was dus om die invloed van die kwaliteit van projek dokumentasie in die lewering van infrastruktuur projekte in Suid-Afrika te ondersoek. Die navorsing is gedoen deur 'n literatuur studie en daarna vraelyste uit te stuur na kenners wat uit kliënte, konsultante en kontrakteurs bestaan. Die vraelyste is voltooi in twee rondtes, waarna invloedsfaktore op 'n ranglys geplaas is. Algehele gemiddelde tellings is gebruik om invloedsfaktore te meet en met mekaar te vergelyk.*

*Die studie het faktore ondersoek wat die oorsaak is vir die mislukking van projekte in terme van koste, kwaliteit en tyd. Respondente van die vraelyste het uitgewys dat lae professionele fooie die prestasie van die konsultant beperk. Die lae fooie veroorsaak dat konsultante nie goeie projekbestuur beginsels in die lewering van infrastruktuurprojekte toepas nie. Die bevindinge dui verder daarop dat weens lae fooie en ooreenstemmende gebrek aan vaardighede, konsultante nie daarin slaag om projekte sodanig te ontwikkel dat daar 'n optimale balans is tussen koste en waarde nie. Dit lei dan tot swak projek dokumentasie, onvoltooide ontwerpe, ontwerpsfoute, swak spesifikasies en swak boubaarheid. Hierdie aspekte kan dikwels die projek koste en tyd verhoog. Verder kan dit ook die kwaliteit en veiligheid van die projek ondermyn. Geskille word ook waargeneem tussen die partye betrokke by die lewering van sommige infrastruktuur projekte.*

*Die kwaliteit van projekdokumentasie is dus 'n groot risiko in die lewering van infrastruktuur projekte in Suid-Afrika. Respondente van die vraelyste ondersteun die konsep dat 'n beperking geplaas word op die hoeveelheid afslag wat op professionele fooie gegee kan word. Die navorsing beveel aan dat die verkrygingstrategieë waarop konsultasie dienste bekom word hersien word. Hierdie moet gedoen word ter bevordering van innovering in konsultasie dienste.*

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## Acknowledgement

I wish to acknowledge Professor Jan A Wium, whose professional and personal guidance, support, diligence and encouragement has been instrumental to the success of the study. His quest to link me with the construction industry experts in South Africa, whose contributions have been instrumental in this submission, is greatly appreciated.

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# Dedication

Dedicated to Winnie, Louis and Mervyn for their constant encouragement.

The late Kelvin J Malinda for laying the foundation stone, rest in peace.

Charles Malinda, you were an inspiration, rest in peace.

To my mother, Anna Magodi Mdeni, I say you have been a lone fighter.

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# Table of Contents

Stellenbosch University https://scholar.sun.ac.za

Stellenbosch University https://scholar.sun.ac.za

Stellenbosch University https://scholar.sun.ac.za

Stellenbosch University https://scholar.sun.ac.za

Stellenbosch University https://scholar.sun.ac.za

# List of Figures

Stellenbosch University https://scholar.sun.ac.za

Stellenbosch University https://scholar.sun.ac.za

# List of Tables

Stellenbosch University https://scholar.sun.ac.za

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# List of abbreviations

| | |
|---|---|
| AfDB | African Development Bank |
| BBBEE | Broad-Based Black Economic Empowerment |
| BOT | Build Operate and Transfer |
| CIDB | Construction Industry Development Board |
| CII | Construction Industry Indicators |
| CoST | Construction Sector Transparency Initiative |
| CPA | Country Procurement Assessment |
| DAB | Dispute Adjudication Board |
| DBB | Design Bid and Build |
| ECC | Engineering Construction Contract |
| ECSA | Engineering Council of South Africa |
| EOI | Expression of Interest |
| FIDIC | Federation Internationale des Ingenieurs Conseils |
| FIFA | International Federation of Association Football |
| GCC | General Conditions of Contract |
| ISO | International Organisation for Standardisation |
| JBCC | Joint Building Contracts Committee |
| LCB | Least Cost Based Selection |
| MDBs | Multilateral Development Banks |
| NDP | National Development Plan |
| OFID | Opec Fund for International Development |
| PIDA | Programme for Infrastructure Development in Africa |
| PMBOK | Project Management Body of Knowledge |
| QCBS | Quality and cost Based Selection |
| QBS | Quality Based Selection |

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| | |
|---|---|
| RM | Risk Management |
| RMI | Road Maintenance Initiative |
| RSA | Republic of South Africa |
| SANRAL | South African National Road Agency Limited |
| SAICE | South African Institute of Civil Engineering |
| SANS | South African National Standards |
| SCM | Supply Chain Management |
| SIPDM | Standard for Infrastructure Procurement and Delivery Management |
| TORs | Terms of Reference |
| UK | United Kingdom |
| WB | World Bank |
| www | World Wide Web |

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# Chapter 1 Introduction

## 1.1 Background

The Construction Industry Development Board (CIDB) Act No. 38 of 2000 (Republic of South Africa, 2000a) defines the construction industry as a grouping of industries and sectors which add value to the creation and maintenance of fixed assets within the built environment. Globally, the construction industry accounts for 10% of the world economy of which 70% accounts for construction in the United States of America (USA), Western Europe and Japan with the Africa region contributing only one percent (Construction Industry Development Board (CIDB), 2004a: 7). Possibly due to this imbalance, the Programme for Infrastructure Development in Africa (PIDA), estimates that Africa requires an annual investment of US$93 billion to satisfy the infrastructure demand up to 2020. This projection is made against the anticipated rural population influx to the city by 2050 (World Economic Forum, 2015: 32). The population influx is likely to put more pressure on the social and infrastructure services.

Globally, countries are striving to transform the social economic status of the populous through the provision of infrastructure (World Economic Forum, 2015). In the same pursuit, the 2016 budget review reported that South African infrastructure spending has been R496.8 billion for the last five years and R2.2 trillion between 1998 and 2015 (NationalTreasury, 2016). The question remains how the developing countries can effectively and efficiently implement the infrastructure delivery programmes if the resources were immediately available due to reported capacity constraints. Some reports have suggested that poor risk management, low professional fees and inadequacies in personnel skills threaten the implementation of infrastructure projects.

Research studies in both developed and developing countries suggest that projects have become unpredictable in terms of expected deliverables of quality infrastructure, and within time and budget. This has been aligned to lack of knowledge to adopt risk management practices (Serpella, Ferrada, Howard & Rubio, 2014; Yim, Castaneda, Doolen, Tumer & Malak, 2015). Research findings show that adoption of risk management (RM) is mostly reactive, and not systematic, due to limited resources that institutions allocate for this cause (Choudhry & Iqbal, 2013). Serpella *et al.* (2014) citing Tihidi (2011), state that RM allows risk identification, assessment of project risks and applying strategies to mitigate the impact of such risks to manageable levels. Failure to apply risk management

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in the project delivery results in time and cost overruns and often to poor quality of constructed structures, notwithstanding budgetary constraints which affect most governments.

Rivera & Kashiwagi (2016) citing the Egan's (1998) Rethinking Construction and the Latham's (1994) Constructing the team, argue that poor service delivery in the construction sector has been a common occurrence across the globe for the last three decades. Construction industry experts strive to improve the construction industry performance although such efforts have not yielded positive results due to inadequate RM practices (Zou, Zhang & Wang, 2007; Serpella *et al.*, 2014). In spite of these challenges, the construction industry remains the most important sector and plays a major role in transforming the social economic needs of society through the creation of wealth and quality of life (Ibrahim, Roy, Ahmed & Imtiaz, 2010)

Efficiency and effectiveness are essential in the delivery of infrastructure projects if the construction industry is to positively contribute to the social economic development worth to society (Construction Industry Development Board (CIDB), 2004a). In advocating such a role, the Construction Industry Development Board through Act No. 38 of 2000, regulates the construction industry in South Africa (Republic of South Africa, 2000a). This is in addition to other 80 different legislative instruments that regulate the Supply Chain Management (SCM) in South Africa (National Treasury, 2015a: 10).

## 1.2 The research project

The guide to the project management body of knowledge (PMBOK) defines a project as a "temporary endeavour undertaken to create a unique product, service or result" (Project Management Institute (PMI), 2008: 5). Hillson (2009) explains that the risk nature of projects originates from the background that each project is distinct and has facets that have not been executed before. A project is founded on notions, limitations and brings together experts with varied attributes and specialities whose differing views and expectations influence project delivery (Hillson, 2009: 11–14). RM therefore focusses on the linkages and relationships constraining effective project delivery. The factors constraining project delivery are therefore linked to key project players, labour, materials and equipment, forms of contract, contract relationships and external factors of which some are controllable while others are not (Ruqaishi & Bashir, 2014).

There has been ongoing research relating to project performance in many countries as well as in South Africa. A few of these studies have focused on key performance indicators either in isolation or in

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combination to understand the factors that impact project delivery for example, delays, cost escalation, quality, effectiveness or efficiency. This research seeks to explore the relationship and impact of project documentation by consultants in the attainment of project objectives in South Africa.

## 1.3 Preliminary review of related literature

The South African construction industry status report of 2004 reported of the adequacy of available capacity in the management of large infrastructure projects in South Africa (Construction Industry Development Board (CIDB), 2004a). In contrast to this, the 2012 budget review report (National Treasury, 2012), exposes challenges that have been acknowledged in the apparent lack of capacity where underutilisation of the provisional budgets in some sectors has been reported. Cost and time overruns, a common phenomenon in infrastructure projects globally, have also been experienced on most projects in South Africa. This trend reveals some shortcomings in the delivery of infrastructure projects in South Africa according to the 2012 budget review (National Treasury, 2012).

A successful project is defined as one that is accomplished within planned constraints of time, cost and quality is constrained within these parameters (Kerzner, 2003). William (1995) as cited by Rafindadi, Mikić, Kovačić & Cekić (2014), add that project performance should also be measured in terms of level of performance. The PMBOK considers project management as the application of knowledge, skills, tools and techniques to project activities to achieve project objectives (Project Management Institute (PMI), 2008). Failure to achieve project objectives originates from unforeseeable occurrences within the project cycle. Doloi (2013) citing Chan and Kumaraswamy (1997), explains that most risks manifest themselves during project implementation.

Risks are those situations that impact project objectives of cost, time and quality (Akintoye & MacLeod, 1997; Serpella *et al.*, 2014). Projects are subjected to risks which are often created by one project participant, and have an impact on other project participants (Hillson, 2009), and risks affect project delivery regardless of project size (Ruqaishi & Bashir, 2014).

Studies have been carried out on the performance of the construction industry covering several aspects of the KPIs. Research studies have explored aspects such as project delays (Sambasivan & Soon, 2007; Fallahnejad, 2013; Ruqaishi & Bashir, 2014). Others have focussed on project cost overruns (Doloi, 2013; Winch, 2013; Cheng, 2014; Rosenfeld, 2014; Shehu, Endut, Akintoye & Holt, 2014).

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Other studies have examined both causes of delay and cost overruns (Yakubu & Sun, 2010). Some studies have examined both causes and the effects of project delays while some studies have focussed on project risks in general (Z*t al.*, 2007; Zou, Kumaraswamy, Chung & Wong, 2014; Wang & Yuan, 2011; Mahamid, 2013; Perlman, Sacks & Barak, 2014; Baghdadi & Kishk, 2015; Os, Berkel, Gilder, Dyck, Groenewegen, Van Os, Berkel, Gilder, Dyck & Groenewegen, 2015). Some research papers have also discussed project management and project success (Alexandrova & Ivanova, 2012; Carvalho, Patah & de Souza Bido, 2015; Joslin & Müller, 2015; Todorović, Petrović, Mihić, Obradović & Bushuyev, 2015).

Sambasivan & Soon (2007) focused on mitigation strategies to project risks, that can be instituted to minimize the severity of their impacts. Other research findings suggest that the key project players impact the implementation of infrastructure projects (Mbachu & Nkado, 2007; Jerling, 2009). Mbachu & Nkado (2007) argue that client organisations influence project characteristics. The CIDB report on construction quality in South Africa from the client perspective, reported that public sector clients recorded 20% dissatisfaction on projects that were completed with 12% of them having inappropriate defects (Construction Industry Development Board (CIDB), 2011). The report suggested that more attention should be focused on the consulting engineer if construction quality is to be realised (Construction Industry Development Board (CIDB), 2011). Results of the CIDB survey in 2014 showed 74% satisfaction with consultants and the quality of project documentation (Marx, 2014). It is also argued that professional fees discounting can result into poor quality of design and documentation, inability to perform value engineering by consultants, inadequate quality control systems and unethical practices (Okonkwo, 2014).

However, the effect of the quality of documentation by consultants, as a major risk source in the delivery of infrastructure projects delivery, has not been conclusively researched in South Africa. Most of the studies have focused on the influencing factors at the project implementation phase.

## 1.4 Problem statement

Traditionally, the consulting engineer forms a link between the contractor and the client in the delivery of infrastructure projects. Exploring the role of the consulting engineer, the project documentation by consultants, and the risks impacted by project documentation on other project players in the delivery of their services, is the focus and motivation for this study.

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The research therefore seeks to answer the following questions:

(i) Does the quality of project documentation by a consultant influence project cost, time and quality of constructed assets?

(ii) Is quality of project documentation by the consultant significantly influenced by the quality of skills and technical capacity of the consultant personnel?

(iii) Are there any mitigation strategies that could be adopted to reduce the impact and severity of risks impacted by the quality of project documentation?

## 1.5 The research aims and Objective

Technological advances in the construction sector have come with the emergence of modern design software, modern and more accurate survey equipment, drafting software, project monitoring tools and availability of modern and efficient construction equipment and Building Information Modelling (BIM). Such innovations have been modelled to improve efficiency in the implementation of infrastructure projects. However, despite all the innovations, documented studies and reports inform that projects are still exposed to more risks in achieving project goals. These documented reports show that there is a global trend in increased poor performance in the attainment of quality, cost and time in infrastructure projects and not only in South Africa.

Studies have also shown that the traditional project delivery approach is mostly used for project delivery by public sector clients in South Africa. This strategy assumes that the consultants are engaged to undertake detailed designs prior to engagement of a contractor. At the time of launch of tenders, it is also assumed that the client or client representative has prepared comprehensive project documentation that forms the basis of tenders in the execution of a project. This relationship is presented in Figure 1.1.

This research examines the relationships exhibited in Figure 1.1 with a focus on project documentation by the consultants in the delivery of infrastructure projects. The research theorises that there are inherent risks associated with project documentation that impact on the delivery of infrastructure projects in South Africa.

The aim of the research is therefore to explore the association and impact of project documentation in the implementation of infrastructure project in South Africa. In an attempt to ascertain the

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overriding risks impacted by quality of project documentation, the objectives of the research are set to undertake some tasks which address the following salient aspects:

(i) Factors that define the quality of project documentation produced by consultants and their associated risks in the life cycle of a project.

(ii) Factors influencing the quality of project documentation as produced by consulting engineers in infrastructure projects.

(iii) The impact and the interdependencies between the quality of project documentation and project outcomes.

(iv) Mitigation strategies that the South African construction industry could adopt to minimize the impact of the identified risks related to project documentation.

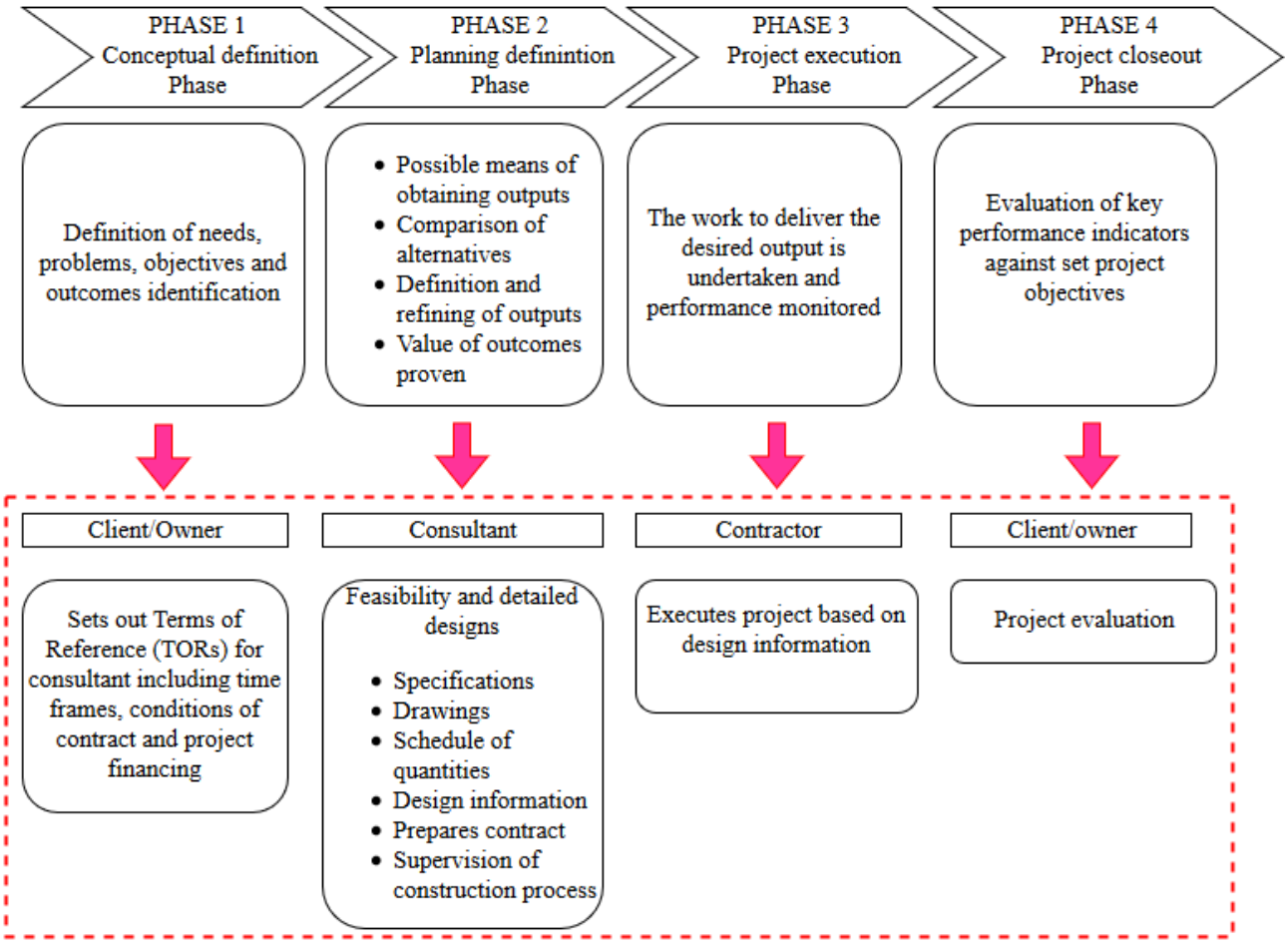


Figure 1.1 Relationships of key project participants in infrastructure delivery

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## 1.6 The research design

The research project included an extensive literature review of current consultancy service practices and general construction industry trends in South Africa and previous research on the subject. Based on the literature study, a structured questionnaire was developed to collect the data, and two rounds of questionnaire surveys were performed. The first round of the questionnaire provided feedback to respondents of the first round findings, with the second round providing a platform for respondents to comment and suggest proposals to the findings in the first round. Respondents were professionals in client, contractor and consultant organisations in civil engineering, building or multidisciplinary organisations in South Africa. Quantitative and qualitative data was generated in both questionnaires. Descriptive analysis was used with the assistance of Statistica V13 statistical software and MS Excel.

## 1.7 Assumptions and limitations

While the research explored the quality of documentation by consultants in the construction industry, the focus was on civil and building engineering disciplines of the built environment. Referenced projects were those undertaken within the last five years. In recognition that creation and implementation of projects require multiple stakeholder involvement, respondents consulted in the questionnaire survey included clients, contractors and consultants. The other aspects that were considered in the research are:

(i) The traditional project delivery approach, design-bid -build was assumed.

(ii) Procurement strategy and award of consultancy services contracts as governed by public sector regulations of the Republic of South Africa.

(iii) The legal framework governed by the constitution of South Africa and existing institutions have been referenced as a guide in the management of public infrastructure in South Africa.

(iv) Factors influencing project delivery are limited to those attributed to project documentation consultants.

## 1.8 Research outline

The research report is presented in six chapters which are outlined below.

Chapter One sets the background to the research. It presents the general overview of the global and local construction industry perspectives. The research problem and statement are introduced and introduces theoretical considerations and main concepts: risks, project documentation, measure of

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project performance and it further introduces project Key Performance Indicators (KPIs). The chapter sets the outline and framework of the research.

Chapter Two provides a summary of literature consulted in the study. An overview of global construction industry performance is discussed focussing on variables that impact project delivery. Main project key influencing factors that impact project KPI's were examined while drawing on project delivery relationships. International best procurement practices for the selection of consulting services are discussed in contrast to those in South Africa, focussing on legislation and procurement strategies. Specifically, procurement practices for consulting services by the World Bank(WB) are further examined with respect to the trends in South Africa.

Chapter Three outlines the methods that the research used to execute the tasks to understand constraints influencing project delivery. The research strategy is explained by defining the strategy, data collection, data analysis, limitations and ethical consideration.

Chapter Four presents the method and results of the first round of the questionnaire survey. A descriptive analysis of results is done using tables, graphs, mean scores (MS) and overall mean scores (OMS) to measure the perception of construction industry experts.

Chapter Five presents results of the second round of the questionnaire survey. Based on the first round of the questionnaire survey, findings were presented as feedback to respondents. Comments from the respondents and based on the results of the first round, mitigation strategies are developed to counter the influencing factors limiting the quality of project documentation.

Chapter Six presents conclusions and recommendations derived from the research.

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# Chapter 2 Literature review

The chapter presents a review of the research studies in the delivery of infrastructure projects in pursuit of understanding the challenges, focusing on the theory and on published relevant literature that is applicable for this study. This is consistent with the definition of literature review as defined by Zikmund, Babin, Carr & Griffin (2010: 65). Main precepts, themes and conclusions of the literature study are provided in this chapter, drawing attention to the assumptions, methodologies, analyses and correlations in the previous studies and how they relate to quality of documentation and infrastructure projects in South Africa.

There is a rich database and a collection of papers available in the literature on the general performance of the construction industry with regards to attainment of project key performance indicators. Rivera & Kashiwagi (2016) citing the Egan's Rethinking Construction and the Latham's Constructing the team, report that global poor delivery of infrastructure projects for the last three decades is reliably documented. They further mention that studies have not provided tangible solutions to change the trend in the delivery of infrastructure projects, despite volumes of research on the subject. The focus in these papers is on factors influencing poor project performance that prevails in infrastructure projects in terms of timely delivery, implementation within budget and acceptable quality. Cost overruns and time overruns are the risks that influence the project performance. Parties involved and the technical communication have been cited as barriers to identifying sources of inefficiencies in the delivery of infrastructure projects (Rivera & Kashiwagi, 2016).

The diverse number of experts involved in the delivery of infrastructure projects has been noted as one of the barriers to identifying sources of inefficiencies as explained by Rivera & Kashiwagi (2016). The present review was therefore limited to quality of project documentation by consultants. The review sought to examine the combined effect of influencing factors which directly or indirectly impact on the final project delivery in terms of quality, cost and time. While focussing on project documentation, the review sought to learn from global construction industry trends in comparison to that of South Africa.

The chapter is divided into five main sections focussing of construction industry performance and the discussion of the literature is guided by Figure 2.1.

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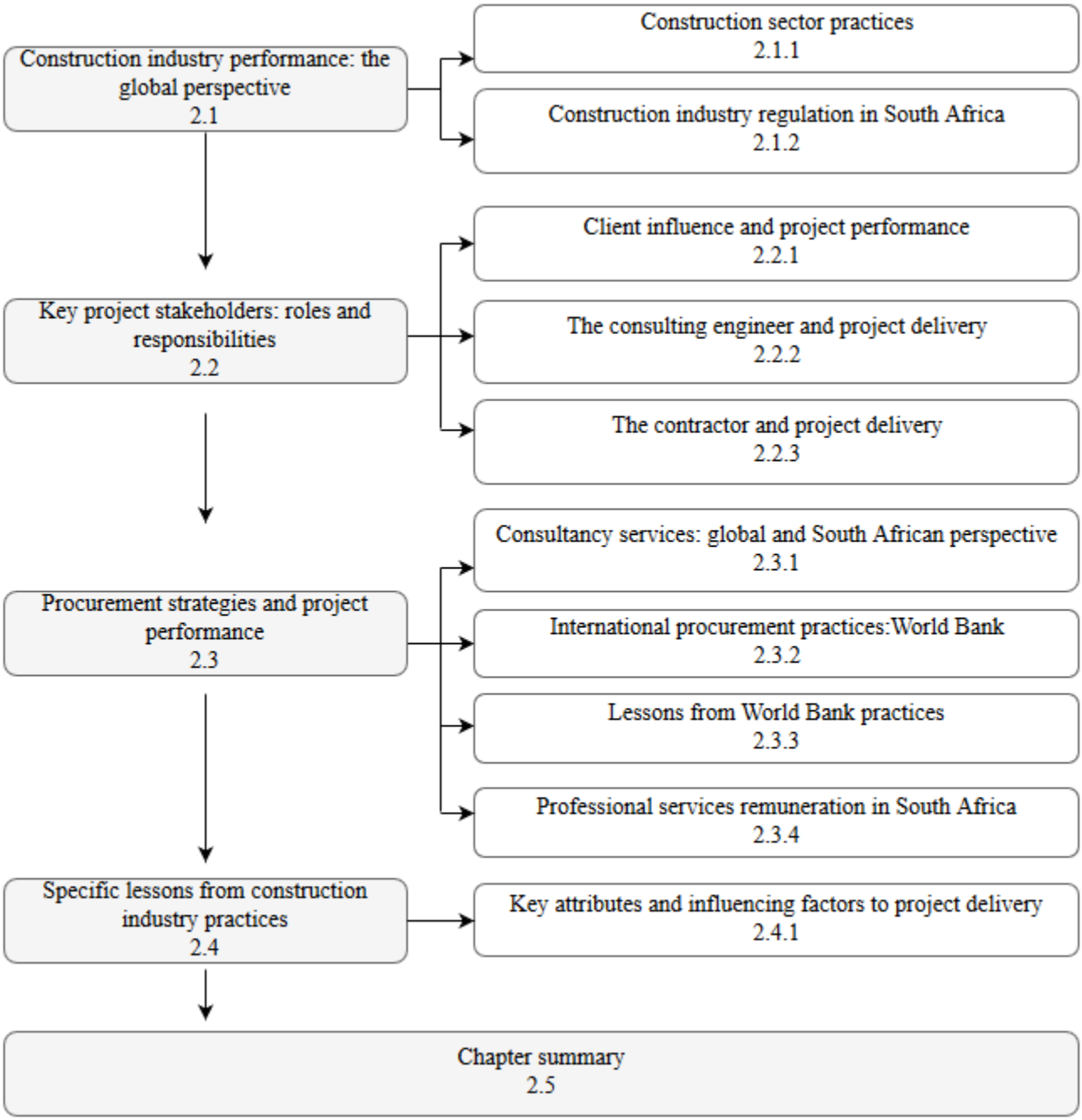


Figure 2.1 Presentation of literature review

The review explored factors that define the quality of project documentation and the risks that are impacted by project documentation. Factors influencing the quality of project documentation were examined in relation to consultancy services, and the relationships that exist between project documentation and project outcomes. The review further focussed on development of mitigation strategies to improve service delivery by consultants in South Africa, through improved quality of project documentation.

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## 2.1 The construction industry performance: the global perspective

The complexities in infrastructure projects, which arise from the involvement of several specialists, who are assembled within a defined space of time to achieve a particular project objective, highlight and explain the risk exposures to project objectives (Hillson, 2009; Rivera & Kashiwagi, 2016). Parameters that define success of a project are traditionally entrenched in time, cost and quality (Toor & Ogunlana, 2010). Unfortunately, the construction industry has traditionally performed poorly with respect to these aspects. Research on construction industry performance has revealed poor project delivery in terms of cost and time and this also extends to lack of efficiency and effectiveness as attested by Eriksson & Westerberg (2011 citing Egan, 1998; SOU, 2000; Yasamis et al., 2002; Chan et al., 2003).

Unlike in the manufacturing industry, the unique nature of processes involved in the delivery of infrastructure projects lies in the concept of creation of a new product and also in the failure to replicate a project for another identical project location (Hillson, 2009: 14). Much as a design for a particular project could be replicated, success for such a project still requires specialist engineering input prior to commencement and throughout the rest of the project implementation phases (Lock, 2007: 5). Project resource inputs may not be identical either, and therefore each project requires expert input to properly define the scope and time of delivery against project goals and objectives (Hillson, 2009: 14).

Due to the large capital outlays involved in the creation of infrastructure assets, the construction industry draws significant attention from the public. However, the construction sector has failed to perform to the satisfaction of the stakeholders despite innovations and research in the sector (Mbachu & Nkado, 2007; Rivera & Kashiwagi, 2016). Projects are seldom delivered on time and within provisional budgets. Although cost and time are the most conspicuous and common project KPIs, quality which is another important attribute, has also been at the centre of discussion. There has been perceived discontent among stakeholders in the quality of some constructed infrastructure assets.

In addition to increased public awareness in the delivery of project objectives, the Construction Sector Transparency Initiative (CoST) was launched in 2008. CoST purports to ensure that projects are executed at low cost or within budget and with increased predictability of project outcomes. Although the initiative has only 16 countries globally committed to the CoST charter, it may suggest the global

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perception of the lack of trust of stakeholders in the construction industry with respect to predicting the final project cost (Construction Sector Transparency Initiative (CoST), 2015).

Threats to project deliverables impact on all project players (Jerling, 2009). Conventionally, projects have been implemented by a project team comprising the client, consultant and the contractor and this type of association has been observed to promote adversarial relationship by scholars and construction industry experts. In South Africa, poor performance in the construction industry, has been reported and discussed in several papers (Construction Industry Development Board (CIDB), 2004a, 2011; Mbachu & Nkado, 2007; Jerling, 2009; Emuze & Smallwood, 2011, 2013; Marx, 2014; Okonkwo, 2014). The papers put into perspective the performance of the construction industry and the associated perceived risks prevailing in the South African Construction sector.

The 2011 CIDB discussion document on construction quality in South Africa from a client perspective, citing FIDIC, explains that:

> "Lack of quality in construction projects is exhibited in poor or non-sustainable workmanship, unsafe structures and in delays, cost overruns and disputes in construction contracts." (Construction Industry Development Board (CIDB), 2011).

Hillson (2009: 52), further explains that quality is manifested by the failure of construction project teams to minimise the impact of project risks. Main drivers to construction risks in the project delivery have been observed to arise from actions of the key project participants, namely, the client, the consultant and the contractor. The research in this study therefore explored the risks that are impacted by project documentation in the delivery of infrastructure projects. Through the understanding of the roles and responsibilities of key project participants, the legislative requirements and procurement strategies, the research seeks to understand how these factors influence project documentation in the delivery of infrastructure projects.

### 2.1.1 Construction sector practices and project performance

Project performance is influenced by several external factors which include resource allocation, efficiency and effectiveness, regulatory sector institutions, and key project players (Zavadskas, Vilutienė, Turskis & Šaparauskas, 2014). Adequate financing in the construction sector for instance, spurs participation and growth and may impact on profitability. Increased profits could stimulate efficiency and effectiveness in the implementation of infrastructure projects through increased value

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engineering. Legislation and regulations create an enabling operating framework through the provision of rules and procedures.

It is therefore the role of project management to ensure that infrastructure projects are executed to the satisfaction of all stakeholders through an effective risk management process (Project Management Institute (PMI), 2008). Fulford & Standing, (2014) contend that the construction industry poor performance emanates from lack of collaboration for shared values, inability to practice value engineering and lifecycle costing, and lack of use of standardised information. Lack of early involvement of the contractor in the delivery of infrastructure projects has been cited as impacting project delivery (Eriksson & Westerberg, 2011; Chartered Institute of Building (CIOB), 2014; Watermeyer & Laryea, 2014; Low, Sui Pheng & Lin, 2015; Laryea & Watermeyer, 2016).

The next section explores and discusses inherent risks in construction projects and how they impact project delivery.

#### 2.1.1.1 Risks in construction projects

A risk is defined as an uncertainty that if it occurs it will affect the achievement of project objectives and comprise of two dimensions; uncertainty and its potential impact on the project objectives (Smith, Merna & Jobling, 2006). Bunni (1997: 95) quoting the British Standard No. 4778: Section 3.9:1991; defines a risk as a combination of probability and the magnitude of the consequences of the occurrence. Rafindadi *et al.*(2014) explain that a risk could have both positive and negative influence on project objectives, hence effective risk management enhances chances of project success through exploitation of the positive risk attributes as explained by Hillson (2009: 21). Hazard is defined as a situation that could occur during the lifetime of a project which has the potential for human injury, damage to property, the environment, or economic loss (Goh & Chua, 2010). Risks are inherent in all construction works regardless of project size and complexity, although it is perceived that small projects are more susceptible to construction risks (Hwang, Zhao & Toh, 2014).

Failure to define construction risks which are aligned to project objectives at an early stage result in failure to undertake risk management effectively (Zou *et al.*, 2007). Development of a risk management plan benefits project participants to think innovatively and plan for successful implementation of the project (Zou *et al.*, 2007). The unique nature of construction projects puts projects to more risk than other industries (Flanagan & Norman, 1993: 1–2). However, other scholars

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share the opinion that unavailability of appropriate tools limit early application of risk management techniques (Yim *et al.*, 2015).

Risk management entails the planning, identification, analysis, response planning, monitoring and control (Project Management Institute (PMI), 2008). Fan, Li & Zhang (2015) citing Zou, Zhang, & Wang (2007), state that risk response strategies can be developed and adopted through prior risk identification and risk analysis. Risk Management involves the processes of identifying factors that are likely to impact project objectives, quantifying the likely impacts and enables planning for strategies to reduce or avoid the risks (Wideman, 1992; Fan *et al.*, 2015). It is therefore appropriate that a review of the risk influencing factors is done thoroughly to ascertain the likelihood of the risk events and the severity of their impact. It is recognised that risks have a dynamic nature making it a tedious exercise as explained in CIDB Best Practice Guideline #A5, managing construction procurement risks (Construction Industry Development Board (CIDB), 2004b). Zou *et al.* (2007) observed that most projects in the Chinese construction industry are exposed to risks due to lack of proper project management and proposed the Build Operate Transfer (BOT) procurement model as a solution to the persistent challenges.

As highlighted in the preceding paragraph, risk management calls for a systematic way of identifying factors that can impact on project objectives. Therefore, in understanding the risk management process, it is necessary to recognise and explore some concepts in the project life cycle. These are discussed in the next section.

#### 2.1.1.2 Project deliverables and project life cycle

Prior understanding of the project life cycle, roles of the key project participants, the procurement processes and strategies and the forms of contracts adopted on a project, assisted in building the relationships that exist in the construction processes. A project life cycle generally follows through project inception, organizing and preparing, project execution and close out phase as presented in Figure 2.2.

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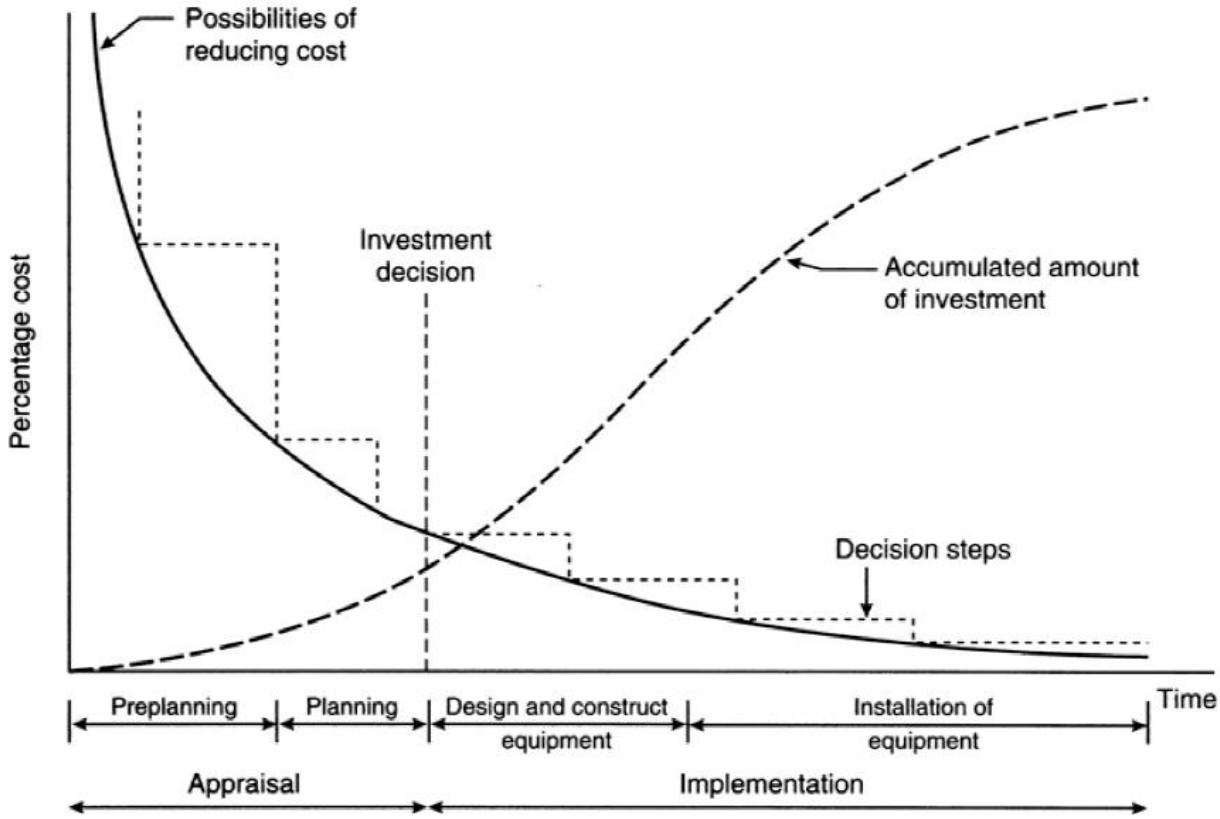


Figure 2.2 Action of stakeholders in project life cycle and project delivery (Jerling (2009)

Project characteristics as presented in Figure 2.2 demonstrate that influencing characteristics of the final project scope without significantly impacting on cost, is relatively easy at the start of the project and decreases with time and across the rest of the project phases (Project Management Institute (PMI), 2008; Jerling, 2009). There is a widespread perception in the construction industry that cost performance on a project is attributed to the performance of contractors alone (Doloi, 2013). Rivera & Kashiwagi (2016) citing Rijt and Witteveen (2011) explain that a construction risk is mitigated effectively through collaboration of all key project stakeholders at the start of the project. This comes against the background that the measure of project success is clearly realised at the implementation stage. Project delivery is attained through a series of decisions made throughout the project life cycle. The planning and design phases form the basis for most of the decisions which impact on project objectives and influence constructability as presented in Figure 2.2.

The next section discusses the construction industry regulation in South Africa.

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### 2.1.2 Construction Industry regulation in South Africa

The 2030 National Development Plan of South Africa recognises infrastructure as a basis for social and economic development to support economic growth (National Planning Commission, 2011: 160–196). The focus in the strategic plan is to enhance regulation and planning to maintain this objective and to expand and maintain effectiveness of the construction industry. Public infrastructure in South Africa is managed by state departments which are already constrained by inadequate investment, leaving some infrastructure in a state of disrepair as reported by SAICE in the infrastructure report card for South Africa 2011 (South African Institution of Civil Engineering (SAICE), 2011). This agrees with Patanakul, Kwak, Zwikael & Liu (2016) citing Chih and Zwikael (2015), and note that it is a global trend where most governments struggle with restricted budgets in their review of performance of 39 government project in United States of America (USA) and the United Kingdom (UK). The Consulting Engineers South Africa (CESA) CEO, Walley Mayne in 2014 highlighted similar sentiments and suggested greater private sector participation and implored upon government to create an enabling environment for the private sector involvement in infrastructure delivery (Consulting Engineers South Africa (CESA), 2014). The Road Maintenance Studies (RMI) studies noting the investment challenges in infrastructure delivery, recognised the need for governments to solicit alternative sources of infrastructure financing (World Bank, 1991a).

Umar *et al.*(2013) citing World Bank recommendations of 2007, state that investments in infrastructure of more than 7% of the GDP is adequate to stimulate sustainable growth. In South Africa, the 2012 budget review reported that capital investment in infrastructure of up to 25% of the GDP is required for a substantial rise in per capita income (National Treasury, 2012). However, in South Africa, capital investment in infrastructure in 2010 was 19.6% of which 7.4% was public sector investment (National Treasury, 2012: 92). The South African 2015 budget provision prioritises spending on economic infrastructure to improve quality of infrastructure spending (National Treasury, 2015b). This is an indication that the South African construction industry is founded on a solid platform which confirms the 2004 construction industry status report that South Africa has the capacity to implement projects of higher magnitude and complexity.

The 2012 South African budget review also outlined the impact of skills shortage on planning, procurement, design, construction and maintenance and the practice of not charging the true value of the economic cost of infrastructure (National Treasury, 2012). The industry however, employs a substantial number of experts as shown in Figure 2.3 and there has been a significant rise in the

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numbers since the 2010 International Federation of Association Football (FIFA) World Cup. This may also confirm the construction industry's contribution to the social economic development in South Africa.


Figure 2.3 Number of employees in the construction industry (in '000) (PricewaterhouseCoopers (PwC), 2013)

### 2.1.2.1 Construction operating framework and registration

The relevant regulatory institutions in South Africa classify contractors and consultants into distinct subsets with each category satisfying some minimum requirements which define the level of competency of a cluster. The CESA grading of consultants takes cognisance of specialisations or skills, size in terms of average annual turnover and the capability to implement quality management system (Consulting Engineers South Africa (CESA), 2016). The annual turnover separates consultants into small, medium and large firms. There are 28 specialist consulting engineering groups registered with CESA and those applicable for the study are firms in the building, civil engineering, structural engineering, architectural engineering, transportation and project management. Contractors are also graded in various categories as regulated by the CIDB. They comprise of Civil Engineering (CE), Electrical Engineering (EB) building, Electrical Engineering (EP) infrastructure, General Building (GB), Mechanical Engineering (ME) and Special Works (SW) (Construction Industry Development Board (CIDB), 2016). Contractors that were applicable for the study were those in the general building (GB) and civil engineering (CE).

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#### 2.1.2.2 South African construction industry legislation and institutions

The South African built environment operates under the Council for the Built Environment (CBE) established by Act 43 of 2000 (Republic of South Africa, 2000b). Act 38 of 2000 led to the establishment of the CIDB, which focusses on providing a regulatory and developmental framework through the promotion of the code of conduct for the construction industry. The CIDB promotes the contribution of the construction industry in meeting national construction demand and in advancing national, social and economic development objectives. The CIDB further promotes the construction industry performance, for improved efficiency, competitiveness and improved value to clients.

The South African construction industry has a long history of available legislation and statutes which govern documentation, procurement, contract administration practices and procedures even dating back to 1996 (Ofori, Hindle & Hugo, 1996). In addition to the CIDB, other institutions include the Engineering Council of South Africa (ECSA), Consulting Engineers South Africa (CESA) and South African Institution of Civil Engineers (SAICE). These institutions originate from the realisation that provision and availability of quality infrastructure can offer solutions resulting from the many challenges specifically with the rapid urbanisation in most developing economies (World Economic Forum, 2015: 32).

There are statutes and regulations that provide guidance and regulatory framework in the construction industry in South Africa. The Acts and statutes are founded on Section 217 of the Constitution of the Republic of South Africa (Republic of South Africa, 1999), which proposes that procurement should be fair, equitable, transparent, competitive and cost effective. Some acts and guidelines, which are relevant to the current study are provided in Table 2.1 and Table 2.2. Notwithstanding the available legislation and regulatory framework in place, the construction industry in South Africa has recorded high construction failure rates with constraints emanating from capacity related issues (Construction Industry Development Board (CIDB), 2004a). Quality of constructed assets was singled out as an area of concern in South Africa with escalating dissatisfaction in quality of infrastructure in the residential building sector (Construction Industry Development Board (CIDB), 2011). In consequence, the banking sector put in place tighter controls for access to guarantees under the presumption of high risks in the construction industry (Construction Industry Development Board (CIDB), 2004a).

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Table 2.1 Legislation of Acts in infrastructure delivery in South Africa

| Legislation | Description of institution |
|---|---|
| Act No. 108 of 1996 | Constitution of the Republic of South Africa Section 217 |
| Act No. 43 of 2000 | Council for the Built Environment |
| Act No 38 of 2000 | Construction Industry Development Board |
| Act No. 5 of 2000 | Preferential Procurement Policy Framework Act (PPPFA) |
| Act No. 53 of 2000 | Broad Based Black Economic Empowerment |
| Act No. 1 of 1999 | Public Finance Management Act |
| Act No. 56 of 2003 | Municipal Finance Management Act |
| Act No. 5 of 2000 | Preferential Procurement Policy Framework Act |
| Act No. 53 of 2004 | Broad Based Black Economic Empowerment Act |
| Act, No. 7 of 1998 | The South African National Roads Agency Limited and National Roads Act |
| Act No. 56 of 2000, Vol 606 of December 2015 | Guideline for services and processes for estimating fees for persons registered in terms of the Engineering Profession Act |

Table 2.2 Guidelines for infrastructure delivery in South Africa

| Guideline | Description of service |
|---|---|
| CIDB, 2004 | Managing construction procurement risks |
| CIDB, 2005 | Best practices guideline for preparing procurement documents |
| CIDB, 2005 | Best practices guideline for preparing procurement documents |
| CIDB 2005 | Choosing an appropriate form of contract for engineering and construction works |
| CIDB, 2007 | Procurement of professional services |
| CIDB, 2008 | Evaluation of tenders |
| CESA, 2011 | Procurement Guideline for Consulting Engineering Services |
| SANRAL, 2012 | Procedures manual |
| CIDB, 2015 | The standard for uniformity in construction procurement |
| National Treasury, 2015 | Supply Chain Management (SCM) policy |
| SANS 10845-1:2015 | South African National Standard: Construction procurement: Part 1: Processes, methods and procedures |
| National Treasury, 2015 | Standard for Infrastructure Procurement and Delivery Management |

The review of the available legislation has shown that South Africa has made adequate provisions to guide institutions in the delivery of infrastructure projects. One of the guidelines in the National Development plan (NDP) document calls for enhanced quality of planning, procurement systems and competition to enable timely delivery of public investments and in the right quantity and at the right price (National Planning Commission, 2011: 27). However, the enactment of the Standard for Infrastructure Procurement and Delivery Management (SIPDM) in July 2016, has been applauded as an initiative that is likely to enhance project delivery by construction industry regulators e.g. SAICE, CESA, South African Forum of Civil Engineering Contractors (SAFCEC), Institute of Municipal

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Engineering of Southern Africa (IMESA) and the South African Institute of Electrical Engineers (SAIEE) (South African Institution of Civil Engineering (SAICE), 2016).

CESA recognises that the SIPDM will enhance delivery of infrastructure in South Africa and more notably, the separation of infrastructure procurement from ordinary procurement. The other notable contributions observed by CESA include emphasis on good quality delivery, improved project planning and preliminary documentation, framework contracts and increased infrastructure spending (South African Institution of Civil Engineering (SAICE), 2016).

#### 2.1.2.3 South African infrastructure investment trends

The construction sector experienced improved investment in infrastructure spending in the years leading to the 2010 FIFA World Cup and the trend has steadily increased as highlighted in the 2012 budget review as presented in Figure 2.4 (National Treasury, 2012).

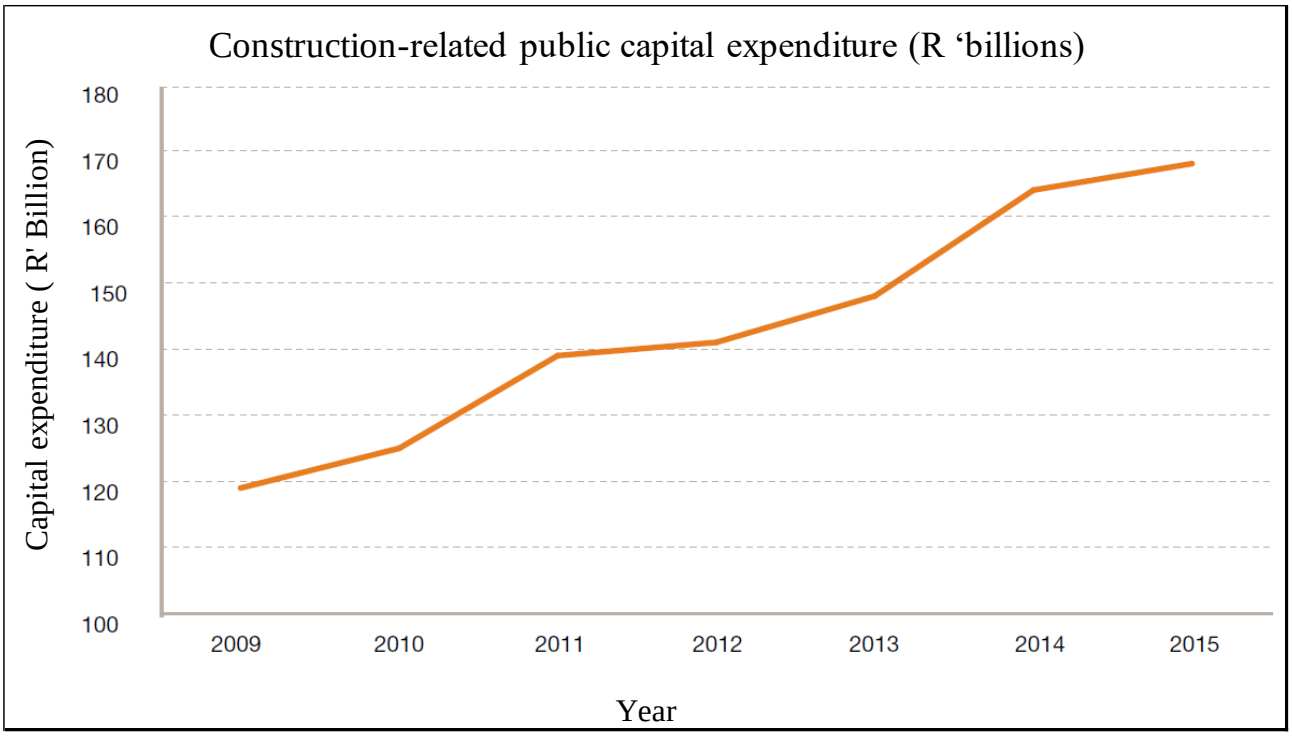


Figure 2.4 Capital investment expenditure in infrastructure (PricewaterhouseCoopers (PwC), 2013)

The current trend in infrastructure spending shows positive projected increase in infrastructure investment (Figure 2.4). Government published reports indicate that infrastructure spending has been R496.8 billion for the last five years and R2.2 trillion between 1998 and 2015, which demonstrates

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the Government commitment to infrastructure development (NationalTreasury, 2016). The construction industry is yet given another picture. Times Media Group reported "*nowhere left to hide for construction sector as money runs out"* (Barron, 2015). The article quoted Elsie Snyman, Chief Executive Officer of Construction Intelligence Analyst and alleges that the construction industry in South Africa is rocked with inadequate government financing (Barron, 2015).

#### 2.1.2.4 Public sector capacity and project delivery

However, based on the construction industry status reports, it is apparent that construction industry performance in South Africa has been somehow dismal in the attainment of project objectives of time, cost and quality in some sectors. Notable challenges reported in the construction industry in South Africa include client generated risks (Jerling, 2009; Okonkwo, 2014), lack of project delivery management skills in the public sector institutions (Construction Industry Development Board (CIDB), 2004a, 2011, Emuze & Smallwood, 2012, 2013; Marx, 2014), and Mbachu & Nkado (2007) reveal that 67% of failures experienced in the sector are attributed to controllable factors.

In 2006, the civil engineering bulletin reported of the struggles that many firms were going through in recruiting skilled technical personnel (Construction Industry Development Board (CIDB), 2007a). The CIDB report indicated that the bulletin had suggested increased incentives in the industry by government and professional associations as a solution to the skills shortage (Construction Industry Development Board (CIDB), 2007a). However, the South African 2012 budget review still highlighted the perceived lack of sufficient skills in engineering and project management, despite showing positive trends from the 2006 performance analysis of the construction sector. This recurrent problem is manifested by reported underspending of approximately 68% of the budgetary allocations in other sectors. The report summarizes the finding of SAICE of 2011, which confirms the limitations in skills availability which eventually impact on planning, procurement, design, construction and maintenance (National Treasury, 2012).

The South African construction industry has experienced high failure rates which are more notable in emerging contractors and this is considered a threat to sustainable construction industry growth (Construction Industry Development Board (CIDB), 2004a). The CIDB report in 2011, revealed that 20% of projects surveyed were not satisfactory of which 12% had inappropriate defects (Construction Industry Development Board (CIDB), 2011). The current fee based system has been perceived as a deterrent to innovation in the delivery of value to clients since it puts pressure on work produced by

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consultants who align their services to the price and mostly in the absence of well detailed project brief (Construction Industry Development Board (CIDB), 2011). The overall findings in the 2014 construction industry survey, showed that contractors were dissatisfied with the employer and employer's agents in the administration of tender documents and specifications and management of variation orders and claims (Marx, 2014). The CIDB 2014 survey recommendations adopted the KPIs and the strategies that were proposed for adoption were:

(a) Proving institutions with a simple method of establishing a performance measuring system.
(b) Providing organisations with a straight forward method of benchmarking their performance against others in the construction industry.
(c) To track long term trends in performance and specifically to demonstrate whether the construction industry was achieving the targets set out in the rethinking construction.

The next section discusses roles and responsibilities of key project stakeholders in the delivery of infrastructure projects.

## 2.2 Key project stakeholders: roles and responsibilities

Project delivery involves a shared participation of key stakeholders who are directly or indirectly responsible for the inconsistencies in the delivery of infrastructure projects (Mbachu & Nkado, 2007). Governments are the main sponsor of public infrastructure in most countries and they are equally mandated to ensure adherence to quality requirements in the delivery of these infrastructure projects (Umar *et al.*, 2013). Governments address societal needs through the provision of infrastructure (Umar *et al.*, 2013). However, studies show that the provision of infrastructure remains a challenge and has been inconsistent, and constrained in lack of efficiency and effectiveness as most projects are seldom delivered within budget and time (Liu, Love, Smith, Matthews & Sing, 2016).

Funds identification, appointment of the right project implementation team, use of appropriate contract terms and conditions and the procurement strategy have an effect in the overall project delivery. The reliability of project documentation prepared by the design team, the level of supervision and the regulatory framework within which projects are implemented, collectively impact on project performance. Figure 2.5 shows a typical project implementation structure which shows the interface that exists between various project stakeholders that influence success of a project.

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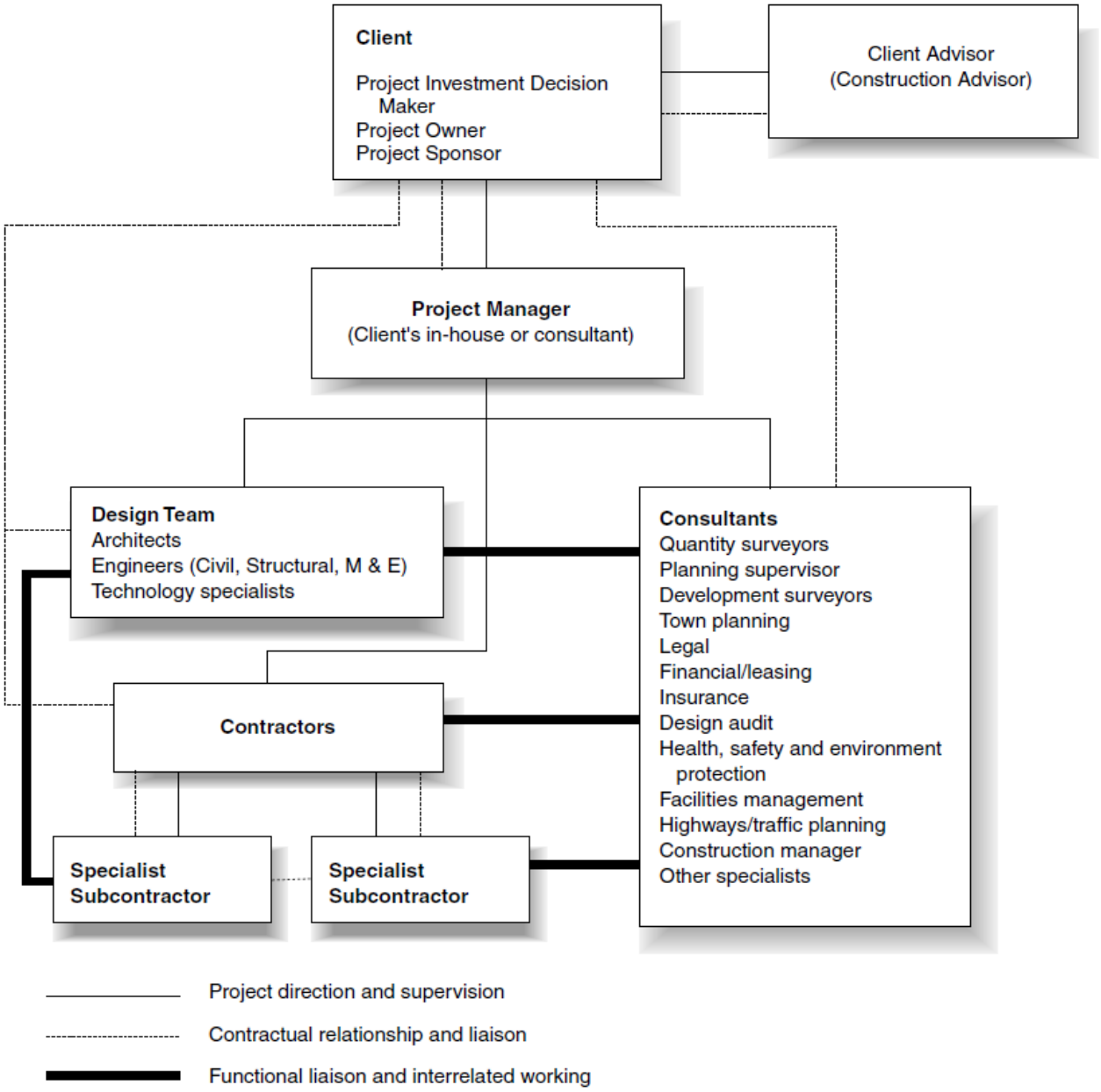


Figure 2.5 Typical project implementation structure (Chartered Institute of Building (CIOB), 2014: 87)

The role and influence of key project participants on project performance is discussed in the next section.

### 2.2.1 Client and project performance

The 2004 South African construction industry status report explains that clients and the procurement strategies adopted regulate the construction industry behaviour, performance and transformation (Construction Industry Development Board (CIDB), 2004a: 18). Bunni (1997) defines the client as the employer and the party that decides the implementation and sponsoring of the works, and assumes that the employer has selected a suitably qualified contractor (FIDIC, 2009). The client is also

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perceived as the institution which is ultimately accountable for the delivery of services through their organizational strategy, services and delivery plans and annual performance plans (Western Cape Provincial Treasury, 2012; Kilinc, Basak & Yitmen, 2015; Republic of South Africa, 2015).

The goals and objectives of the client are set on a premise of assumptions which include a predetermined budget, defined scope and quality attributes. In attaining the project goals and objectives, clients involve consulting engineers, who in some cases are seldom involved at project conception; with the contractor coming even much later in the project cycle. The involvement of the contractor at the execution phase only, limits the effectiveness of the contractor in reducing project risks and uncertainties (Jerling, 2009). This has been the trend with the traditional model of contract strategy. The client therefore needs prior understanding and expertise of project characteristics and technical capacity in the determination of project deliverables, through adoption of appropriate contract strategy.

#### 2.2.1.1 Client influence, risk allocation and project delivery

Jerling (2009) citing Flanagan & Norman, (1993) illustrates that risk identification, analysis and apportioning of construction risks should be done openly and professionally. The New Engineering Contract (NEC) form of contract has been perceived to provide for this type of risks management (Wright & Fergusson, 2009). Wright & Fergusson (2009) citing Broome and Hayes (1997), advocate that the clarity of NEC offers better risk management than other forms of contracts since NEC provide clearer risk allocation for all key project participants.

While clients reposition themselves in ensuring success in achieving project objectives, it is conceived that the realisation for trust, collaboration, commitment to sustainability, stakeholder early involvement and conditions of contract should be explored in the project delivery (Rafindadi *et al.*, 2014) . This concurs with Kerzner (2003), who defines project success as the completion of a project within time, cost, proper performance level, as may be agreed by all parties (Kerzner, 2003: 6).

#### 2.2.1.2 Client capacity and project delivery

The World Bank, through the RMI study, recommended outsourcing of services as a means of enhancing efficiency in public sector institutions in the Sub Sahara Africa (World Bank, 1991b). Public sector institutions in South Africa, just like most of the Sub-Sahara Africa, are characterised by inadequate personnel skills (CIDB, 2007b; CIDB, 2011; Emunze & Smallwood, 2013, CIDB, 2014). The client capacity constraints therefore necessitate engagement of consultants in the design

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and supervision of infrastructure projects. Research findings confirm that project failure emanates not largely on technical issues but managerial practices (Eigbe, Sauser & Felder, 2014).

The continued use of traditional standard forms of contracts which are characterised by adversarial relationships other than project objectives, reduces efficiency further in the delivery of projects (Wright & Fergusson, 2009). It is also argued that collaboration in its own right does not influence enhanced project performance without applying project management principles (Suprapto, Bakker & Mooi, 2015; Suprapto, Bakker, Mooi & Hertogh, 2016). It is evident that the client should take the leadership role in the delivery of infrastructure projects as suggested by some research studies (e.g. Doloi, 2013; Kilinc *et al.*, 2015). It is contended that lack of expertise and tools stem from the client's internal governance limitations, and understanding of the client's role in driving innovation in the delivery of infrastructure projects (Loosemore & Richard, 2015).

The next section discusses the role and responsibilities of the consultants in projects execution, who are referred to as the client representative in some literature.

### 2.2.2 The Consulting Engineer

The standard for a construction procurement system defines the consultant as the contracts manager (Western Cape Provincial Treasury, 2012), and also refers to any suitably qualified registered professional person in terms of section 18(1) of Act No. 46 of 2000. He is the person appointed to administer a contract and as the main representative of the employer. Where applicable, the consultant performs duties relating to the overall management of the contract (Western Cape Provincial Treasury, 2012). Professionalism, objectivity and competency are three guiding principles and attributes expected of the consulting engineer as set by FIDIC statutes (Bunni, 1997: 155–187). It is expected of the consulting engineer to demonstrate expertise, knowledge and experience in fulfilling his responsibilities.

From the foregoing, Bunni (1997: 155) summaries the roles and responsibilities of the consultant in the delivery of infrastructure projects as follows:

(i) To prepare a design that communicates the details of every aspect of the project.
(ii) To prepare documentation that can be used by a client to launch a competitive tender.
(iii) To supervise and inspect the works to ensure conformity with the design requirements.

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(iv) To administer the contractor and deal with situations as they arise and certify completed works and act as an adjudicator of disputes.

#### 2.2.2.1. Consultant capacity and service delivery

How efficient engineering consultants have fulfilled their role in the delivery of infrastructure projects remains debatable. Pointers of some research studies attest shortfalls of project management skills in the delivery of infrastructure projects (Lo, Fung & Tung, 2006; Munting & Cruywagen, 2008; Shane, Molenaar, Anderson & Schexnayder, 2009; Construction Industry Development Board (CIDB), 2011; Jaffar, Tharim, Shuib, Abdul Tharim & Shuib, 2011; Love, Lopez, Goh & Tam, 2011; Doloi, Sawhney, Iyer & Rentala, 2012; Emuze & Smallwood, 2013; Gündüz, Nielsen & Özdemir, 2013; Cheng, 2014; Verweij, Meerkerk & Korthagen, 2015). Behavioural factors, have been cited to significantly influence project documentation (Love, Lopez, *et al.*, 2011; Rafindadi *et al.*, 2014). Failure to evaluate constructability aspects, clarity and completeness of design drawings; inadequacies in site management and poor communication are likely to impact on project performance.

In contrast, some studies have attributed the consultants' dismal performance to other related factors. Client attributes have been reported to impact service delivery, for instance, unrealistic time expectation imposed by the client (Wulff, Rasmussen & Westgaard, 2000; Lo *et al.*, 2006; Love, Lopez, *et al.*, 2011). Lack of clarity in scope definition has also been cited to influence performance of the consultant (Cheng, 2014; Rosenfeld, 2014; Verweij *et al.*, 2015). In South Africa, the client's preference to discounted fees in the selection of consultants (Okonkwo, 2014), use of contracts favouring the client alone (Jerling, 2009) have also been reported to influence performance of the consultant. Lack of use of formal planning tools and methods with reliance on experience of consultants alone (Olawale & Sun, 2015), have been identified to impact quality of documentation by the consultant.

Service delivery by the consultants is a function of technical knowledge and experience of the experts. Although technical capacity of the consultant is central and critical to the delivery of services by consultants, other studies contend that project complexity, time and cost constraints increase the instances of errors in the project design documentation ( Manavazhi (2004) cited in Love, Edwards, Han & Goh, 2011). The other aspect is the failure by the consultant to provide coordinated and effective site management (Doloi, 2013). Much as a project has time, cost and quality constraints,

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the client requires extra precaution in the determination and setting of the benchmark for these parameters. Premature tender documents often have incomplete and inconsistent documentation prior to launch of such tenders which may result in unrealistic tender prices by contractors (Rosenfeld, 2014). Consequently, the project may risk experiencing too many changes at the implementation resulting in project cost escalation.

Project success and failure, causative attributes and their impact on project objectives have been researched widely with focus on cost overruns, schedule increases and quality of the built assets. Reasons aligned to factors influencing cost overruns in infrastructure projects have been discussed and summarised as systematic, project and organisational related (Shane *et al.*, 2009; Doloi *et al.*, 2012). During the project implementation phase, the project key participants comprehend the challenges associated with design documentation as errors become more apparent. Consequently, studies show that most changes in scope during implementation arise from design and feasibility stages (Doloi *et al.*, 2012; Williams & Johnson, 2014; Verweij *et al.*, 2015).

#### 2.2.2.2. Remuneration and performance of the consultant

Governments and institutions generally have not identified the appropriateness of the determination of professional fees, with counter arguments on either using percentage fees or published professional fees scales for example in the United States of America (USA) (Carr & Beyor, 2005). In the South African case, this is discussed in the guideline for services and processes for estimating fees for persons registered in terms of the Engineering Profession Act, 2000: Government Gazette: (Republic of South Africa, 2015). Walesh (2007) further argues that the trend for the price based selection results in consultants offering less fees in comparison to the expected level of service delivery. It is stated that price based selection results into reduced profits although the consultant is ultimately responsible for the final project delivery (Walesh, 2007). In South Africa, the appointment of consultants for service delivery is determined on cost of their services other than effectiveness in achieving project deliverables and this is perceived to limit innovation (Jerling, 2009).

In summary, the roles and responsibilities of the consulting engineer broadly cover the entire project cycle. The design function underscores the level and quality of performance, project cost, work processes and methodologies and timing and sequencing of project elements (Bunni, 1997: 158–160, Lock, 2007). Engineering consultants are obliged to perform their functions with due diligence and within the set standards of code of conduct (Piyadasa & Hadikusumo, 2014; Republic of South Africa,

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2015). The other phases after the project design phase, largely focus on the contract management and administration. The actions of the consulting engineers arising from any shortfalls in planning, design, inspection and certification have far reaching consequences and result in increased construction risks on the other stakeholders, namely clients and contractors.

The next section discusses factors that influence the contractor in the delivery of infrastructure projects.

### 2.2.3 The Contractor and project delivery

The contractor is one of the three main key stakeholders responsible for the execution phase of a project. He is a juristic person or organization that is contracted to provide the goods, services or engineering and construction works covered by the contract (Western Cape Provincial Treasury, 2012). Design drawings, specifications, schedule of requirements and bills of quantities, conditions of contract are the tools that guide the contractor in fulfilling the client requirements on a project.

The performance of the contractor as heighted in the CIDB construction industry development status report of 2004, depends on the competence of the contractor to scrutinise tender documents, drawings and construction management (Construction Industry Development Board (CIDB), 2004a). The ability to relate the schedule of requirements, technical specifications, and conditions of contract, payment terms, and the risks involved. Understanding of such attributes enables a contractor to prepare a competitive offer for a project (Construction Industry Development Board (CIDB), 2004a). However, it has been stated that project delivery is a function of collaboration among the key stakeholders, and all these impact on the success of the project (Rumane, 2011; Doloi, 2013).

The level of achieving the client requirements necessitates quality monitoring and enforcement by the consulting engineers. Level of client involvement in the project and the work processes are also instrumental in realizing the defined specifications and client project objectives (Doloi, 2013). The competence of personnel, and commitment to quality in the delivery of projects equally play an important role in the execution phase. It is at the project execution phase that the level of completeness of project design documentation and its accuracy is revealed since most errors become more pronounced at the implementation stage (Doloi *et al.*, 2012; Doloi, 2013).

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### 2.2.3.1 Project execution and contractor related risks

Timely completion of a project by a contractor is dependent upon several factors. Learning from the Constructing the team, a construction project will not be free of construction risks which cannot be ignored (Latham, 1994: 14). The "Rethinking construction" explains that construction risks can either be managed, minimised, shared, transferred or accepted through appropriate risk management strategies (Latham, 1994). Choice of the contracting and pricing strategy in this respect has the potential to influence performance of the contractor since it defines the level of risk allocation on the project (Latham, 1994: 19).

Available country legislation also plays a role in the selection and performance of contractors. However, other factors relating to the performance of a contractor which may define suitability of a contractor for a project, for instance, past relevant experience, financial capacity, personnel requirements, historical non-performance, may not be given much weight. Unlike with the selection of engineering consultants, specifically with quality and cost based selection (QCBS), it is common practice to allocate weighting for quality and cost; with at least 20% weight on the cost and 80% weight on the technical capacity of the consultant (World Bank, 2011: 19).

### 2.2.3.2 Project documentation, contractor attributes and project success

The successful performance of the contractor is dependent upon both the client and consultant attributes. Besides the capacity of the contractor to execute a project, other influencing factors include clarity of the bidding documents and scope of the project (Cheng, 2014). Lack of a data base in estimating schedule duration and resources (Abd E-Razek, Bassion & Mobarak, 2008), changes in drawings and specifications (Abd E-Razek *et al.*, 2008; Ruqaishi & Bashir, 2014), client generated variations resulting in changes in scope (Lo *et al.*, 2006; Hamzah, Khoiry, Arshad, Tawil & Che Ani, 2011; Peansupap & Cheang, 2015), unclear drawings and guidelines (Cheng, 2014), and poor definition of payment milestones (Ruqaishi & Bashir, 2014), have been cited to impact the performance of a contractor.

There is an apparent huge variation between the construction plan and the expected project delivery time (Cheng, 2014). Other studies attribute this variation to the unrealistic contract duration imposed by client organisations (Lo *et al.*, 2006). Additionally, other factors include lack of quality assurance systems and controls, delays in undertaking inspections and monitoring of the contractor's programme by engineering consultants (Ruqaishi & Bashir, 2014). This is exacerbated by the

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adversarial relationships exhibited in the management of projects associated with the traditional methods of project delivery, where the design function is separated from the construction phase (Umar *et al.*, 2013). Other studies mention the client's irregular behaviour and often government interference in construction programmes as a deterrent to project delivery (Fang, Li, Fong & Shen, 2004; Assaf & Al-Hejji, 2006). Lack of constructability considerations of the design, relevance of prescribed specifications and undefined level of demand on quality also impact project performance (Cheng, 2014). Delays due to inadequate financial capacity by the client organisation, although compensation contractual clauses may be provided, they have proved to limit the performance of the contractor (Sambasivan & Soon, 2007).

The section has highlighted and explored roles and responsibilities of the key project stakeholders and the prevailing relationships in the delivery of infrastructure projects. It has been argued that, in addition to the key project participants, the procurement strategy is one of the project performance determinants that influence project delivery and this is discussed next in section 2.3.

## 2.3 Procurement Strategies and project performance

Section 2.2 has highlighted the roles and responsibilities of the various key stakeholders and how they influence project delivery. This section briefly summarises the available forms of procurement strategies that are widely used, the methods of selection and forms of contracts, and how they influence project delivery. From the foregoing discussion, it is evident that collaboration among the project key stakeholders is key to achieving the principle of the golden triangle through minimizing or reducing construction risks throughout the project cycle.

In evaluating the various roles and responsibilities of key project participants, and to fully comprehend their influence in the delivery of infrastructure projects, the research further explores the correlation of the resulting project success with respect to procurement processes discussed hereunder and presented in Figure 2.6.

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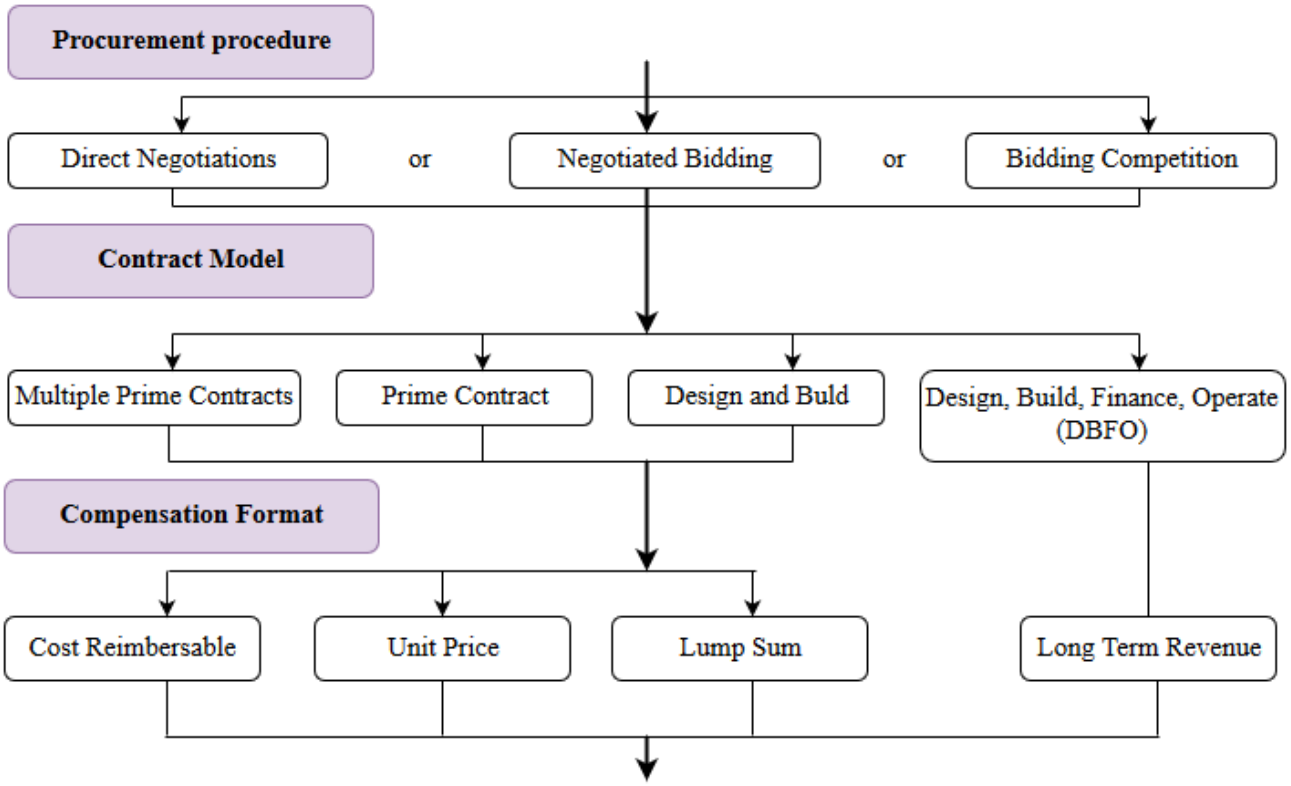


Figure 2.6 Procurement route elements (adapted from Lædre, Austeng, Haugen & Klakegg, 2006)

### 2.3.1 The Procurement Strategies: previous and current trends

Watermeyer & Laryea (2014) defines procurement, based on ISO 10845, ISO 2010 and BS 8534, BSI 2011, as a process of identification, selection, commissioning of contributions required for the construction phase of a project. The procurement strategy is the procurement choice that an entity could endeavour to adopt to achieve the project objectives. Some of the available procurement options include the traditional route, total package options, design and build, construction management and sequential negotiated work packages, guaranteed maximum price and full cost reimbursable (Walker & Hampson, 2003). The different procurement options, which are presented in Table 2.3, suggest differences in the risk allocation and responsibilities of key project participants defined by a particular mode of project delivery (Bunni, 1997; Lædre *et al.*, 2006).

Characteristics of the procurement strategies are presented in Table 2.3.

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Table 2.3 Procurement strategies and characteristics in construction projects

| Item | Characteristic | Procurement model | | | |
|---|---|---|---|---|---|
| | | Traditional | Design and build | Management contracting | Construction management |
| 1 | Diversity of responsibility | Moderate | Limited | Large | Large |
| 2 | Size of market from which costs can be tested | Moderate | Limited | Large | Large |
| 3 | Timing of predicted cost certainty | Moderate | Early | Late | Late |
| 4 | Need for early precise definition of client requirements | Yes | Yes | No | No |
| 5 | Availability of independent assistance in development of design brief | Yes | No | Yes | Yes |
| 6 | Speed of mobilisation | Slow | Fast | Fast | Fast |
| 7 | Flexibility in implementing changes | Reasonable | Limited | Reasonable | Good |
| 8 | Availability of recognised standard documentation | Yes | Yes | Yes | Limited |
| 9 | Ability to develop proposals progressively with limited and: | | | | |
| | • progressive commitment | Reasonable | Limited | Reasonable | Good |
| | • Cost-monitoring provision | Good | Poor | Reasonable | Good |
| | • Construction expertise input to design | Moderate | Good | Good | Good |
| 11 | Management of design production programme | Poor | Good | Good | Good |
| 12 | Client influence on trade contractors | Limited | None | Good | Good |
| 13 | Provision for controlling quality of construction materials and workmanship | Moderate | Moderate | Moderate | Good |
| 14 | Opportunity for contractor to exploit cash flow | Yes | Yes | Yes | No |
| 15 | Financial incentive for contractor to manage effectively | Strong | Strong | Weak | Minimal |
| 16 | Propensity for confrontation | High | Moderate | Moderate | Minimal |

Adapted from Chartered Institute of Building (2014: 153)

The empirical data presented in Table 2.3, give an overview of the attributes associated with various procurement strategies in the implementation of infrastructure projects. The data in the table reaffirms some of the research findings that procurement strategies that embrace collaboration bring significant benefits to the project delivery (Eriksson, 2008; Wright & Fergusson, 2009). Watermeyer & Laryea (2014) argue that the traditional standard forms of contract promote adversarial relationship by the separation of the design function from the construction processes. Osipova & Eriksson (2011) citing Dagenais (2007), confirm that through collaborative contracting practices, there is openness, trust and cooperation. Sir John Egan, in the Rethinking Construction contends that it is detrimental for client organisations to put more emphasis on the project cost without due consideration of time, quality and functionality (Egan, 1998).

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### 2.3.2 Procurement strategies and the client influence

Ruparathna & Hewage (2013) citing Lædre *et al.*(2006) proclaim that there is a tendency by some clients to use some procurement strategies out of routine. This may explain why in practice, the traditional Design-Bid-Build (DBB) has remained predominant in the construction industry despite reported shortcomings associated with it (Wright & Fergusson, 2009). Essentially, the choice of a procurement strategy without due regard to project characteristics and appropriateness of the delivery method result in poor risk allocation and hence the poor delivery of infrastructure projects (Osipova & Eriksson, 2011).

A thorough review of the current procurement trends is essential to learn why other models of procurement strategies are not yet popular and have not been embraced in their totality, despite promoting innovation, collaboration and shared risks (Watermeyer & Laryea, 2014). The Private Finance Initiative (PFI), for instance, has been perceived to enable faster project delivery although there is scepticism relative to the actual benefits realised against this procurement strategy. Some research findings explain that this is due to limited publicly available data in support of this alternative strategy in comparison to the traditional procurement strategy (Umar *et al.*, 2013).

Procurement strategies advanced by multilateral financial institutions and existing South African procurement regulations while promoting accountability and transparency, in a way suggest preferred used of the traditional DBB procurement strategy (Construction Industry Development Board (CIDB), 2005a). The Egan's "Rethinking Construction", recommended replacement of competitive tendering with long term relationships based on clear measurement of performance and sustained improvement in quality and efficiency (Egan, 1998). In the same line of thought, in South Africa, the Standard for Infrastructure Procurement and Delivery Management (SIPDM) is seen to promote the use of framework agreements (National Treasury, 2016: 42).

There is evidence from the available literature of the benefits that can be realised through application of alternative procurement strategies in infrastructure project delivery. However, despite the inclination to the continued use of a traditional contract strategy in infrastructure projects, attainment of KPIs remains unpredictable in terms of overall cost against budget, with unprecedented delays imminent in most infrastructure projects. The construction industry is still struggling with the

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adherence to quality requirement, constructability, efficiency and effectiveness in the project implementation, hence it remains the riskiest among other sectors.

Having presented the general global construction industry practices, roles and responsibilities of key project stakeholders, and procurement strategies, the next section explores the construction industry in South Africa. The section examines the performance of the industry and the current developments relative to the international practices. A review of selection of consultants under WB guidelines is done in comparison to South Africa to understand the impact of the selection strategy with regards to the performance of the consultants.

### 2.3.3 Consultancy services: Global and South African perspective

Procurement strategies adopted by most governments and government agencies globally, are guided by rules and procedures for the procurement of goods, works and services. These rules and procedures are mostly an adaptation of World Bank guidelines and standard bidding documents. Multilateral Development Banks and other financial institutions have developed own procurement guidelines founded on the same World Bank documents, which is also like the case of South Africa. The FIDIC conditions of contract have also been adopted and are widely used by many countries although in principle, several countries and agencies have formulated their own conditions of contract.

The WB guidelines are based on the selection and employment of consultants under IBRD loans and IDA loans, credits and grants by the World Bank borrowers (World Bank, 2011). The WB guidelines provide five main considerations for the selection process of consultants (World Bank, 2011: 2):

- The need for high quality services.
- Consideration for economy and efficiency.
- Giving all eligible consultants opportunity to compete in providing the services.
- Encouraging the development and use of national consultants in its developing member countries.
- Promotion of transparency in the selection process.

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These guidelines are designed to allow for the selection of consultants with the requisite qualifications to carry out services which are in accordance with set schedules, scope and consistent with project outcomes.

In line with the same principle, the CESA has developed a code of practice for engineering consultants. The CESA code of practice stipulates adherence to quality management systems in the implementation of services which are in accordance with accepted standards and practices (Consulting Engineers South Africa (CESA), 2011a). However, the general procurement guidelines as promulgated by the government of the Republic of South Africa require the construction industry to uphold five core principles just like with the World Bank. These are values for money, open and effective competition, ethics and fair dealings, accountability and reporting and equality as stipulated in the Public Finance Management Act No. 1 of 1999 (Republic of South Africa, 2010). The South African National Road Agency Limited (SANRAL) procedures manual discusses similar procurement principles. These are transparency, efficiency, competitiveness, fairness, ethics, proportionality, uniform application, accountability, openness and value for money (South African National Roads Agency Limited (SANRAL), 2012).

It shows that in principle, the main procurement guidelines for South Africa are consistent with international practices, in particular with the World Bank guidelines. The next section discusses the international practices, specifically the guidelines for the selection of consultancy services as promoted by the World Bank.

#### 2.3.3.1 World Bank procurement: professional services processes

World Bank (WB) procurement policies are designed to promote selection of professional services to ensure high quality services, promoting economy and efficiency, giving equal opportunity to eligible firms, encouraging use of national firms and upholding transparency (World Bank, 2011). Member countries are encouraged to use Quality and Cost Based Selection (QCBS) although other methods are available, for instance; Quality Based Selection (QBS), Least Cost Based Selection (LCBS) or single sourcing methods. Nevertheless, use of such alternative approaches is dictated by the nature of services and their application calls for justification and sanction by the World bank.

The selection of consultants in WB financed projects start with prequalification of a minimum of six firms with a wide geographical spread (World Bank, 2011: 15). Five main proposal evaluation

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criteria that are considered include past relevant experience specific to the assignment, adequacy of quality of proposed methodology and work plan in responding to the Terms of Reference (TORs), qualifications and competency of key experts for the assignment, transfer of knowledge and participation of local staff in key expert positions (World Bank, 2011: 19). The guidelines for the selection of consultants for the provision of consulting services put more weight on methodology and key experts (refer Table 2.4). The World Bank procurement process could be lengthy and may take approximately 250 days or longer and depending on client capacity managing the procurement function (based on researchers previous WB assignments). However, with the WB reviews throughout the process, fairness, adherence to procedures, fraud prevention, and transparency are enhanced.

Table 2.4 Typical scoring criteria for professional services

| Proposal evaluation criteria | Score range | Typical scores |
|---|---|---|
| Consultant's specific experience | 0 to 10 | 10 |
| Methodology | 20 to 50 | 20 |
| Key experts: | 30 to 60 | 60 |
| Transfer of knowledge | 0 to 10 | 5 |
| Participation by national experts | 10 to 10 | 5 |
| Total | 100 | 100 |

Adapted from World Bank (2011: 19)

### 2.3.3.2 Client capacity and tender adjudication in WB financed projects

Several factors are taken into consideration to enable the consultants to prepare responsive technical proposals. The Terms of Reference (TORs) are expected to be prepared by a person or firm specialised in the assignment. The schedule of requirements and scope should be compatible with budget, timing of deliverables and staff inputs which are based on the client's assessment of resource requirements. The bid evaluation committee (BEC) is expected to include qualified specialists in the sector of the assignment to conduct a critical evaluation which includes highlighting the weaknesses and strengths of proposals the purpose of which is to ensure quality of evaluation (World Bank, 2011: 18). Table 2.4 shows typical attributes which provide a scoring guide in the evaluation of technical proposals (World Bank, 2011: 19).

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Evaluation of the proposed technical approach and methodology, requires highly qualified evaluators to objectively analyse technical proposals since subjectivity elements cannot be avoided. Emphasis for quality of service delivery is also observed in the WB guidelines (Table 2.4), where more weight is placed on the key experts. In this respect, it remains the responsibility of the client to prepare TORs which must clearly define project objectives to enable consultants to prepare responsive technical and financial proposals which address salient issues of the TOR. This confirms research findings that imply that consultants' work quality is a function of the personnel qualities (Momparler, Carmona & Lassala, 2015).

#### 2.3.3.3 Financial proposal costing: Remuneration in World Bank Projects

Traditionally, proposal pricing in WB projects comprise of professional fees and reimbursable or direct costs (World Bank, 2011: 20–22). The Request for Proposals (RFPs) are structured to provide guidance to consulting engineers, using standardised templates. Ambiguity in the schedule of requirements and expected deliverables may result in differing interpretation and costing resulting into either under-pricing or over-pricing or failure to execute the services. Timing of tasks is quite critical for proper pricing for both fees and reimbursable cost elements, that are consistent with the TORs and project deliverables. In most instances, the TORs in WB projects are detailed enough with the guide of WB task team leaders, to allow the consultant to price for all anticipated direct costs.

With the global trends where competition largely focuses on price, clients very often struggle to determine the sufficiency of fees, more specifically if the TORs are not clear (Cheng, 2014). Unlike with the works contractors, consultants often carry out their assignments with minimal client supervision where there is limited client capacity. This is also an aspect where the quality of documentation as provided by the design engineer may be compromised. Based on the prior discussions, it can be deduced that in WB financed consultancy services, consultants are paid full fees for the services they provide, which includes remuneration and direct costs.

Another aspect of WB financed projects are the forms of contract that are often recommended by the Bank to all member countries and these are discussed in the next section.

#### 2.3.3.4 Forms of contract and challenges on World Bank financed projects

The forms of contract on WB financed assignments are limited to those stipulated in standard documents which are published by the WB. Most civil engineering consultancy services contracts are administered though lump sum and time based contracts (World Bank, 2011: 22–23). Challenges

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associated with lump sum contracts include precise determination of scope, duration, outputs and milestones for effective delivery of the assignment (World Bank, 2011: 32). In contrast with time based assignments, payments are based on agreed rates for fees and reimbursable expenses. This calls for availability of expertise and project delivery management skills within the client organisation (Emuze & Smallwood, 2013). A consultant may not be encouraged to be innovative where the scope as originally defined by client changes requiring more time and other resource inputs without additional compensation.

FIDIC general condition of contract are preferred by Multilateral Development Banks (MDBs) in principle and the traditional type of contract is mostly used for infrastructure delivery. The Red Book of the FIDIC general conditions define the duties and roles of the parties with the involvement of employer primarily for greater budgetary controls thereby distributing the risks between the contractor and client. Quality assurance and interpretation of the documents and work processes are left with the contractor presumably under the supervision of the consultant and the contractor is not mandated to alter or correct drawings provided by the employer or his representative. The contract also provides for the client to incorporate and decide on the composition of the Dispute Adjudication Board (DAB) at the tender stage also to be included in the contractor's offer.

### 2.3.4 Lessons from World Bank practices

WB guidelines for professional services promote cost effectiveness and the guidelines have proved to offer value for money in the delivery of infrastructure projects. The WB provides a procurement framework and leadership in procurement for other multilateral development banks (Nwogwugwu, 2005 cited by Williams-Elegbe, 2014).

Determination of fees is based on a clearly structured and set guidelines where standard forms are used by all eligible consultants. It is mandatory for all firms to list all costs in the financial proposal associated with the assignment. Professional fees are also subject to revision if the duration of the assignment exceeds 18 months, which is a motivation to the consultant (World Bank, 2011: 33). In comparison to WB procurement guidelines, which promote the development of national entities in the evaluation criteria (refer to Table 2.4), its application is not synonymous to the preferential procurement policy as applied in South Africa. It has been argued that the horizontal policies in the traditional procurement law, as the case applies with South African procurement law, may not serve the intended purpose (Helmrich, 2014). The discounting of published professional fees, in addition

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to the other horizontal policies like the broad-based black economic empowerment (BBBEE), may not provide adequate incentives to promote innovation among professionals in the construction industry in South Africa.

### 2.3.5 Professional remuneration in South African construction industry

The Best Practice Guideline for the competitive selection of professional service providers in South Africa provide procurement guidelines which are similar to those of the WB in principle (Construction Industry Development Board (CIDB), 2007b,c). Based on SANS 294, the guide recognises professional and technical competence, financial resources, equipment and associated facilities, managerial capability, reliability, experience and reputation as qualifying attributes to the selection process. Unlike with WB financed projects, South Africa adopted fees discounting based on fee scales published by ECSA for both lump sum and time based assignments. Remuneration in WB funded projects considers the cost for actual personnel inputs and that of direct costs. Quality and cost based selection encourages consulting firms to propose highly qualified personnel.

#### 2.3.5.1 Historical and current professional fess determination in South Africa:

The procurement of professional services in South Africa are regulated by the CIDB Best Practices Guideline #A7 (Construction Industry Development Board (CIDB), 2007b) and the procurement Guideline for Consulting Engineering Services enacted through the Act No 46 of 2000 (Republic of South Africa, 2015). The Engineering Council of South Africa (ECSA), Consulting Engineers of South Africa (CESA), South African Institution of South Africa (SAICE) are engineering institutions which operate under the CIDB in regulating the operations of consulting engineers in the built environment.

ECSA is required by legislation under the Practice Note SCM 3 of 2003, to publish fee scales for professional services. Published fee scales date back to the 1980s and they have been used as a basis for the determination of fees in South Africa. In the years that have followed, with increased competition, price has been the major determinant for the selection of professional services. Professional fees discounting has been used, with contracts awarded to firms offering the most discount for consulting services. Published reports indicate that such discounts have ranged between 20 and 50% and in some cases even more with increased competition (Construction Industry Development Board (CIDB), 2007b).

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In 2001, South Africa resolved to align the selection of professional services with international best practices, in particular WB guidelines for the selection of a consultant following a country procurement assessment (CPA) review in the same year (Construction Industry Development Board (CIDB), 2007c). Adoption of World Bank procedures in their fullness in South Africa has not been possible with the introduction of preferencing in the evaluation criteria. Secondly, the assessment of quality in proposals requires knowledgeable clients (Construction Industry Development Board (CIDB), 2007b). CESA (2014), notes that procurement in South Africa is primarily founded on price and broad-based black economic empowerment (BBBEC) points, with functionality or quality having a minimum threshold. This is compounded by lack of client capacity in technical, contractual and procurement procedures (Construction Industry Development Board (CIDB), 2011; Marx, 2014). In South Africa, the CIDB recommends use of the FIDIC conditions of contract, General Conditions of Contract (GCC) (2010), the Joint Building Construction Committee (JBCC), and the New Engineering Contract (NEC 3) (Construction Industry Development Board (CIDB), 2005b).

#### 2.3.5.2 South African construction industry development and performance

The SA construction industry has experienced rapid growth in both public and private infrastructure investment thereby contributing positively to the social economic development of the country. Challenges affecting the industry as discussed in section 2.1.2, demonstrate the need for a closer examination of the quality of documentation as a source of risk in the construction industry. How the construction industry legislation, performance of the key stakeholders impact the level of service delivery remains a subject for discussion, if the project KPIs are to be attained. It is acknowledged that the quality of project documentation from project conception, design and implementation have a direct relationship on the key project performance objectives.

While noting that the key considerations in the engagement of engineering consultants have been quality of deliverables to meet client expectations, and with reasonable skill, compensation for the effort provided by consultants has often been regarded as a source of poor project delivery (Davies, 2005; Construction Industry Development Board (CIDB), 2007c; Consulting Engineers South Africa (CESA), 2011b; Okonkwo, 2014). It is perceived that the trend for discounting of fees greatly impact service delivery by consultants; resulting in possible financial loss, inadequate supervision and quality control, and inability to perform value engineering. The downstream effect is the inability of the industry to attract and retain high calibre engineers. It has been suggested that the quality of consulting services and fees may have a direct impact on the level of service which emanates from the personnel attributes (Momparler *et al.*, 2015).

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The determination of fees has been traditionally based on fee curves as shown in Figure 2.7, as a relationship of project cost and complexity of works in consultancy services assignments. Each of the curves define a class of work. The CIDB through Government Gazette No. 39480, Guideline for services and processes for estimating fees for persons registered in terms of the engineering profession Act No. 46 of 2000 (Republic of South Africa, 2015) is the recent ECSA guide for determination of professional fees. The same approach has been used in other countries and it is argued that the approach may not provide a fair compensation for professional services (Carr, Asce & Beyor, 2005, Feldmann, Ph, Chrusciel, Pohlmann, Ii, *et al.*, 2008).

ECSA advises in this latest guideline that was gazetted in 2015 that:

> "This guideline should not be seen as a starting point from which to try to discount fees to the extent that the consulting engineer's remuneration becomes insufficient to attend to all aspects of the services that are required to the detriment of the project. This guideline rather provides an indication of the range of fees that will normally be required to ensure fair remuneration and also gives some indication of factors that would require higher or lower fees that can be negotiated on the basis of mutual trust." (Republic of South Africa, 2015: 4).

> "The recommended method for the procurement of a consulting engineer is through a selection process based either on direct negotiation, or via a competitive bidding process where proven competence, qualifications, resources, experience, preferencing and developmental criteria are the primary selection factors and price is a secondary factor." (Republic of South Africa, 2015: 27).

In practice, fees discounting is still being practiced in the determination of professional fees as shown in Figure 2.8, as reported in the CESA 2015 bi-annual economic and capacity survey.

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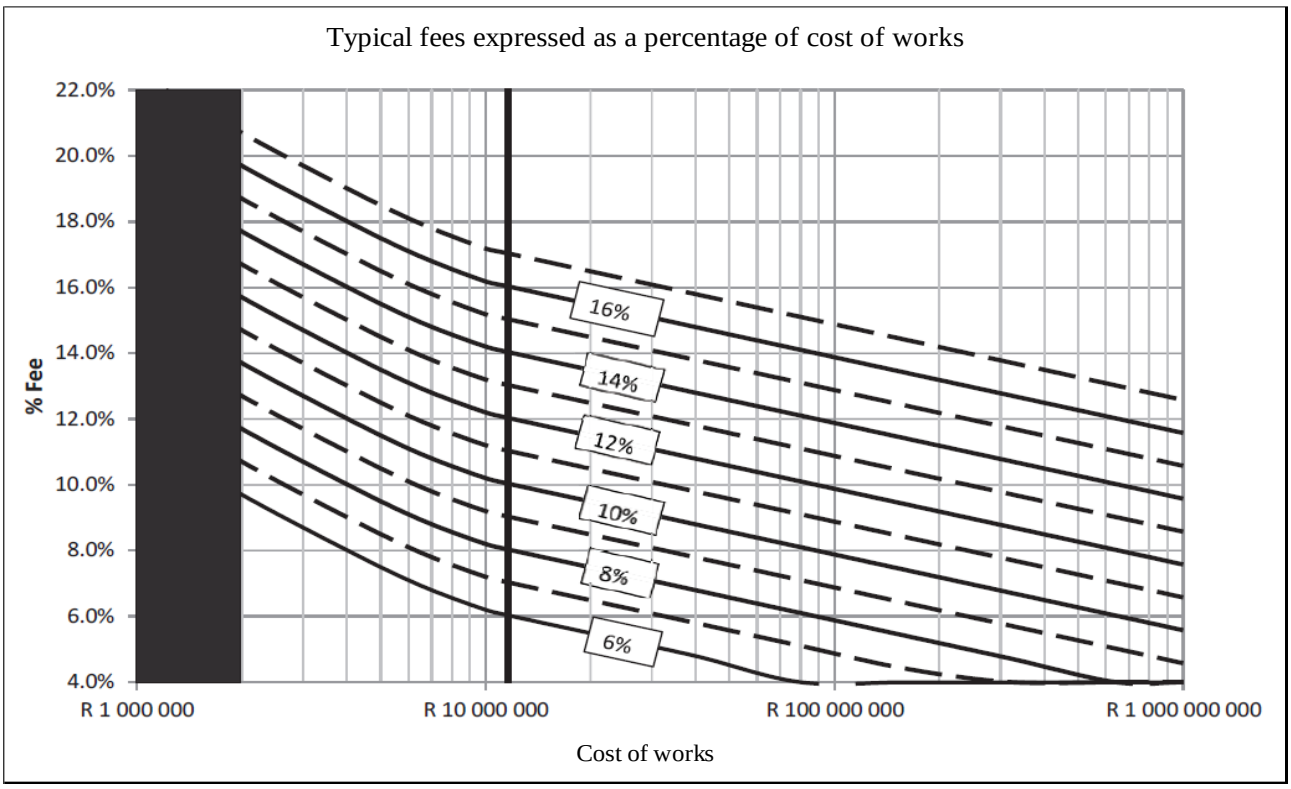


Figure 2.7 Typical Fee Expressed as % of the cost of work, Adapted from Republic of South Africa (2015)

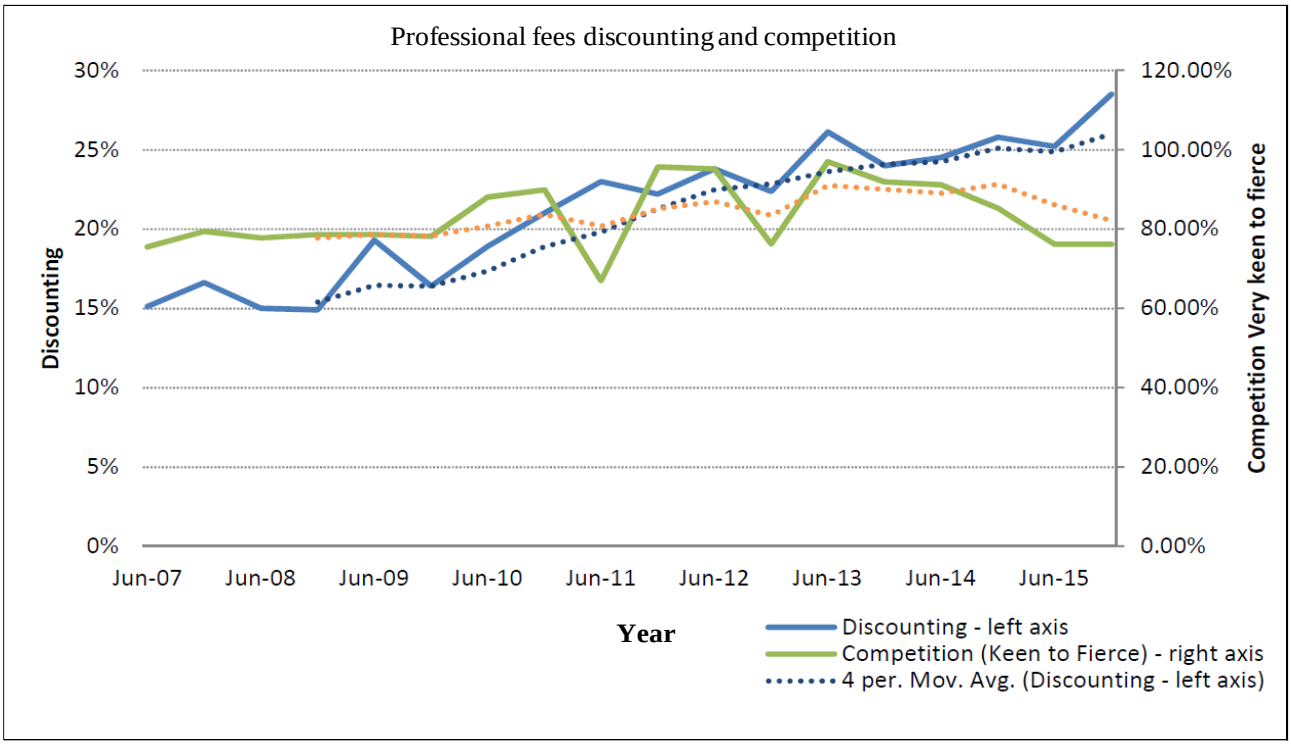


Figure 2.8 Professional fees discounting in South Africa Adapted from CESA bi-annual economic and capacity survey CESA (2015: 20)

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## 2.4 Summary of literature review

Lessons learnt from the review of the literature can be summarised by way of key attributes identified to influence key performance indicators. Specific lessons and key attributes that have been observed in the review, provide a diverse range of views on the influencing factors that impact project KPIs. The influencing factors are drawn from the risk factors that impact the stakeholders directly involved on the projects, the regulatory framework, procurement strategies and contract provisions or legislation. It is recognised that there is a need for institutions to regulate the construction industry performance, by promoting efficiency, competitiveness and improved value to clients. Factors that have been identified in the review are summarised below from which the questionnaire was developed.

A selection of key influencing factors as identified from several studies that impact project KPIs are provided giving the main themes and the attributing factors. The summary includes general factors that influence project delivery (Table 2.5), factors influencing project delays (Table 2.6), factors influencing project cost overruns (Table 2.7), factors influencing design errors (Table 2.8) and factors influencing project documentation (Table 2.9). It is observed from the studies that personnel skills, procurement strategies, project management skills and attributes attached to key project stakeholders significantly influence the delivery of infrastructure projects.

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Table 2.5 General factors influencing project delivery

| Risk factors | Authors | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ofori *et al.* (1996) | Construction Industry Development Board (CIDB) (2004a) | Rwelamila & Edries (2007) | Jerling (2009) | Eriksson & Westerberg (2011) | Construction Industry Development Board (CIDB) (2011) | Okonkwo (2014) | Consulting Engineers South Africa (CESA) (2015) | Republic of South Africa (2015) | *Jaffar et al.* (2011) | Sauser, Reilly & Shenhar (2009) | Doloi *et al.* (2012) | Laryea & Watermeyer (2016) | Rafindadi*et al.* (2014) | Rosenfeld (2014) | Fulford *et al.* (2014) | Low, Sui Pheng & Lin (2015) | Rivera & Kashiwagi (2016) |
| Undesirable tendering practices | ● | | | | | | | | | | | | | | | | | |
| Excessive underbidding | | | | | | | ● | ● | | | | | | | | | | |
| Fees discounting limit innovation | | ● | | | | | ● | ● | ● | | | | | | | | | |
| Inappropriate methods for selection of consultancy services contracts | | ● | ● | | | ● | | | | | | | | | | | | |
| Behavioural, contractual and technical (skills) | ● | ● | | | | | | | | ● | ● | ● | | | ● | ● | | ● |
| Trust, collaboration and commitment | | ● | | | | | | | | | | | ● | ● | | | | |
| Early involvement of contractor | | | | | ● | | | | | | | | ● | | | | ● | |
| Conditions of contract | | | | | | | | | | | | | | | | | | |
| Failure to select right approach for project | | ● | | | | | | | | | ● | | | | | | | |
| Focus on lowest price | | ● | | | | | | | | | | | | | | | | |

Table 2.6 Factors influencing project delays

| Risk factors | Authors | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Abd E-Razek*et al.* (2008) | Ruqaishi & Bashir (2014) | Doloi *et al.* (2012) | Lo *et al.* (2006) | Jaffar, Abdul Tharim & Shuib (2011) | Głuszak & Leśniak (2015) | Wium (2013) | Yana & Wibowo (2015) | Gündüz, Nielsen & Özdemir (2013) | Rivera & Kashiwagi (2016) |
| Design changes by owner or consultant | ● | | | ● | | | | | ● | |
| Client variations | | | | ● | ● | | | ● | | |
| Lack of project management skills | ● | | | | | | | | ● | ● |
| Poor coordination among project participants | ● | | | | | | | | | |
| Inefficient site management | | ● | ● | ● | | ● | | | ● | |
| Lack of effective communication | | ● | ● | | ● | | | | | |
| Poor coordination of subcontractors at procurement stage | | ● | | ● | | | | | | |
| Lack of clarity in project scope | | ● | ● | | ● | | | | | |
| Inconsistencies in contract documents | | ● | | ● | | | | | | |
| Exceptionally low fees | | | | ● | | | | | | |
| Unrealistic contract duration imposed by client | | | | ● | | ● | | | | |
| Reluctance to check constructability. | | | | | ● | | ● | ● | ● | |
| Mistakes in design documentation | | | | | ● | ● | | | | |

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Table 2.7 Factors influencing project cost overruns

| **Risk factors** | Authors | | | | | | |
|---|---|---|---|---|---|---|---|
| | Shane, Molenaar, Anderson & Schexnayder (2009) | Westin & Sein (2014) | Peansupap & Cheang (2015) | Yakubu & Sun 2010) | Cheng (2014) | Rosenfeld (2014) | Verweij *et al.* (2015) |
| Data and information quality decreases project delays and cost overruns | ● | ● | | | | | |
| Changes in schedule by owner | ● | | ● | | | | |
| Poor or incomplete design | | | ● | | | | ● |
| Changes in design function by owner | | | ● | ● | ● | ● | ● |
| Changes in material specification | | | ● | ● | | | |
| Risks and uncertainties | | | | ● | | | |
| Inaccurate evaluation of project duration | ● | | | ● | | | |
| Project complexities | ● | | | ● | | | |
| Non-performance of subcontractors | | | | ● | | | |
| Clarity in project scope definition | ● | | | | ● | | ● |
| Lack of skills | ● | | | | | | ● |
| Lack of cost control | | | | | ● | | |
| Premature tender documents | | | | | | ● | |
| Tender-winning prices are unrealistically low | | | | | | ● | |
| Delivery or procurement approach | ● | | | | | | |
| Conflicts in Contract document | ● | | | | | | |

Table 2.8 Factors influencing design errors

| **Risk factors** | **Authors** | | | | |
|---|---|---|---|---|---|
| | FIDIC (2001) | Love, Lopez *et al.* (2011) | Love, Lopez, Edwards & Goh (2012) | Peansupap & Ly (2015) | Rivera & Kashiwagi (2016) |
| Lack of quality management system in the appointment for consultants | ● | ● | | | |
| Lack of technical skills, training and experience | | | ● | ● | ● |
| Lack of resources and poor use of technology | | | ● | ● | |
| Poor coordination and project management of design team | | | ● | ● | |
| Poor scope definition | | | ● | | |
| Traditional procurement and adversarial attitudes | | | ● | | |
| Competitive tendering | | | ● | | |
| Inadequate design checks and reviews | | ● | ● | | |
| Time limitation imposed on the design tasks | | ● | | | |

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Table 2.9 Project documentation and project delivery

| Risk factors | Authors | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FIDIC (2001) | Munting & Cruywagen (2008) | Love, Lopez,*et al.* (2011) | Love, Lopez, Edwards & Goh (2012) | Williams & Johnson (2014) | Philips-Ryder, Zuo & Jin (2013) | Zillante, Mikucki, Zuo & Jin (2013) | Westin & Sein (2014) | Peansupap & Cheang (2015) | Rivera & Kashiwagi (2016) |
| Lack of quality management system | ● | | ● | ● | ● | ● | | ● | | ● |
| Inappropriate managerial and project management practices | | ● | ● | ● | ● | | | | | |
| Competitive tendering | | | | ● | | | | | | |
| Time constraints imposed by the client | | | ● | | ● | | | | | |
| Ineffective communication/coordination | | | | | ● | ● | | | | |
| Lack of innovation, reliance on software | | | | | | ● | | | | |
| Design projects driven by cost | | | | | ● | | | | | |
| Poor or incomplete design | | | | | | | | | ● | |
| Poor document control, inappropriate and bulky documentation | | | | | | ● | | | | |
| Choice of procurement method | | | | | | | ● | | | |
| Errors and omissions | | | | | ● | | | | | |
| Reliance on generic specification | | | | | | ● | | | | |

## 2.4.1 Key attributes and influencing factors to project delivery

The influencing attributes have been summarised based on the key drivers which impact project KPIs. They are grouped and include factors driven by key project participants, procurement strategies, and project management practices as detailed below.

### (a) Factors attributable to the client

The list includes client actions that are perceived to influence the performance of either the consultant or contractor and subsequently impact attainment of KPIs.

- Client changes introduced at project implementation.
- Lack of use of formal planning tools and methods.
- Unrealistic time estimation for project elements.
- Lack of clarity in scope definition or inadequate project brief.
- Compensation strategy adopted by the client with preference to discounted fees in the selection of consultants.
- Selection of consultants based on professionalism, objectivity and competency of the consulting engineer.

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- Understanding of project characteristics, due diligence and market competition.
- Lack of client capacity in technical, contractual and procurement procedures.
- Excessive bureaucracy.
- Inadequate financial capacity by the client organisation.
- Client's irregular behaviour and government interference in construction programmes.
- Poor definition of payment milestones.
- Lack of a data base in estimating schedule duration and resources.
- Premature adjudication of tender documents.
- Use of contract forms that favour the client alone leading to poor risk allocation.
- Internal governance limitations, and understanding of the client's role in driving innovation.

**(b) Factors attributable to the consulting engineer**

The factors listed are extracted from the various studies and project management theoretical concepts which define the roles and responsibilities of the consultant and how they influence project delivery.

- Use of generic specifications.
- Delays in undertaking inspections and monitoring of the contractor's programme.
- Failure by the consultant to provide coordinated and effective site management.
- Failure to evaluate constructability aspects in the design.
- Clarity and completeness of design drawings and guidelines.
- Design efficiency.
- Clarity of the bidding documents and scope of the project.
- Lack of expertise and use of supporting tools.
- Inadequate experience of consultant.
- Delays in approving drawings and sample materials.
- Mistakes and discrepancies in design documents.
- Lack of quality assurance systems and controls.
- Slow decision making.
- Design changes due to incomplete designs.
- Changes in material specification.
- Lack of experienced personnel.
- Excessive discounting in the selection of professional services.

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### (c) Factors attributable to the contractor

Competence and experience of the contractor to relate the schedule of requirements, technical specifications, and conditions of contract, payment terms, and the risks involved.

### (d) Factors attributable to the procurement process

The factors listed are those which arise from procurement strategies and procurement decisions that impact performance of a project or key project players.

- Appropriateness of determination of professional fees.
- Price based selection of consultants relative to the expected level of service delivery.
- Procurement founded on price and broad-based black economic empowerment (BBBEE) points.
- Industry incentives and ability to retain skilled personnel.
- Use of the traditional Design-Bid-Build (DBB) in the construction industry.
- Model of project delivery and risk allocation.
- Choice of the contracting and pricing strategy.
- Trust, collaboration, commitment to sustainability and stakeholder early involvement.
- Collaboration of all key project stakeholders at the start of the project.
- Detailed examination of key personnel attributes.

### (e) Factors attributable to project management

Several papers have discussed the benefits of applying project management principles in the delivery of infrastructure projects. The list provides some project management aspects that were identified in the review.

- Project planning and monitoring.
- Lack of project management skills in the delivery of infrastructure projects.
- Technical issues and managerial practices.
- Project planning and preliminary documentation.
- Unavailability of appropriate tools.
- Early application of risk management techniques.
- Lack of proper project management.
- Lack of collaboration for shared values.

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- Lack of practice of value engineering and lifecycle costing.
- Lack of use of standardised information.
- Failure of project teams to minimise the impact of project risks.
- Use of design software, design errors and design constructability.
- Behavioural factors and project documentation.
- Skills shortage in planning, procurement, design, construction and maintenance.

## 2.5 Chapter Summary

The chapter has discussed in general the construction industry sector practices, construction risks relative to project deliverables of time, quality and cost. The available research confirms the challenges facing the project delivery globally and in South Africa. Unlike other sectors such as the manufacturing industry, the construction industry continues to miss scheduled completion dates, experience increased cost overrun, and quality of completed infrastructure remains below expected levels. Final project costs are increasingly difficult to predict with challenges emanating from poor productivity.

The review has identified factors that constrain project delivery. Through learning and understanding the project relationships, it has been established that mistakes and discrepancies in the bid documents could result in either under-pricing or overpricing of infrastructure projects. Clarity, completeness and reliability of project documentation by the consultant significantly influences performance of a contractor. Additionally, delays by the consultant and client in performing their functions increase project risks with possible delays and cost overruns encountered.

Project risks put the contractor at crossroads to provide a balance between satisfying the client requirements and sustaining themselves in business. The severity, frequency and significance of the risks from the quality documentation by consultants has not been adequately addressed in the literature. This emanates from the background that project failure has been perceived as being a result of the failure of the contractor performance alone, with more attention put on contractor related challenges to project delivery.

It is observed from the literature review conducted that the majority of reasons for project failure lie in the behavioural pattern of project team members and this negatively impact their technical as well

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as managerial capabilities. Personnel competency, skills and experience significantly impact project planning, design, supervision resulting in poor quality documentation by the design engineers. Incomplete and /or insufficient designs, design changes, and wrong specifications result in either delays, cost overrun or poor quality of the completed assets.

The remuneration for engineering consultants in South Africa, where the focus of most clients is on fees and not on project objectives, impact service delivery by the consultants. In addition, the practices of discounting fees in South Africa limits innovation among consulting engineers. This motivated this researcher to explore further how the factors identified and discussed impact project documentation. Procurement processes and country legislation will also be examined regarding the selection of consultants and mode of compensation to establish linkages between project documentation and project delivery.

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# Chapter 3 Research methodology and design

The research seeks to explore the risks in the delivery of infrastructure project in the South Africa construction industry which are influenced by the quality of project documentation by consultants. Construction risks in the construction industry are not uncommon and risks often result in failure of the project teams in achieving planned project objectives. Effectiveness and efficiency with which projects are implemented are the other dimensions in addition to delays, cost overruns, and quality of constructed assets. The traditional delivery of infrastructure projects integrates clients, contractors and consultants, who are the three key stakeholders and are all bound by contractual provisions as may be set by the client. The key stakeholders have defined roles and responsibilities, they have a defined time frame to complete a project, and hence, the target group for this study has incorporated all these three key stakeholders.

This chapter discusses the research philosophy, research approach, research strategy, the data and the research methodology adopted in the research. The methods used to collect data are analysed while discussing the application and challenges associated with the chosen methods.

## 3.1 The research design

Research encompasses a phased technique which uses the natural setup and analysis of data whose objective is to augment the understanding on a particular research question (Creswell, 2012: 3; Leedy & Ormrod, 2014: 2). Saunders, Lewis & Thornhill (2009) assert that research is done to find out things in a systematic technique and based on logical correlations. Research also adds knowledge in the application of concepts and allows critical analysis of facts which are the three main functions of research (Creswell, 2012: 4–7). Research demands the formulation of a research objective, review of the literature, designing the research, collection and analysis of data from which conclusions and recommendations are drawn and established on critical assumptions (Creswell, 2012; Leedy & Ormrod, 2014).

The research in this study adopted a questionnaire survey to identify the risks as impacted by the quality of project documentation by consultants in the implementation of infrastructure projects in South Africa. A structured questionnaire was administered and key findings relating to project documentation were examined further through a second round of the questionnaire for a deeper understanding of the influencing factors. Questionnaire surveys enable data gathering for both

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descriptive and analytical studies from a comparatively large number of respondents within a short time (Naoum, 2013: 45). It is stated that questionnaires must be simplified and standardised, which imply that they lack flexibility and consequently, respondents tend to provide generalised responses with the lack of control as to who actually answers the questionnaire (Naoum, 2013). However, there is an opportunity for exploring more on some particular answers (Aleandri & Russo, 2015), although it is not possible to determine the exact response rate. Bowen, Edwards & Cattell (2009) note that it is not possible to ascertain whether the questionnaire is opened by the purported respondent. It is also argued that a web-based questionnaire has potential technological challenges which may be biased towards computer users in most cases despite enhancing anonymity of the respondents (Creswell, 2012; Zou *et al.*, 2014).

## 3.2 Research philosophy and approach

Research philosophy relates to the development of knowledge, and the nature of knowledge in a particular field is defined by the procedure, time constraints and the chosen route. The research approach could be achieved through experiments, surveys, case studies, active research, grounded theory, ethnography and archival research. All approaches and philosophies are based on assumptions and practical considerations, and Saunders *et al.* (2009: 107) clarify that the research philosophy is guided by nature; ontology, and structure of reality of the study of acquiring such knowledge; epistemology, which are the two basic ways of thinking to guide the researcher through the process. The research philosophy of interpretivist epistemology was therefore adopted in this research to understand the role of the various key players, which is consistent with the advice by Saunders *et al.*(2009: 109).

The research approach adopted six steps of research design which are within the two broad methods of quantitative and qualitative means which are used in the collection, analysis and interpretation of data (Creswell, 2012; Leedy & Ormrod, 2014). The research approach builds on the research strategies involving critical thinking, built on theoretically known concepts through observation of facts, theory building and collaboration (Leedy & Ormrod, 2014; Fellows & Liu, 2015). The research that is followed in this study, considers the basic understanding of respondents to draw relationships of the variables influencing project delivery. Based on that analogy, specific instances or occurrences in the sample drawn from a population is used to draw conclusions about the entire classes of objects or events. It is also debated that the research approach taken should consider social interactions and take cognisance of the extent and direction of dynamics of change (Fellows & Liu, 2015: 92).

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## 3.3 Research Strategy

### 3.3.1 Quantitative and qualitative research techniques

Quantitative research is a strategy that takes a probe approach which is useful for describing trends and explaining the relationship between variables found in the literature (Fellows & Liu, 2015: 28). Narrow questions are postulated to gather data which answers the research questions. The numerical analyses from the results are achieved using statistics to interpret the data using prior predictions (Creswell, 2012; Naoum, 2013; Leedy & Ormrod, 2014). The principle in quantitative research is that the investigator can make deductions from the research.

A qualitative research approach focusses on the phenomenon that occurs in the natural setting and seeks to gain insights to understand perceptions of respondents (Leedy & Ormrod, 2014; Fellows & Liu, 2015). Peshkin, (1993) as cited by Leedy & Ormrod (2014) state that qualitative research is aligned with descriptive, interpretive, verification or evaluation of problems within the given phenomenon. Leedy & Ormrod (2014: 141–142), assert that qualitative research is valuable in synthesising several viewpoints and reveals the nature of such views, without necessarily allowing the research to identify the cause and effect of the relationships.

Qualitative research reveals multidimensional situations, settings, processes, relationships, systems and people such that in interpretive research, the researcher gains new insights, and can develop new concepts, while discovering the problems that exist within the phenomena. With verification, the researcher can test the validity of certain assumptions, claims, theories or generalisations within the real scenarios. In practice, an evaluation provides a means through which a researcher can judge the effectiveness of particular policies, practices or innovations. Qualitative research shows the pattern of perceptions.

### 3.3.2 Questionnaire survey development

To obtain the perceptions of experts in the construction industry in South Africa, relative to the impact of quality of project documentation, an electronic questionnaire survey was administered using the SurveyMonkey software. The development of the questionnaire involved an extensive evaluation of literature in the construction industry, focussing on international and local trends and in developed and developing countries. The available literature highlight the risk factors that impact the successful implementation of infrastructure projects with respect to time, cost and quality. Literature on project

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performance and project risks were also consulted, to establish the linkage between key performance indicators and quality of project documentation. Specifically, there is limited literature on "quality of project documentation by consultants as a major risk source that influence project delivery." Therefore, the literature review focussed on the risk factors influencing time, cost, quality, safety, effectiveness and efficiency in the delivery of projects. Procurement strategies used internationally and those strategies used locally were also examined.

The risk factors impacting the contractor performance were grouped into three main attributing categories; general factors impacting performance, factors impacting project KPIs and factors influencing project documentation. This was done to align the questionnaire with the research objectives and to explore the risks which influence KPIs with respect to quality of project documentation. The questionnaire design also followed the advice by (Bourque and Clark (1994), as cited in Saunders *et al.*, 2009), that the questionnaire can either adopt or adapt questions used in other questionnaires or the researcher may formulate own questions.

### 3.3.3 Format of questionnaire

The questionnaire was formulated on a five-point Likert-style rating scale and multiple choice questions. Attributes of a questionnaire include provision for efficient collection of data with a diverse means of alternatives, which could be either in person, telephone or internet. The questionnaire survey coaxes respondents to formulate opinions concealing the complexity of conflicting verses of unconscious bias amongst respondents.

Three sets of questionnaires were specifically formulated, one for each of the three respondent groups. The split was motivated to capture information that was specific to a particular group although most of the questions were similar. There were three sections in total, with the first section tailored to capture the profile of the respondents which covered type of organisation, industry, age, academic qualifications, work designation, working experience and size of the respondent organisation. The second section covered attributes on general project performance regarding procurement and legislation, construction delays, cost overruns, frequent design changes in projects at implementation, quality of project documentation and effectiveness of client and consultant involvement in the project delivery. The last section covered impact of quality of quality of project documentation in the project delivery. The questionnaire sections were aligned to the four research objectives.

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The formulation of the questionnaire was set to provide answers to the first three research objectives, namely, defining the quality of project documentation, factors influencing the quality of project documentation, and examining interdependencies between the quality of project documentation and project deliverables. Only those who had agreed to participate were approached by the researcher. The forth research objective was addressed in the second round of the questionnaire survey.

The second round of the questionnaire focussed more on the main influencing factors to quality of project documentation and the suggested mitigation measures as revealed from the first round. The second questionnaire, was also internet based, and largely generated qualitative and quantitative data. It requested the opinion of respondents on the identified risk factors and essentially tested the validity and reliability of the questionnaire (Saunders *et al.*, 2009; Leedy & Ormrod, 2014). The design of the questionnaire followed the same pattern but responses were limited to three response options: often, seldom and never, or agree, disagree and not sure.

The questionnaires are presented in Appendix B (first round questionnaire) and Appendix C (Second round questionnaire).

### 3.3.4 Reliability and validity of responses

Saunders *et al.*(2009) contend that a questionnaire can only be valid if it is reliable. The consistency of a research instrument measures the reliability to which same results could be attained through repeated trials. Piloting the questionnaire and discussions with some academic and construction industry experts was done to enhance the validity and reliability of the questionnaire. This is consistent with recommendations that success of a questionnaire may not be ascertained without a trial run (Saunders *et al.*, 2009; Leedy & Ormrod, 2014). Reliability and validity of the questionnaire define whether research results could be applied to a wider group other than those that took part in the survey. Threats to reliability and validity include subject error, subject bias, observer error and observer bias (Sekaran, 2003: 203). The next section discusses the data collection strategy that was adopted in the research.

## 3.4 The data

Leedy & Ormrod (2014) define data as pieces of available information that any particular situation gives to an observer making the research to be practical. Data can be collected from primary and secondary sources. Primary data comprises information obtained first hand by the researcher on

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variables of interest while secondary data is generated from existing information sources (Sekaran, 2003: 219–222). Primary data is closest to the truth and research seeks to discover the underlying truths in the various layers of truth and conceived as most valid in comparison to secondary data which is derived from the primary data (Leedy & Ormrod, 2014: 80–81).

### 3.4.1 Primary data sources

Primary data for this research was generated from the research questionnaire based on responses of respondents. The respondents in this research comprised construction industry experts from client, consultant and contractor organisations operating in South Africa.

In compliance with the admissibility of data, primary data in this research was sourced through two rounds of questionnaires. The approach adopted followed the Research Ethics guidelines of Stellenbosch University (Stellenbosch University, March 2015). Based on a literature review of current practices in the construction industry in South Africa, the researcher administered a questionnaire to ascertain whether the quality of project documentation over the project cycle, as produced by the consultants has a bearing on the achievement of projects objectives.

Based on the first round of the questionnaire survey, quantitative and qualitative data was solicited through email on the validity of the results obtained. The purpose of the second round was twofold: to assist the researcher to get a deeper understanding of the expert opinion on the extent and severity of the root cause to poor quality of project documentation and the impact thereof. Secondly, the research sought to learn from the experts the possible approaches to mitigating the impact of poor quality of project documentation.

### 3.4.2 Secondary data sources

The extensive literature study provided secondary data from a wide range of sources which included books, journals, newspapers, government publications, conference presentations and internet websites. The study targeted research done internationally in pursuit of the construction industry practices in general and to examine risk influencing factors that culminate into project delays, cost overruns, reduced quality expectations, efficiency and effectiveness of project delivery. Of interest were the studies that had been conducted specifically for the South African construction industry for example, the CIDB construction industry reports, academic papers and conference papers e.g. (Ofori *et al.*, 1996; Construction Industry Development Board (CIDB), 2004a, 2011; Jerling, 2009;

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Watermeyer, 2012; Kuo, 2012; Roux, 2013; Emuze & Smallwood, 2013; PricewaterhouseCoopers (PwC), 2013; Watermeyer & Laryea, 2014; Consulting Engineers South Africa (CESA), 2014; Marx, 2014; Okonkwo, 2014).

The research adopted a self-screening mechanism by adapting academic and established research processes in developing the research tools with strict adherence to research ethics and included peer reviewed sources in the literature review. Stellenbosch University hosts data in form of books, electronic databases such as: abstracts, Compendex, Citation Index, Google Scholar, Science Direct, Scopus, Statistics SA, SUNscholar and WorldCat. Recent and peer reviewed electronic data bases available within the domain of Stellenbosch University were consulted by the researcher as proposed by Leedy & Ormrod (2014: 82) and Zikmund *et al.*(2010: 65). This was purposely done to isolate relevant data and ascertaining aspects already addressed, perspectives and available data, methodologies, measurement tools and interpretation used by other researchers.

It is largely recognised that risks are threats to project objectives in the project lifecycle and in this research, focus was on the impact of flawed project documentation in the project delivery. The review also examined factors that impact the traditional measure of project performance of time, cost and quality, in addition to the legislation, international procurement trends and conditions of contract. Governance of WB financed programmes were examined to understand how the quality of project documentation compares to that of the South African construction industry environment. The involvement of key stakeholders and how they influence the performance of a project was also explored.

The literature review identified 85 risk factors which were grouped into four broad categories; risk factors causing delays, factors influencing project cost overruns, procurement and legislation risk factors and those risk factors impacting the quality of constructed assets.

### 3.4.3 Acceptability of data

Leedy & Ormrod (2014) suggest that the availability of which data supports the research objective to answer the research questions makes the research to be achievable. Variabilities of the nature in the approach followed in the collection of data may result in unreliable data, which can affect the strength upon which research conclusions are made. The criteria must be defined and adopted as a benchmark for replicability and precision, to establish the limits and standards that all data must comply to be

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admitted for the research (Leedy & Ormrod, 2014: 82). It is therefore appropriate that the research clearly defines what data and characteristics are needed, the location of the data, and the means of obtaining and interpreting the data. The researcher adopted research methodologies guided by accepted methods in form of structure, wording, sequencing, layout and pilot testing with a carefully sampling process.

## 3.5 The research methodology

The questionnaire was the preferred research instrument as discussed in section 3.3.2 and 3.3.3 to obtain the perceptions of the construction industry experts.

### 3.5.1 Study Population

Practical considerations of time and cost limit research studies from being done on an entire population (Fellows & Liu, 2015: 162). A population for the research is defined as an asset of entities from which the research sample is drawn (Fellows & Liu, 2015: 89). Sekaran (2003: 265) further defines a population as an all-inclusive assemblage of people, events, or things of interest that the research intends to investigate. However, the inclusion of all members of the population would be affected by resource constraints. The determination of the study population was guided as presented in Figure 3.1. It is an obligation of the researcher to properly define a representative population which adequately reflects the population heterogeneity in terms of geographic, demographic, biological and other variables such as the clients, consultants and contractors registration requirements (Sekaran, 2003: 267–290).

The population survey targeted professionals in the construction industry in South Africa working for client, consultant and contractor organizations. The qualifications for inclusion in the population sample for consulting engineers were registration with CESA, an annual turnover of R35million and implementation of quality management systems. 47 consulting engineers in the civil engineering, general building, structural engineering, architectural engineering, transportation and project management were targeted out of 577 consulting engineering registered with the CESA in different specialties.

Contractors included those in the general building and civil engineering categories and grades 8 and 9 of the Construction Industry Development Board (CIDB). The total number of contractors in general building (GB) and civil engineering (CE) categories and in grade 8 and 9 is 478.

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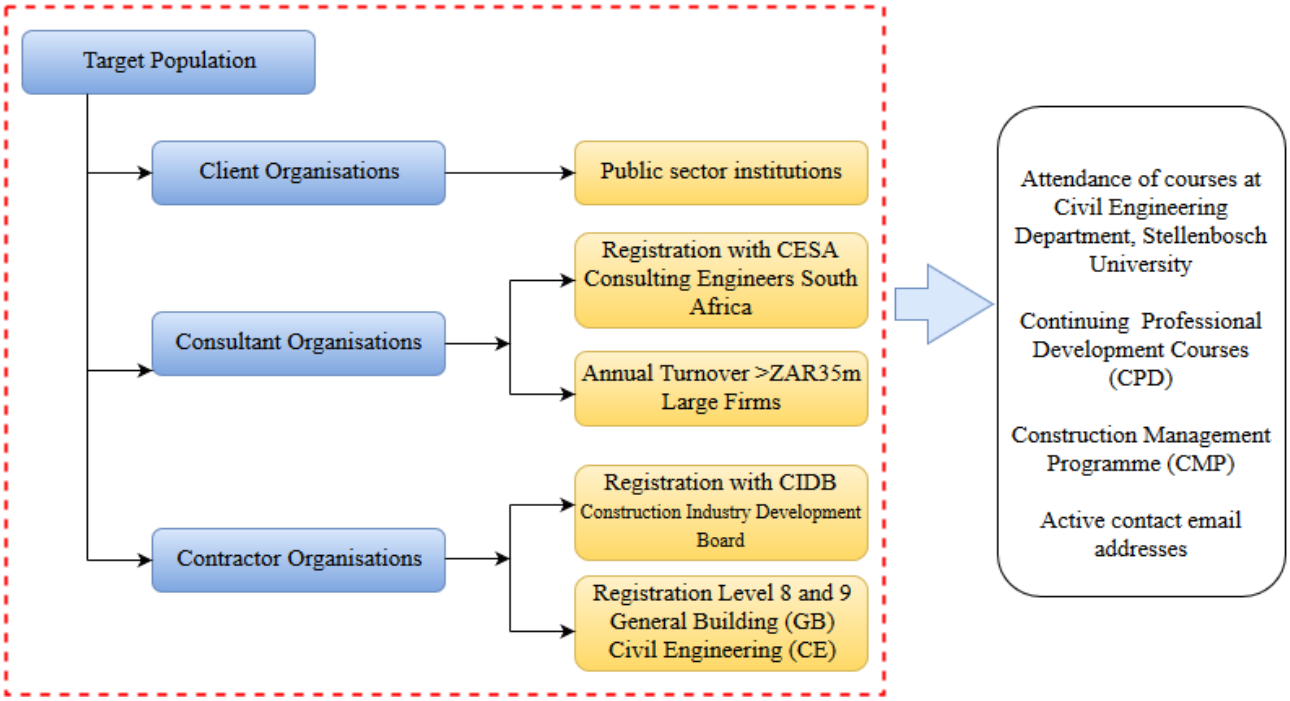


Figure 3.1 Research target population determination

The other prerequisite was accessible contact details i.e. email and/or telephone numbers of the respondents. The researcher also considered participants to the Construction Management Programme (CMP) and to continuing professional development (CPD) courses which are held at the Civil Engineering Department of Stellenbosch University and acceptance of the participants to participate in the survey. The CMP, a jointly organised course by universities of Cape Town, Pretoria, Stellenbosch, and Witwatersrand, was perceived to provide an appropriate sample for the research due to its attributes as discussed by Ofori *et al.* (1996). It is highly recognized in South Africa with the support of the major construction companies and draws together senior executives from major construction companies. The gathering exposes participants to management theories and strategic management, sharing valuable experiences in innovations and management practices from experts around the globe (Ofori *et al.*, 1996).

Public sector financed projects were considered since the government is a major financier of most of the large projects. The research targeted those subjects that have specific exposure and requisite experience to the project environment to objectively provide credible input into the survey. This is consistent with the advice from (Leedy & Ormrod, 2014) who advise that:

> "the sample should be carefully chosen that, through it, the researcher is able to see characteristics of the total population in the same proportions and relationships that they would be seen if the researcher were, in fact, to examine the total population." (Leedy & Ormrod, 2014: 213)

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### 3.5.2 Sampling technique

The sampling techniques adopted the eight sampling approaches (Saunders *et al.*, 2009; Leedy & Ormrod, 2014), that categorise sampling approaches into probability and non-probability sampling methods which are applicable for different situations. Available sampling techniques include simple random sampling, stratified random sampling, proportional stratified, cluster sampling, systematic sampling, convenience sampling, quota sampling and purposive sampling. Random sampling in probability sampling assumes that characteristics of a sample approximate those of the total population (Creswell, 2012; Leedy & Ormrod, 2014).

Probability sampling approaches include simple random sampling for a homogeneous population, stratified random sampling for a population of definite strata and of approximately equal size, a proportional random sampling which defines a population having definite strata of different proportions, cluster sampling, systematic sampling where the population has discrete clusters with similar characteristics. Non-probability sampling methods cover convenience sampling, quota sampling and purposive sampling (Saunders *et al.*, 2009; Creswell, 2012; Fellows & Liu, 2015).

The precision, accuracy and reliability of the information provided for the study relied largely on how active the firm has been over the last 10 years in the construction sector. The level of competence of the technical personnel employed to synthesize the salient aspects allowed the research to align the research findings to the research objectives. The ability of respondents to articulate the issues on general factors affecting the construction industry is a function of academic training and experience. The performance of contractors and consultants relative to regulations governing procurement strategies, factors causing delays, factors impacting on cost overruns, factors impacting on quality and design changes, factors contributing to the quality of project documentation, requires expert input, hence the decision use purposive and snowballing sampling technique.

Although the contractors and consultants are registered into distinct categories defining the level of competency of a particular cluster, in reality, within a particular stratum, the firms may not have the same attributes, for instance past similar assignments undertaken within a particular time, annual turnover, capacity to mobilize or owned equipment, financial capacity and availability of managerial and technical personnel. It was therefore not feasible to use probability sampling methods in this study.

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### 3.5.3 Working population and size

The sample size in research is defined by what has to be done in terms of convenience, reliability and within available resources (Saunders *et al.*, 2009). In this study, all the 144,089 contractors in the CIDB register and in the various disciplines would be eligible subjects, and such a census would provide vital information for the study. However most of these firms are engaged as subcontractors either in the building or civil engineering projects. Additionally, all firms in the CE and GB categories could provide such vital information, although most of the firms, especially in the lower categories might not have traceable contacts. The capacity of such firms to employ qualified technical personnel, who are critical in this study may be limited, hence the decision to consider the 478 registered in Grade 8 and 9 of the CE and GB categories.

The consideration however, was limited to participants of the CMP and CPD programmes for the last 10 years, and had traceable email and physical contact addresses. Available records show that a total of 426 participants had attended these courses, which also includes clients, consultants and contractors. The research therefore considered 525 as the population sample size. This was a limitation as some potential respondents could not be considered for the study.

Requests for the participation in the research was sent through emails and a total of 116 questionnaires were sent to respondents who had agreed to participate in the survey as further discussed in section 4.4.2, Chapter 4. A total of 56 responses were received, 38 from the first round and 18 from the second round. From the results of the first round, key factors influencing quality of project documentation and project delivery were identified and the second round sought clarification from respondents on the aspects identified from the first round. Proposed mitigation measures to ascertain their effectiveness were sent to respondents for comments and the data generated in the second round was both quantitative and qualitative.

### 3.5.4 Data analysis

Quantitative studies may yield statistical evidence of associations and strengths of the variables and such statistical methods, when combined with theory and literature assist in providing direction of the relationships (Fellows & Liu, 2015). Data analysis therefore, provides evidence of relationships and the understanding which supports decision making and it is from the decisions that inferences are derived as conceptualized by Popper (1989) and cited by Fellows & Liu (2015).

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Data was edited to check for completeness, accuracy, inconsistencies and uniformity as suggested by Fellows & Liu (2015: 189–190). The raw data was assembled for analysis and, while identifying the classes and themes of the main findings to establish patterns or relationships, major variables and differences. The results were integrated and summarized to establish the variables and their relationships in accordance with the prescribed steps (Leedy & Ormrod, 2014: 160, 282; Creswell, 2012: 175–201; Fellows & Liu, 2015). Statistical methods provide a powerful tool in interpreting data which assist in providing logical interpretation of research findings and descriptive statistics was used as advocated by Leedy & Ormrod (2014: 282). The Statistica software package was used to aid the analysis.

Statistical analyses that were used in the analysis of the data were mean score (MS) and the overall mean score (OMS) which are presented by equation 1 and equation 2 respectively. The OMS statistical analysis was used to define the relative significance of the risk factors by the three groups, client, consultants and contractors. The expression for MS used, is consistent with approaches used by other researchers who have used the expression for example (Li, Akintoye, Edwards & Hardcastle, 2005; Lo *et al.*, 2006; Yakubu & Sun, 2010; Alkaf, Karim, Rahman, Memmon & Jamil, 2012; Doloi *et al.*, 2012; Hwang, Zhao & Gay, 2013).

The Mean score is given by the following expression:

$$MS_i = \frac{\sum(f\ x\ S)}{N} \qquad \text{Equation (1)}$$

Where, S = the score for each factor.

$f$ = frequency of responses to each score for each factor.

$i$ = the factor being considered.

$N$ = total number of responses in the respective groups for the respective factor.

The Overall Mean Score (OMS) which is used to identify the overall important factors and the formula is an adaptation from Lo, Fung & Tung (2006) as proposed by Chan and Kumaraswamy (1996) and is presented by the following expression:

$$OMS = \sum_{i=1}^{3} MS_{ij}\ \ x\ \ \frac{N_i}{N_1 + N_2 + N_3} \qquad \text{Equation (2)}$$

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Where, $MS$ = is the Mean Score.

$i$ = the group, being clients, consultants and contractors.

$N_i$ = is the number of respondents in each group and j is the *j*th item in each group.

## 3.6 Limitations

The main key stakeholders in the delivery of infrastructure projects are clients, consultants and contractors, and the respective roles of these stakeholders have been discussed in chapter 2, literature review. Based on the literature review and the identified risks which may impact project delivery, the research examined the impact of quality of project documentation by engineering consultants in the delivery of infrastructure projects. The questionnaire was designed to solicit views and the perceptions of the construction industry experts of the risks that impact on KPIs resulting from the poor quality of project documentation. Internet based questionnaires are subject to non-response bias, coverage bias, selection bias and response bias. However, the research required careful consideration of the population sample, hence the preference for purposive and snowballing sampling techniques were adopted. The questionnaire adopted a Five-point Likert scale to counter the bias associated with the internet based questionnaires. This is in accordance with the "7 plus or minus 2" principle as advanced by (Miller, 1956 cited in Zhao, Sui, Low, Zhao, Sui, *et al.*, 2015). Zhao *et al.* (2015) citing Lam et al., 2010, and postulate that this type of rating is convenient since it allows respondents to make their judgement.

Challenges encountered on the internet based questionnaire could have been overcome with personally administered questionnaires. Face to face interviews could have provided the researcher more insights and deeper understanding of the experts (Leedy & Ormrod, 2014; Aleandri & Russo, 2015). Alternatively, focused interviews could have been ideal in comparison to individual interviews. Focused interviews for the research would have provided a platform for a collection of shared understanding from several individuals (Creswell, 2012: 156–157). That platform would have created shared opinion and exchange of ideas among the three interest groups. However, assembling the professionals to a convenient venue would be a challenge. Additionally, the success of the discussions depends on the willingness of members to share ideas and feelings considering that the subject is somewhat sensitive and considering safety, confidentiality, anonymity and informed consent of the respondents. Where there are time constraints, Leedy & Ormrod (2014: 155), proposes that the focus group technique is desirable.

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## 3.7 Ethical considerations

The research has been carried out in accordance with Stellenbosch Research guidelines, (Horn, Graham, Prozesky & Theron, 2015), which highlight the moral and ethical issues of research. In conformity with the ethical considerations, the respondents were briefed of the informed consent for their participation which was attached to the email. The informed consent highlighted privacy, anonymity and complete protection of confidentiality and that there were no anticipated risks to participating in the study.

The questionnaires were administered electronically through the SurveyMonkey software package, where each of the respondents was issued with a link. Consultants, contractors and clients were protected by making the questionnaire anonymous and confidential since the responses were sent without the identity of the respondent. In compliance with Stellenbosch Research ethics guidelines, of March 2015, written informed consent was obtained from all respondents. This statement was provided as an additional attachment to the link, where a "YES/NO" option was provided in the first question of the questionnaire and selection of a 'NO" resulted in the termination of the process.

## 3.8 Chapter summary

This chapter has discussed the research methodology and strategy adopted in the research. Items discussed in the section include the research design and methodology, research strategy, data collection, research methodology, limitations to the research strategy and ethical consideration.

The chapter has presented the research design covering theoretical aspects of research philosophy and research approach. The research strategy has highlighted qualitative and quantitative research strategies, triangulation of data collection, theory to the questionnaire development, format of the questionnaire and concepts relating to the reliability and validity of the chosen research instrument. The methods and definitions of data collection methods, covering the primary and secondary data that were used in the research and acceptability of the data have been discussed. The research methodology has also discussed the chosen population for the study, the sampling technique and sample population and size and how the data is analyzed. The section has further highlighted the limitations in the chosen research strategy and finally ethical considerations were discussed.

The next chapter presents research findings from the results of the first round questionnaire.

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# Chapter 4 Results, analysis and discussion of research findings

## 4.1 Chapter introduction

The methodology presented in Chapter 3 outlined the research strategy that was adopted to explore the relationships between project documentation by consultants and the performance of infrastructure projects in South Africa. Two structured questionnaires, comprising closed and open ended questions were administered to elicit opinion of construction industry experts in South Africa. Respondents were carefully chosen from a cross section of experts from client, consultant and contractor organizations. Infrastructure projects are exposed to risks which are often linked to key project participants whose actions may impact on the other participants. Such actions often result in delays, cost overruns, poor constructability and poor quality of constructed assets, thereby significantly impacting lifecycle costs of the constructed assets. The questionnaires were therefore designed to collect data to explore the influence of project documentation by consultants on the project delivery.

The association between quality of project documentation and project KPIs was examined from the data collected relative to project outcomes. Mitigation strategies that can reduce the impact of risks originating from flaws of project documentation were also sought from the experts.

Ideally, clients and consultants are best positioned to provide relevant information with respect to project documentation. The traditional procurement methods often assume that clients and consultants are actively involved in the project conception and design, with the contractor coming at the far end of the project cycle. Chan and Kumaraswamy, 1997 as cited in Doloi (2013), establish that most project cost overruns are revealed in the construction phase. In this regard, the research incorporated the contractor group even though cost overruns are mostly conceived in the conception and design phases. This realization has been conceptualized by Baldry (1998), that dealing with construction risks involves all participants who have an interest in project outcomes, as cited by Tang, Qiang, Duffield, Young & Lu (2007). Tang *et al.*(2007), further proposes that the collective sum of values, beliefs, and expectations show divergent patterns and are most likely to define the profile of the risk management process. In this research, it is understood that collection of data from such a diverse range of experts, would provide some answers to risks emanating from project documentation by engineering consultants.

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Three sets of questionnaires were administered in the first round, each specifically tailored for the client, consultant and contractor respondents. Most of the questions in the questionnaire sets were identical but some sections were formulated to capture perceptions of the particular groups of respondents.

The chapter provides a summary of the data analysis procedures, and the research findings with respect to project documentation based on the questionnaire survey. The main research findings summarise influencing factors and perceptions of key experts and their perception on the quality of project documentation, factors that characterize the quality of project documentation, key drivers that limit the quality of project documentation and impact of quality of project documentation on project KPIs.

Finally, proposals for improving the quality of project documentation are presented. Analysis of the research findings are performed to unravel risks that have direct relevance to the quality of project documentation and their influence. Recommendations and sub conclusions are then presented.

## 4.2 Outline of chapter

The chapter present results, analysis and discussion of the research findings which include the profile of respondents and key findings on the main tasks that were set to achieve the research objectives. The profile and organizational information of respondents is presented first. Project delivery and influencing factors covering risk factors and project performance, procurement and tendering practices, in particular the selection of consulting services are then summarized. The purpose of examining procurement of consulting services was to establish the most commonly used procurement and tendering methods, perceptions of key industry experts to the selection methods and how the methods compare with international procurement trends.

The chapter then summarises and discusses significant factors impacting project KPIs, specifically delays and cost overruns. Based on the factors impacting these KPIs, the results are analysed to assess their relevance and significance to the quality of project documentation and their risks on project delivery.

A summary is then presented which highlights key influencing factors impacting project

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documentation and project delivery in general. The summary was prepared for feedback to the respondents for the second round of the questionnaire survey. From the second round of the questionnaire, proposals for mitigation measures are subsequently discussed and presented which are drawn from the comments and suggestions of respondents. Figure 4.1 shows the chronology of the presentation of the results of the survey which are presented in Chapter 4 and Chapter 5.

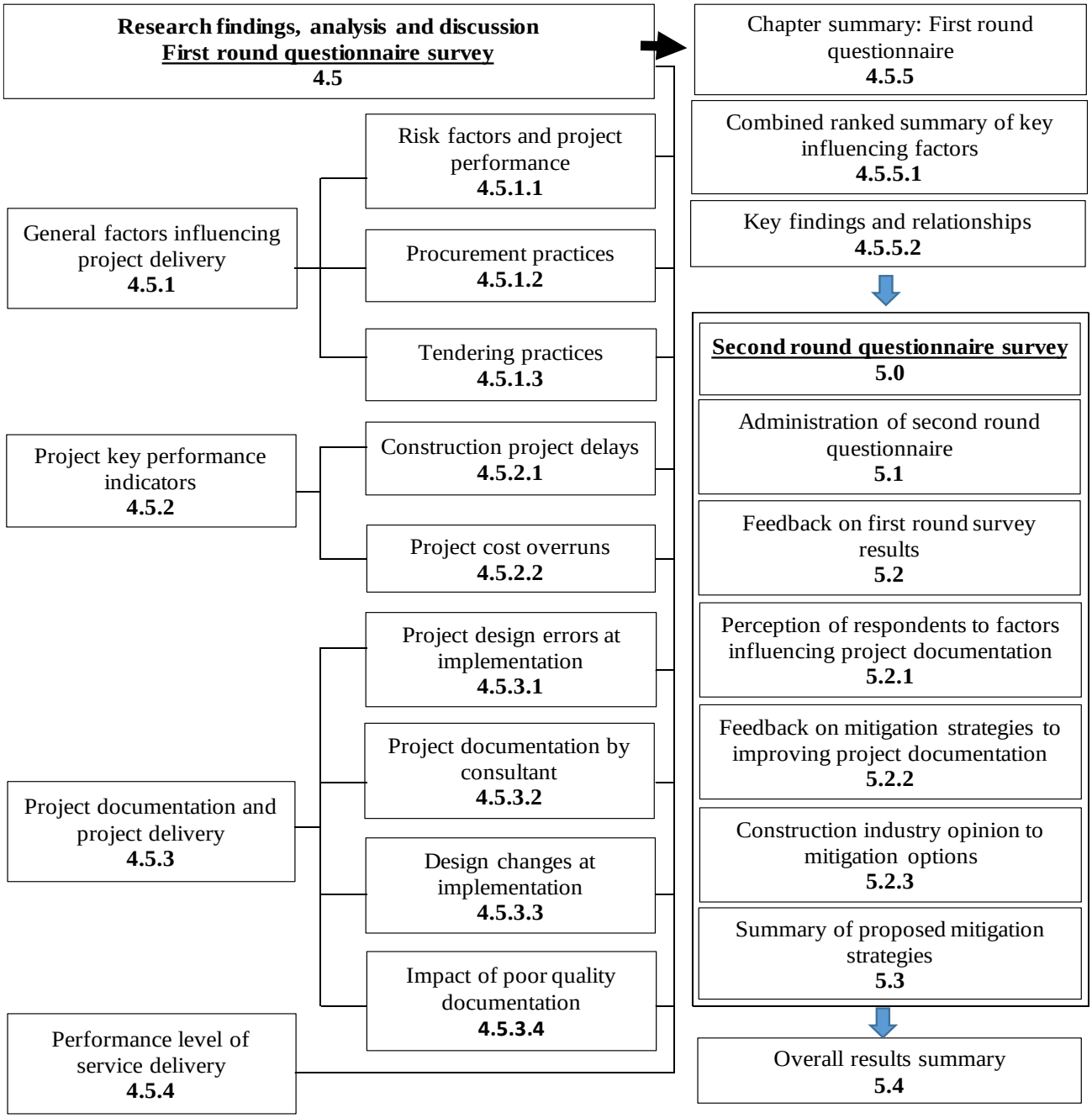


Figure 4.1 Flow diagram illustrating presentation of research findings

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## 4.3 Format and presentation of the questionnaire

The first round questionnaire comprised of 4 sections. The first section consisted of a formal consent and confidentiality aspects relative to the participation of respondents in the survey. The form of consent was attached to the body of the email which introduced the researcher, the subject under investigation and briefly highlighted the conditions of voluntary participation of respondents and instructions for the survey. The form of consent is presented in Appendix A. The three questionnaires with clearly identifiable hyperlinks for the client, consultant and contractor were attached to the body of the email (Appendix A).

In principle, respondents were required to sign, scan and return to the researcher the consent form, in compliance with ethical guidelines and terms of participation in the survey. The process of returning the signed form of consent was perceived to impact the response rate, hence it was replaced by Section One of the questionnaire which had a "YES" and "NO" option. A "YES" option meant the respondent agreed to the terms and would be guided through the rest of the questionnaire. Where the respondent did not agree to the terms of participation in the survey, the respondent would select the "NO" option which terminated the continuation of the questionnaire survey.

Section two of the questionnaire sought the biographical data of the respondent, which captured the type of organization and industry, the age of respondent, academic qualifications and work experience. Specific sub sections of section two captured several factors relative to the research question. The first was the legislation, procurement and tendering practices. The second was set to capture factors that impact project key performance indicators. The third section was to explore influencing factors to quality of project documentation and project delivery.

## 4.4 Measurement and analysis of research findings

### 4.4.1 Measurement of data and scales used

Chapter three, research design and methodology, discussed the measurement and analysis of data. Mean scores (MS) and Overall Mean Scores (OMS) were used in measuring the attitudes of respondents to the research questions. A coding frame which is applicable to attitudinal questions, used ranking and frequency to define the level of agreement and significance of the identified factors as guided by Naoum (2013: 89). The data analysis used in the research adopted the approach used by other researchers who used mean scores to rank important factors in their studies (Li *et al.*, 2005;

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Lo *et al.*, 2006; Yakubu & Sun, 2010; Alkaf *et al.*, 2012; Doloi *et al.*, 2012; Hwang *et al.*, 2013). The statistical software, Statistica version 13.0 and Microsoft Excel 2016 were used to assist in the data analysis, and to measure reliability and consistency of factors.

Likert Scales were used in the survey questionnaire. A Five-Point Likert scale was used in the first round and a Three-Point Likert scale was used in the second round of the questionnaire. The scales, interpretation, application and discussion of the results of the Likert scales are provided in Appendix D (Table D.1, Table D.2, Table D.3, Table D.4, Table D.5, Table D.6 and Table D.7).

### 4.4.2 Questionnaire response rate

Requests were sent to 388 potential respondents for participation in the first round of the survey of which 116 agreed to participate. A total of 116 questionnaires were therefore sent electronically using SurveyMonkey software to the selected clients, consultants and contractors in the Western Cape region in South Africa. The survey target population was respondents from civil engineering and building construction sectors. The survey maintained some heterogeneity in the respondents to enable the survey to capture the impact of the various attributes of respondents representing the key industry roles in the infrastructure delivery. Identification and selection of the individuals were critical to the research taking cognisance that the correctness of the research findings is a function of the representativeness of the population sample.

A total of 56 responses were received, 38 in the first round of the survey and 18 responses were recorded in the second round giving an aggregate total response rate of 48.3%. The response rate is considered acceptable for internet based questionnaire surveys, since it is higher than the minimum 30% as recommended by Saunders, Lewis & Thornhill (2009: 364). The low response rate was anticipated in the study as warned by Creswell (2012), that lack of respondent's personal investment in the study may result in the respondent declining to respond to the questionnaires. Efforts to improve on the response rate consisted of several reminders through emails and personal contacts by the study leader. The response rate in a study for exploration of risk management in small construction projects in Singapore (Hwang *et al.*, 2014), was 17% and the low response rate was attributed to confidentiality and sensitivity of information such that respondents were unwilling to divulge. Similar types of surveys recorded lower response rates e.g. 42% (Olawale & Sun, 2015). Olawale & Sun (2015), cite other studies that have recorded equally lower response rates for example,

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42%, Akintoye and Fitzegerald (2000), 37%, Kumaraswamy and Chan (1998), and 25%, Iyer and Jha (2005).

### 4.4.3 Data reliability and consistency

The profile of respondents exhibited in this study manifest suitability of the chosen sample which suggests adequacy through the suitability of academic qualifications, work experience and the role of respondents in their respective sectors. Over 50% of the respondents are working for firms with over 200 personnel, 49% are in the top and middle management and 51% working in operations. Olawale & Sun (2015), and Jerling, (2009), citing Flannagan and Norman, (1993), agree with the assertion that large construction and consulting firms have the potential of adopting formal project control practices. This may suggest that respondents in this research may have the exposure to risk management processes in the delivery of infrastructure projects.

A Cronbach's Alpha reliability and average inter-item analysis were also conducted to validate the internal consistency of the data sets. Cronbach's Alpha values of greater than 0.7 indicate adequacy of internal consistency which is the minimum standard of acceptability for reliability (Sekaran, 2003; Fellows & Liu, 2015). The acceptable average inter-item correlation for reliability falls between 0.15 and 0.50. Average values were 0.790 and 0.45 respectively for Cronbach's Coefficient Alpha and Inter-item correlation respectively were achieved in this survey, confirming that the data sets were acceptable and reliable for further analysis. The results are consistent with other studies for example Asad & Pinnington (2014), citing Cronbach (1951) and Nunnally (1978). The actual Cronbach's coefficient Alpha and Inter-item correlation values are presented in appropriate sections.

### 4.4.4 Summary of biographical data of respondents

The first section of the first round of the questionnaire was designed to capture demographic data of the respondents. The data captured consisted of the construction sector, grouping in terms of the client, consultant and contractor, the age, the academic qualifications, the level of employment, the size of the institution where respondent works and professional experience.

**(a) Total number of respondents**

Table 4.1 shows the distribution of respondents by grouping and categories of the construction industry and provides an overview of the combined summary of the profile of respondents. The client group constitutes 34%, consulting engineers, 37% and 28% contractors; out of which 76% are from the civil engineering construction sector, 18% building construction and 5% are multidisciplinary

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firms. The distribution also shows that the largest grouping comprises the civil engineering sector. The consultant group had the largest composition followed by the client group. This may suggest that the results may portray trends in the civil engineering sector more than building or other related sectors. However, it is noted that there is no dichotomy in the nature of the project documentation in these two sectors. The results may also suggest a balanced opinion of the client and consultant respondents.

Table 4.1 Distribution of total respondents

| Distribution of respondents | Grouping by class of construction | | | | |
|---|---|---|---|---|---|
| | Civil Engineering | Building | Other | Total | % of respondent group |
| Client group | 11 | 2 | | 13 | 34.2% |
| Consultant group | 11 | 2 | 1 | 14 | 36.8% |
| Contractor group | 7 | 3 | 1 | 11 | 28.9% |
| Total | 29 | 7 | 2 | 38 | 100.00% |
| % of class of construction | 76.3% | 18.4% | 5.3% | 100.00% | |

## (b) Academic qualifications and age of respondents

Most of the respondents participating in the survey, 58%, have attained a postgraduate level of education, while 48% of the respondents are between 36-45 years old as indicated Figure 4.2.

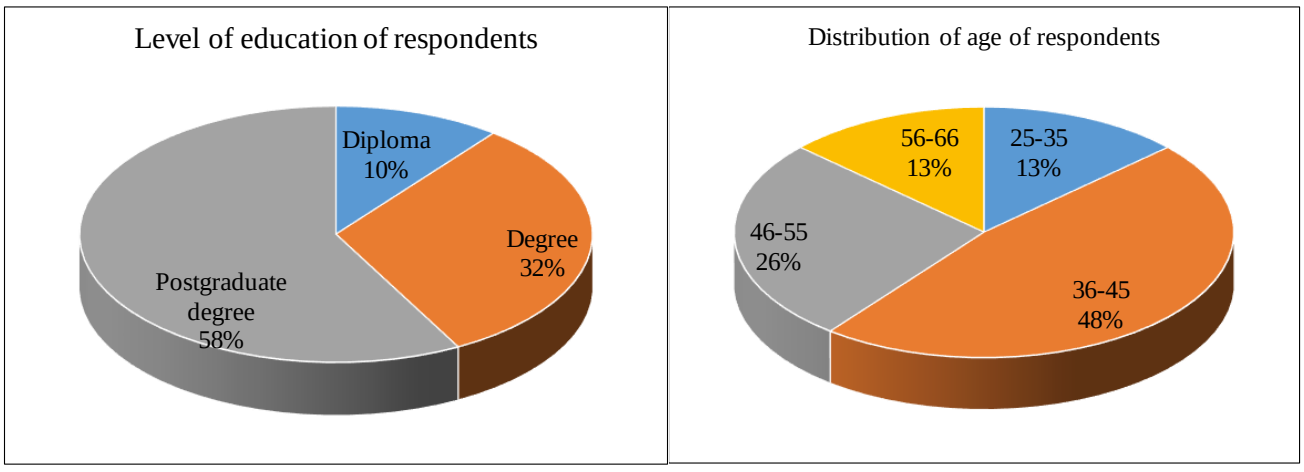


Figure 4.2 Level of education and age of respondents

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### (c) Work designation and size of organisation

The professional level of employment of respondents and size of institutions where respondents are engaged are presented in Figure 4.3. The profile of respondents comprises those in the management and operations positions in the respective respondent organisations. 27% of the respondents are in top management positions, 22% middle management and 51% in operational positions. In relation to the size of institutions, 51% work in institutions with a work force of more than 200, 22% in institutions with 50-200 workforce, and 27% with less than 50.

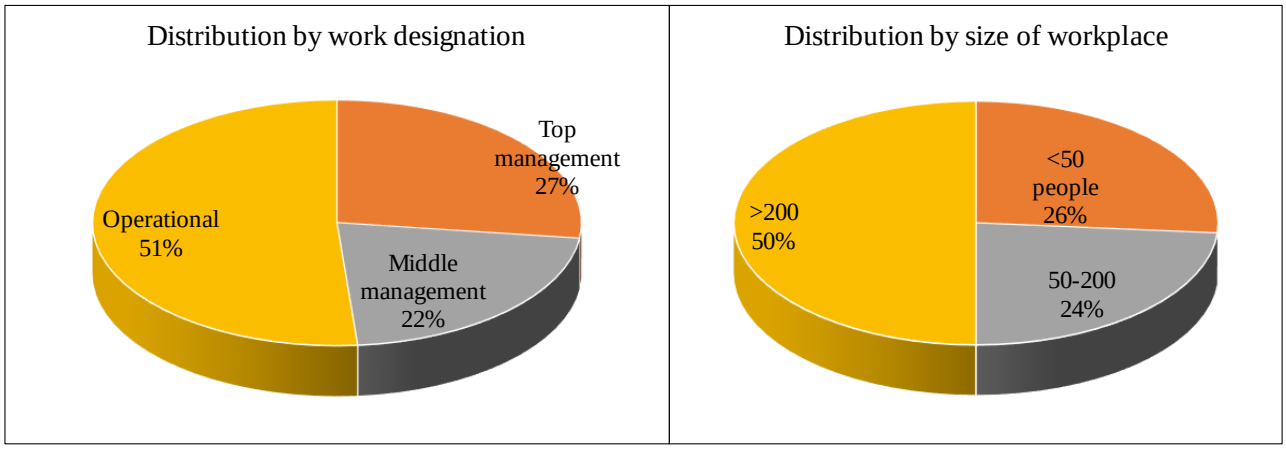


Figure 4.3 Distribution by work designation and size of work place

### (d) Summary of work experience

Respondents were also requested to indicate their working experience as shown in Figure 4.4. From Figure 4.4, it can be shown that 60% of the respondents have over 16 years of experience of which 34% have working experience of more than 20years. 26% have experience of more than 16 years, 29% between 11 and 15 years and 11% has experience less than 11 years.

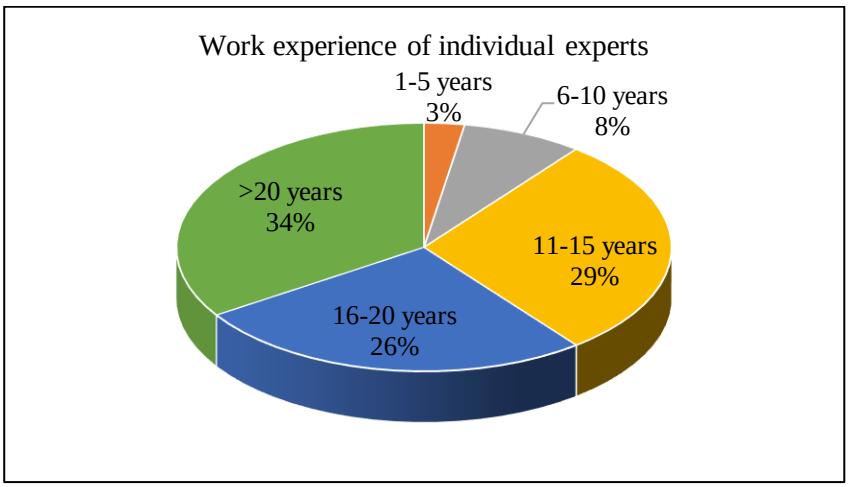


Figure 4.4 Work experience of individual experts

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### (e) Summary of profile of respondents

Project documentation by consultants in infrastructure projects may influence project deliverables at different stages of the project life cycle. Project documentation includes work specifications, design drawings, schedule of quantities and quality assurance systems. The calibre of respondents in the survey population has a direct influence on the reliability of data collected since it impacts on the understanding and realisation of the concepts relative to the quality of project documentation, project risks and the impact of quality of project documentation on the project KPIs.

In consideration of 58% of respondents having achieved postgraduate qualifications, 49% in the top and middle management and 60% with over 16 years' construction experience, it provides a suitable degree of reliability of the data obtained in the research. The academic and senior managerial level of the respondents suggest that the respondents have the requisite attributes to understand and explain important concepts with respect to project documentation in the construction industry.

## 4.5 Research findings, analysis and discussion

The research aims to learn from construction industry experts the association that exists between project documentation and project delivery. This section is modelled to present results, interpretation, and relationships of the data sets, to address the four research objectives:

- Firstly, the research intends to explore the factors that define the quality of project documentation as produced by consulting engineers and the associated risks that impact project objectives.
- Secondly, it investigates factors that influence the quality of project documentation.
- Thirdly, to explore the impact and linkages that exist between the quality of documentation and project outcomes.
- Fourthly, it seeks to explore the mitigation strategies that the industry can adopt to improve project delivery through improved quality of project documentation.

In addressing the research objectives, the questionnaire was tailored to identify the risk factors that impact project delivery. Mean scores (MS) and the overall mean score (OMS) were used in the analysis of data using the expressions provided in Section 3.5.4 in Chapter 3. Results of the first round of the survey are presented through four main subheadings.

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A summary of key influencing factors to key project performance indicators set the platform for discussions of the results of the second round of the questionnaire survey which are presented in Chapter 5.

### 4.5.1 General factors influencing project delivery

This section presents results of findings relative to general factors influencing project delivery. The results are presented under three sub headings as shown in Figure 4.5, namely, risk factors and project performance, procurement and tendering practices.

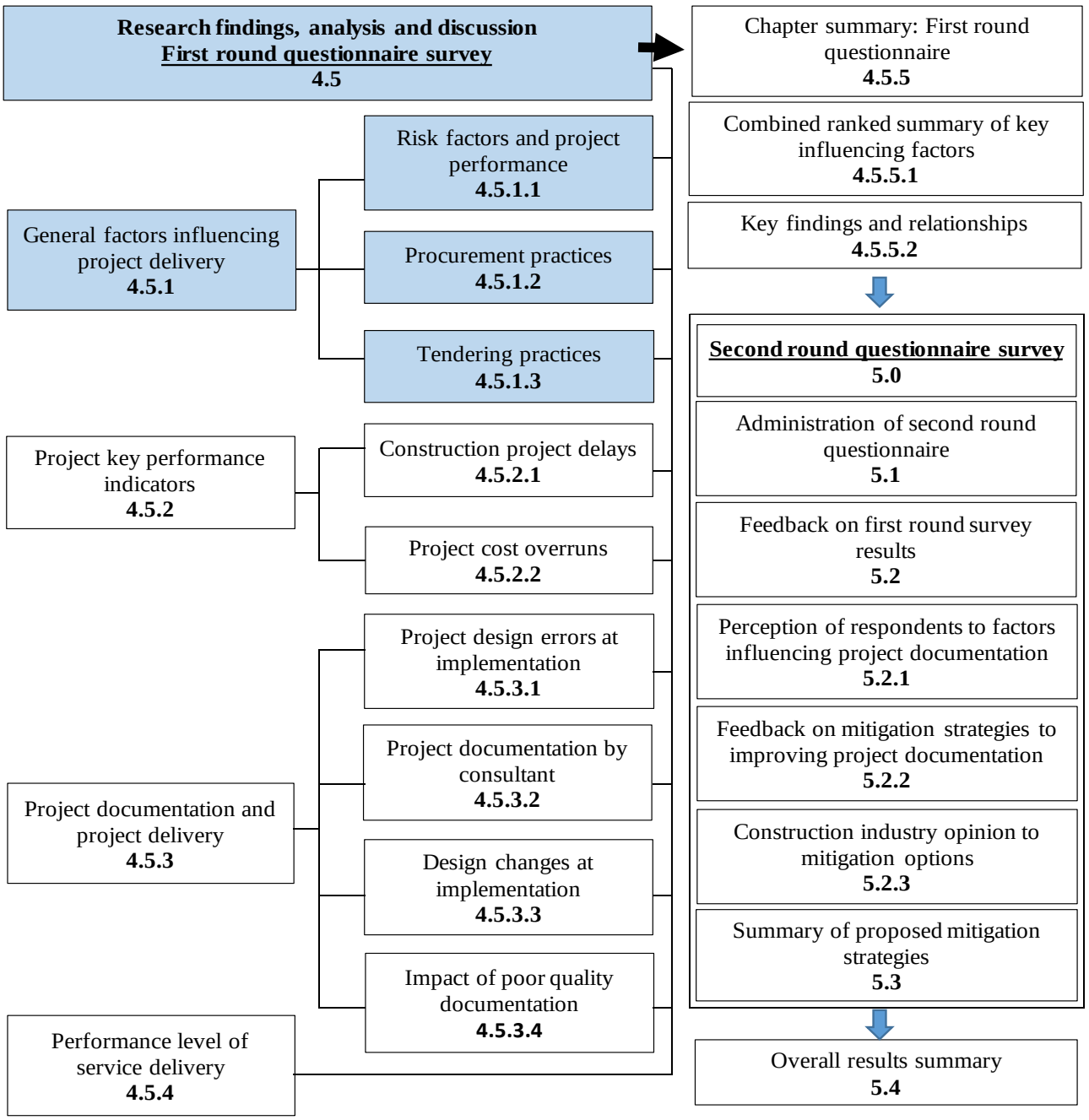


Figure 4.5 Presentation of results of general factors influencing project delivery

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#### 4.5.1.1 Risk factors and project performance

Respondents were requested on a Five-Point Likert scale of strongly disagree (1) to strongly agree (5) (Table D.1), the extent to which the identified factors influence the performance of the consultants thereby limiting project delivery. The questions in this section of the questionnaire were set to solicit the opinion of respondents regarding legislation and construction environment and project performance with respect to quality, cost and time.

**(a) Responses and observations on general factors influencing project delivery**

The results provided in Table 4.2 show the overall mean scores (OMS), and group mean scores for each respondent group. The data sets presented in Table 4.2 show internal consistency and are sufficiently correlated to yield a single concept with Cronbach's Coefficient Alpha value of 0.747 and an Average inter-item correlation of 0.23.

Table 4.2 General factors limiting project delivery

| Factor No. | General factors influencing project delivery | OMS | Rank | Group Mean Scores | | |
|---|---|---|---|---|---|---|
| | | | | Client group | Consultant group | Contractor group |
| F11 | Exceptionally low fees due to competition | 4.41 | 1 | 4.38 | 4.79 | 3.90 |
| F6 | The procurement methods by government departments influence the level of service of key project participants | 4.08 | 2 | 3.92 | 4.21 | 4.10 |
| F8 | Inadequate experience of contractor/consultant result in poor delivery of service | 4.00 | 3 | 4.62 | 3.79 | 3.50 |
| F10 | Lack of technical skills among contractors and consultants | 3.84 | 4 | 4.38 | 3.50 | 3.60 |
| F9 | Contractor's/consultant's lack of project management practices | 3.81 | 5 | 4.23 | 3.43 | 3.80 |
| F4 | New forms of contracts (NEC3, Design and Build, PPP) empower project participants in the services they provide | 3.76 | 6 | 4.15 | 3.21 | 4.00 |
| F7 | Clients often have unrealistic requirements which limit performance of key project participants | 3.52 | 7 | 3.23 | 3.79 | 3.50 |
| F3 | Traditional forms of procurement (Design Bid and Build) limit key participants in the services they provide | 3.43 | 8 | 4.08 | 2.71 | 3.60 |
| F5 | There is too little participation of client at project design phase | 3.32 | 9 | 3.31 | 3.21 | 3.50 |
| F1 | Legislation on award of contracts limits a contractor or consultant in the delivery of services | 3.19 | 10 | 2.85 | 3.50 | 3.20 |
| F2 | Traditional contract forms is a limitation to contracting services | 2.65 | 11 | 3.00 | 2.29 | 2.70 |

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The results show that low professional fees (F11, OMS=4.41), is agreed upon by the three respondent groups as the main influencing factor to the achievement of project objectives. In the opinion of the consultants, low professional fees also have the largest influence and impact on the service delivery by the consultant (MS>4.79).

Notably, the other factors as presented in Table 4.2, (F4, F3, F2, F1) are linked to compliance with legislation requirements which are related to procurement strategies. The legislation is an aspect that the public sector clients may consider the possible review in consultation with regulatory bodies (CESA, SAICE and ECSA). Specifically, the procurement legislation may take cognisance to enable the procurement process to be synchronized with international practices. A review of the literature reveals that NEC form of contract, design and build and PPP procurement strategies, provide a platform for equitable or fair distribution of project risks and this has been observed by the respondents in this survey.

The impact of the traditional form of procurement is also recognised by respondents as having a significant impact and influence, which confirms research findings in previous studies, both in South Africa and across the borders. However, due to the adversarial relationship promoted by this procurement strategy, all project players should demonstrate vigilance in their respective tasks in the project delivery, with the client taking a leading role as shown the rating for factors (F4, F7, F3, F5, F1 and F2). The general conditions of contract (GCC), the Joint Building Contracts Committee (JBCC), are the main forms of contracts used in the administration of contracts, in addition to FIDIC and NEC. The traditional forms of contract have been ranked the least in this survey by respondents (F2, OMS=2.65), suggesting that forms of contracts used in South Africa have moderate influence in the delivery of infrastructure projects.

Table 4.3 provides ranked and varied perceptions of the three groups regarding the most significant influencing factors limiting project delivery. However, it is observed that among the groups perceptions, low professional fee, personnel skills are procurement strategies are the most significant attributes.

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Table 4.3 Perceptions of the three groups on factors impacting project performance

| Client group | | | Consultant group | | | Contractor group | | |
|---|---|---|---|---|---|---|---|---|
| Ranked factors according to client group perception | | | Ranked factors according to consultant group perception | | | Ranked factors according to contractor group perception | | |
| F8 | 4.62 | Inadequate experience of contractor/consultant result in poor delivery of service | F11 | 4.8 | Exceptionally low bids due to competition | F6 | 4.10 | The procurement methods by government departments influence the level of service of key project participants |
| F11 | 4.38 | Exceptionally low bids due to competition | F6 | 4.2 | The procurement methods by government departments influence the level of service of key project participants | F4 | 4.00 | New forms of contracts (NEC3, Design and Build, PPP) empower project participants in the services they provide |
| F10 | 4.38 | Lack of technical skills among contractors and consultants | F8 | 3.8 | Inadequate experience of contractor/consultant result in poor delivery of service | F11 | 3.90 | Exceptionally low bids due to competition |
| F9 | 4.23 | Contractor's/consultant's lack of project management practices | F7 | 3.8 | Clients often have unrealistic requirements which limit performance of of key project participants | F9 | 3.80 | Contractor's/consultant's lack of project management practices |
| F4 | 4.15 | New forms of contracts (NEC3, Design and Build, PPP) empower project participants in the services they provide | F10 | 3.5 | Lack of technical skills among contractors and consultants | F10 | 3.60 | Lack of technical skills among contractors and consultants |
| F3 | 4.08 | Traditional forms of procurement (Design Bid and Build) limit key participants in the services they provide | F1 | 3.5 | Legislation on award of contracts limits a contractor or consultant in the delivery of services | F3 | 3.60 | Traditional forms of procurement (Design Bid and Build) limit key participants in the services they provide |
| F6 | 3.92 | The procurement methods by government departments influence the level of service of key project participants | F9 | 3.4 | Contractor's/consultant's lack of project management practices | F8 | 3.50 | Inadequate experience of contractor/consultant result in poor delivery of service |
| F5 | 3.31 | There is too little participation of client at project design phase | F4 | 3.2 | New forms of contracts (NEC3, Design and Build, PPP) empower project participants in the services they provide | F7 | 3.50 | Clients often have unrealistic requirements which limit performance of of key project participants |
| F7 | 3.23 | Clients often have unrealistic requirements which limit performance of key project participants | F5 | 3.2 | There is too little participation of client at project design phase | F5 | 3.50 | There is too little participation of client at project design phase |
| F2 | 3.00 | Traditional contract forms is a limitation to contracting services | F3 | 2.7 | Traditional forms of procurement (Design Bid and Build) limit key participants in the services they provide | F1 | 3.20 | Legislation on award of contracts limits a contractor or consultant in the delivery of services |
| F1 | 2.85 | Legislation on award of contracts limits a contractor or consultant in the delivery of services | F2 | 2.3 | Traditional contract forms is a limitation to contracting services | F2 | 2.70 | Traditional contract forms is a limitation to contracting services |

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**(b) Lessons from the general risk influencing factors and construction environment**

In respect of competition, fees discounting and fees preference in the award of tenders puts the consultancy fees on the downward scale in South Africa. It is contended that consulting services are of standard nature, and this results in most clients to consider price as the determining factor (Sturts & (Bud) Griffis, 2005). The competitive environment provides for consultants to voluntarily reduce fees to offer a competitive pricing advantage. However, it was recorded in the survey that there are indeed challenges with competitive tendering in the context of South Africa, where it is confirmed that professional fees discounting takes precedence, as observed in the comments cited below:

- "*It could be true for certain Consultants, but a prudent consultant will deliver quality irrespective of fees*."

- "*Having to compete with consultants who offer highly discounted prices and deliver substandard quality work, cut corners and do not comply with legislative requirements is resulting in many more design issues being experienced. Clients need to consider the potential poor quality services they will get (even from reputable companies) if they are offered highly discounted prices."*

The findings are consistent with findings by various authors and stakeholders in South Africa. Legislative requirements relating to fees have been investigated with respect to construction industry performance, and findings have suggested a need for a review of the compensation methods for consultancy services contracts (Okonkwo, 2014; Consulting Engineers South Africa (CESA), 2015). In the United States of America it was predicted that achievement of quality in the consultancy services would be impossible without a thorough review of the practice to published professional fees scales (Carr & Beyor, 2005). Other authors note of the requirement to explore possibilities of determining fair and realistic market prices for consultancy services (Sturts & (Bud) Griffis, 2005).

Acknowledgement by the client and contractor groups on the benefits of other procurement strategies (F4, OMS=3.81), testify the need for the public sector clients to embrace procurement practices that may encourage collaboration. Reports have recorded that procurement practices that encourage collaboration to promote innovation in construction projects (Wright & Fergusson, 2009; Umar *et al.*, 2013). However, procurement strategies embracing collaborative practices in some instances have

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raised accountability concerns with such relationships misconstrued and linked to corrupt practices, for example in Australian public sector projects (Ling, Ong, Ke, Wang & Zou, 2014). In the Chinese construction industry, the lack of training and innovation by public sectors clients are cited as barriers to adopting partnering contracting strategies (Ling *et al.*, 2014).

Studies showing similar trends of factors influencing project delivery are presented in Table 2.5, in the literature review.

#### 4.5.1.2 Procurement and contract models commonly used in South Africa

To identify the procurement strategies and contract models that are often adopted by clients in the delivery of infrastructure in South Africa, the client group was requested to rate the frequency of use of procurement models and contract forms on the scale of always (5) to never (1) (Table D.2). The purpose was to allow the client group to explain how frequently the traditional design-bid-build, design and build, construction management and PPP, and other contract forms, for example the New Engineering Contract (NEC) have been used in the last five years.

**(a) Procurement strategies and contract models: common trends**

The results presented in Figure 4.6 show a diverse range of procurement, tendering and contract models that are used in South Africa. In consideration of the frequency, the assumption has combined mostly and always in estimating the frequency of procurement strategies and forms of contract used in the delivery of infrastructure projects in South Africa.

The results show that 55% of contract awards are mostly based on the traditional procurement methods. Design and build, 13%, Construction Management, 23% and 6% for PPP. The NEC form of contract is used in 6% of the projects. It is evident from this survey that the traditional procurement model is the predominant model used by client organisations in infrastructure delivery in South Africa with other models used to a lesser extent.

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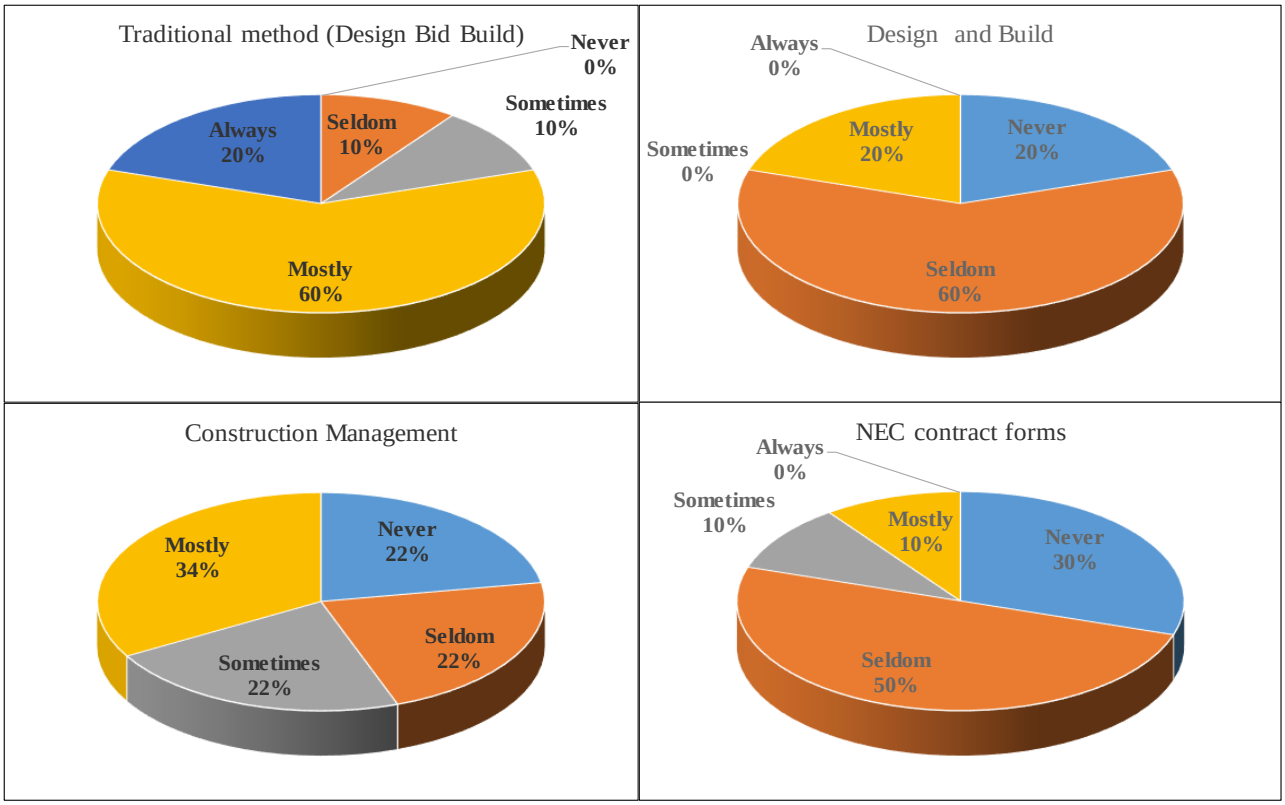


Figure 4.6 Procurement strategies and contract forms used by client organizations

### (b) Procurement and contract models: significance and lessons

The results show that there is propensity by South African clients' preference to traditional procurement methods in preference to other available alternatives. In most government operations, there is more focus on predetermined budgets prior to committing financing for infrastructure projects. Additionally, there is perceived leverage over finances with traditional procurement strategy although the strategy inevitably shifts most of the risk to other project participants. Studies reveal that the use of alternative approaches as opposed to traditional methods, promote collaboration, reduces likelihood of conflict with possibility of early resolve of conflict, in addition to offering value for money (Egan, 1998; Wright & Fergusson, 2009; Umar *et al.*, 2013; Fulford *et al.*, 2014; Spang & Riemann, 2014; Emuze, Kadangwe & Smallwood, 2015).

However, the application of these new forms is a function of skills availability within the client organizations. It requires a well-informed client to conceptualise design risks, construction risks, lifecycle costs, financial risks and service delivery risks, transferred through the adoption of other procurement strategies that promote collaboration. Rwelamila & Edries (2007) argue that the preference for a particular system suggests a lack of knowledge of the available options. Other studies

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also inform that lack of knowledge is also perceived as a lack of consultants to adequately advise clients of the available procurement alternatives (Rwelamila & Edries, 2007). Some research findings allege that most South African consultants have limited understanding and application of value management and that where it is applied, it is seldom aligned to international standards (Bowen *et al.*, 2009).

With respect to the traditional procurement strategy, which places much emphasis on competition, Eriksson & Westerberg (2011), advise that this form of procurement should be reserved for simple and standardized projects which have insignificant risks. It is also reasoned that continued use of traditional procurement methods is a hindrance to improved performance not only in SA, but also in other countries in Sub Sahara Africa e.g. Malawi (Emuze *et al.*, 2015).

### (c) Procurement strategy and performance of the contractor

The Procurement strategy adopted by the client has been perceived to undermine the performance of the contractor. The research therefore further probed the perception of the contractor group on a scale of strongly disagree (1) to strongly agree (5) (Table D.1), the extent to which procurement strategies adopted by clients in South Africa influence the performance of a contractor. Results of the perception of contractors are presented in Figure 4.7 and show that 54% are satisfied with the procurement strategies adopted by clients. This may suggest that procurement strategy somehow has a significant influence in the delivery of projects.

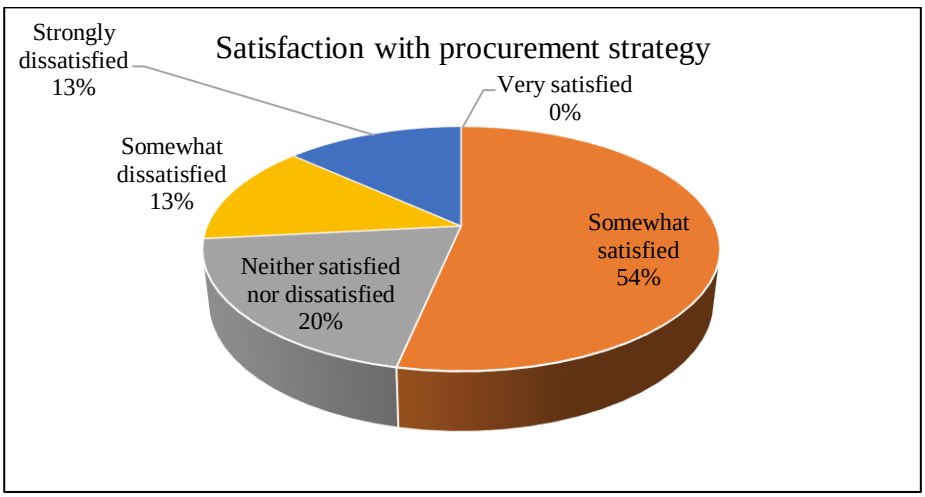


Figure 4.7 Influence of procurement strategy adopted by client

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### 4.5.1.3 Tendering practices and strategies in South Africa

Client organisations adopt different tendering practices as guided by the prevailing legislation. To get an insight into the tendering practices, the client group was requested to rate the procurement, tendering practices and motivation for use of such practices in their respective organizations on the scale of always (5) to never (1) (Table D.2.). The results presented in this section provide an overview of the trend of procurement and tendering strategies in the South African construction industry.

#### (a) Services and works administration (TM1 AND TM2)

With reference to Figure 4.8, 60% of consultancy services and 70% of works contracts are predominantly procured through open tender procedures.

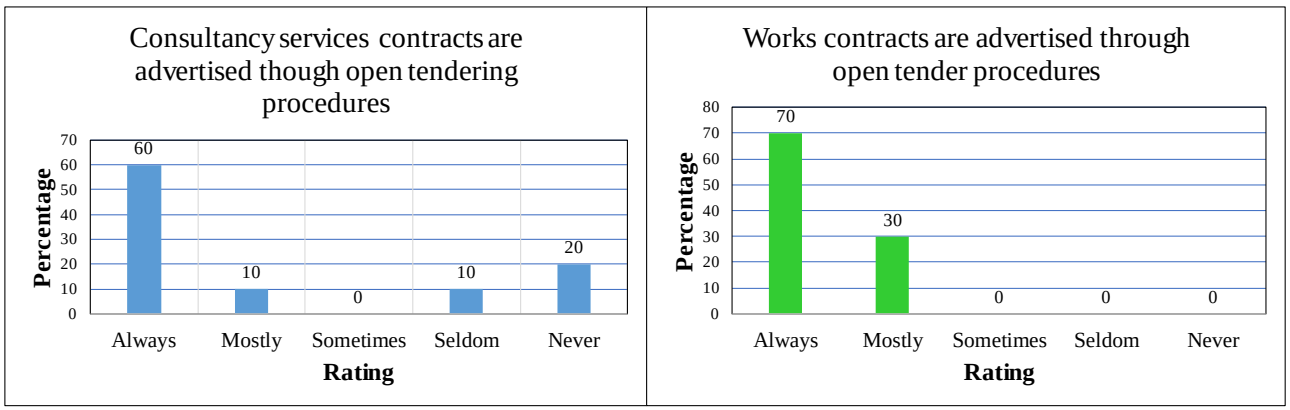


Figure 4.8 Tendering practices: consultancy services and works contracts

#### (b) Award of consultancy services and works contracts (TM3, TM4)

In most client organisations, 60% of consultancies are awarded based on quality and cost, while 60% of works contracts are awarded based on least cost evaluated bids (Figure 4.9).

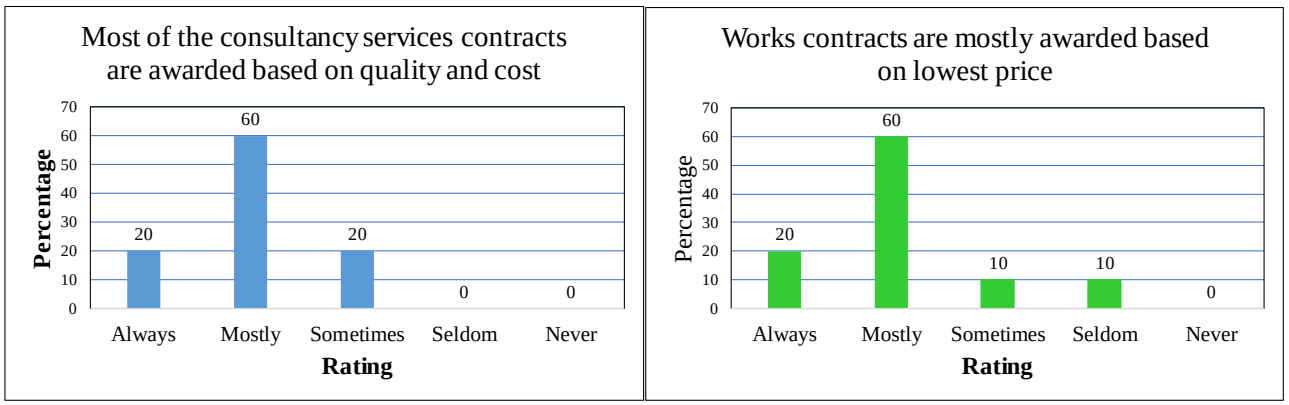


Figure 4.9 Contract award criteria: consultancy and works

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### (c) Consultancy services implementation model (TM6, TM7)

The results presented in Figure 4.10 shows that in some client institutions, 70% of consultancy services are outsourced mostly due to lack of capacity. 40% of client institutions have the capacity to undertake detailed engineering design.

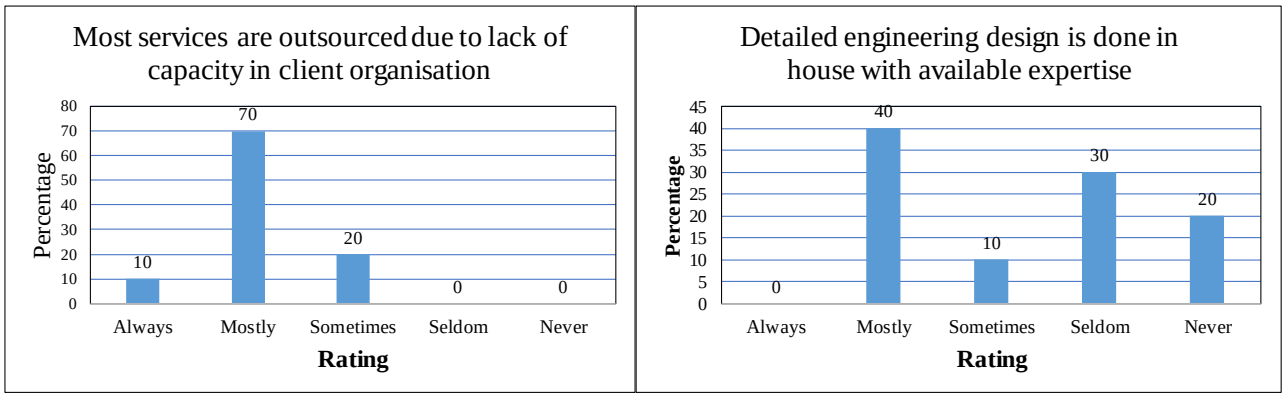


Figure 4.10 Tendering: outsourcing and awards of contracts

### (d) Contracts award criteria

Figure 4.11 suggest that in some client institutions, 40% of contracts are mostly awarded without factoring in other attributes.

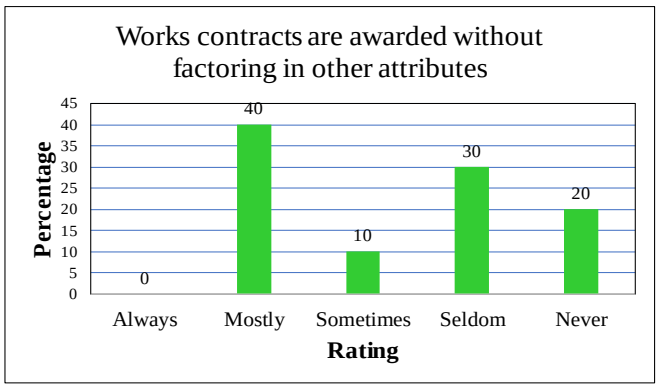


Figure 4.11 Contract award criteria

The findings on the tendering and awards of contracts, are consistent with the compliance to the provisions of Act No. 108 of 1996, Section 217 of the constitution of South Africa on procurement regulations (Republic of South Africa, 1999) and the South African National Standard for public

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sector clients (SANS 10845-1 (ISO 10845-:2010), 2015). The provisions require clients to consider preference points in the evaluation and award criteria. The results therefor also suggest that:

- There is an apparent shortage of skills in some client organisations as revealed by results presented in Figure 4.10, and this confirms findings of the CIDB construction industry report (Construction Industry Development Board (CIDB), 2011), and the 2015 public sector supply chain management (SCM) review (National Treasury, 2015a), and the reports testify that:

    - The procurement in some public sector entities put more consideration on price and preference only with no cognisance of functionality.
    - There is apparent inconsistency in incorporating quality in the evaluation criteria for consultancy services contracts due to capacity constraints in some public sector establishments.

- Contract awards consider not only quality and cost but also other factors. An indication of this trend is observed in the research findings by the 40% agreement of awards having to consider other factors (Figure 4.11). This may also confirm the use of horizontal policies in the evaluation criteria, for example, the Preferential Procurement Policy, the BBBEE, as advanced in the public procurement policy framework (Helmrich, 2014).

- The results may also suggest that the research captured both public and private sector clients.

### 4.5.2 Project key performance indicators

Results of influencing factors on two of the traditional key performance indicators in the delivery of infrastructure projects are presented in this section. Project delays and project cost overruns are two of the three traditional KPIs used for the measure of success of project performance that are discussed in this section as guided in Figure 4.12.

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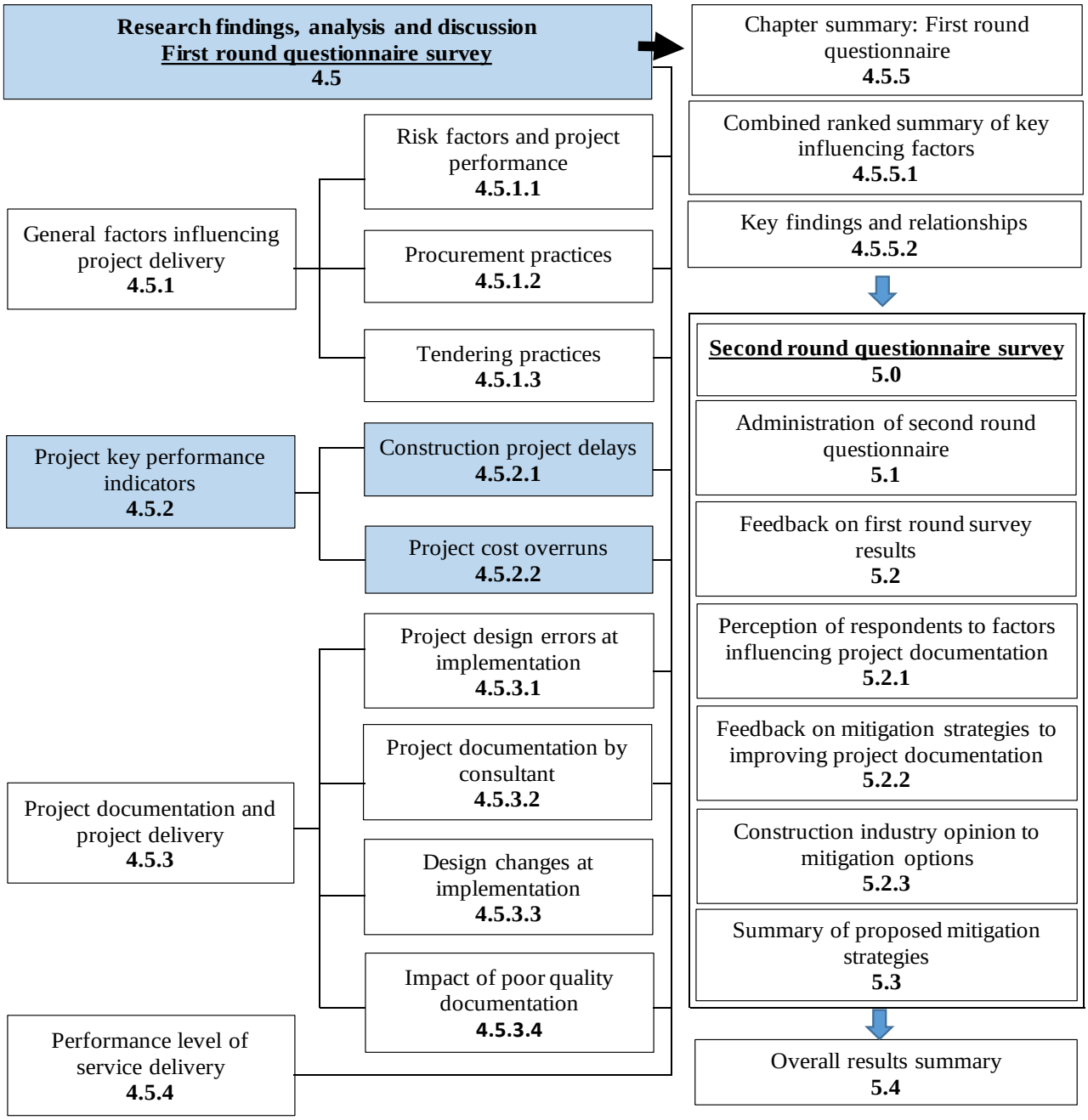


Figure 4.12 Presentation of results on key performance indicators: delays and cost overruns

### 4.5.2.1. Construction project delays

Project delivery time is one of the three traditional KPIs in the delivery of infrastructure projects. Through literature review, 18 risk factors were identified that have the potential of impacting project delivery time. For each of the statements, experts in all the three construction groups were requested to respond on a scale of strongly disagree (1) to strongly agree (5) (Table D.1), the extent to which the given factors contribute towards project delays.

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The ranked Overall Mean Scores (OMS) and the individual group perceptions are presented in Table 4.4. Figure 4.13 shows a graphical presentation of the ranked group perceptions to the factors influencing project delays based on ranked Mean Score (MS). The data sets presented in Table 4.4 show internal consistency and sufficiently correlated to yield a single concept with Cronbach's Coefficient Alpha value of 0.798 and an Average inter-item correlation of 0.19.

Table 4.4 Ranked overall mean scores of factors influencing project delays

| Factor No. | Factors contributing to project delays | Rating | | | | |
|---|---|---|---|---|---|---|
| | | OMS | Rank | Group Mean Scores | | |
| | | | | Client group | Consultant group | Contractor group |
| F13 | Client variations leading to changes in scope | 4.09 | 1 | 3.70 | 4.21 | 4.43 |
| F16 | Lack of communication among the project participants | 4.01 | 2 | 3.90 | 4.21 | 3.86 |
| F12 | Many design changes at implementation | 3.99 | 3 | 3.80 | 3.86 | 4.43 |
| F19 | Unclear and inadequate details in drawings | 3.90 | 4 | 4.00 | 3.64 | 4.14 |
| F25 | Unrealistic contract duration imposed by client | 3.82 | 5 | 3.60 | 3.79 | 4.14 |
| F17 | Lack of skilled and experienced technical personnel | 3.77 | 6 | 4.20 | 3.93 | 3.00 |
| F15 | Inadequate experience of the consultant | 3.76 | 7 | 3.70 | 3.64 | 4.00 |
| F21 | Poor site management and supervision by the consultant | 3.71 | 8 | 4.10 | 3.36 | 3.71 |
| F27 | Mistakes and discrepancies in contract documents | 3.69 | 9 | 4.10 | 3.29 | 3.71 |
| F20 | Lack of quality control | 3.65 | 10 | 4.20 | 3.71 | 2.86 |
| F14 | Delays in approving drawings by client | 3.60 | 11 | 3.20 | 3.79 | 3.86 |
| F18 | Adversarial/confrontational culture | 3.54 | 12 | 3.40 | 3.64 | 3.57 |
| F29 | Delay in progress payment by client | 3.49 | 13 | 3.40 | 3.71 | 3.29 |
| F28 | Interference by client/owner in construction operations | 3.36 | 14 | 3.20 | 3.36 | 3.57 |
| F24 | Excessive bureaucracy in project owner operations | 3.31 | 15 | 3.20 | 3.64 | 3.00 |
| F26 | Slow response by the consulting engineers in performing testing and inspection | 3.25 | 16 | 3.20 | 2.86 | 3.86 |
| F23 | Unrealistic inspection and testing methods proposed in contract | 2.74 | 17 | 2.90 | 2.50 | 2.86 |
| F22 | Poor definition of payment milestones | 2.73 | 18 | 2.80 | 2.79 | 2.57 |

The results presented show that the most influencing factor to project delays is client variations F13 (OMS=4.09), which lead to project scope changes, and in some cases project cost overruns. The consultant and contractor groups agree that the client initiated changes are the most influencing factor and it shows that it has the highest impact on project implementation time.

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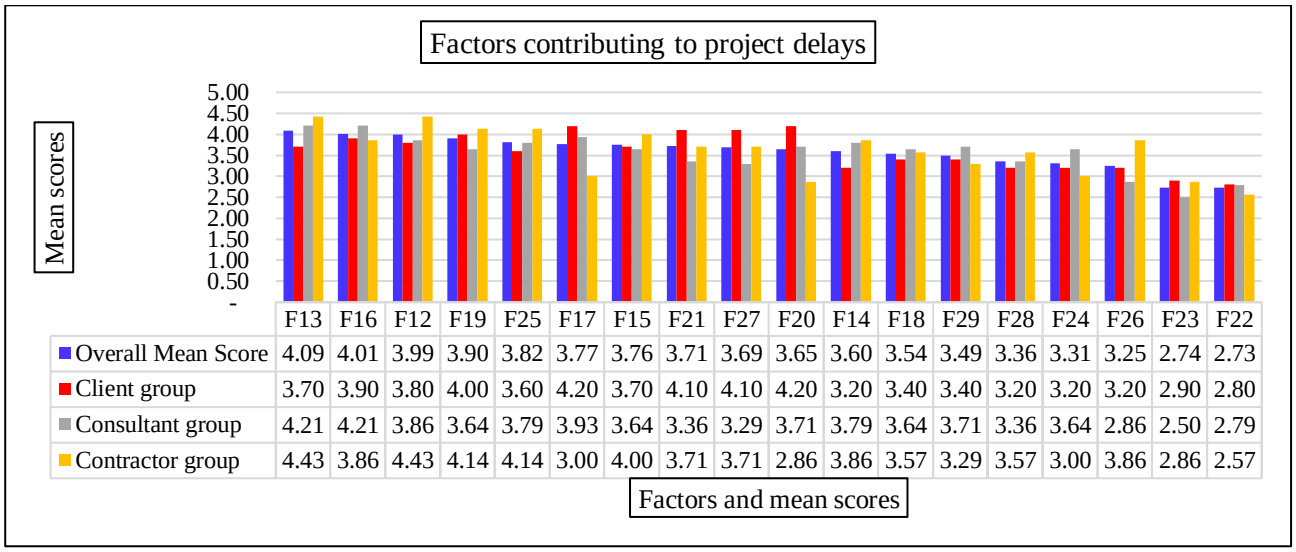
In contrast, the client group rates personnel skills and lack of quality control in the consultant team as the most influencing factor to project delays F17 (MS=4.20) and F20 (MS=4.20). Of the 18 factors, six have moderate influence and impact, OMS<3.5 (F29, F28, F24, F26, F23 and F22). The rest (F12, F19, F25, FF17, F15, F21, F27, F20, F14 and F18, have high influence and impact on project delivery time (OMS>3.51).

Some of the influencing attributes that are linked to the client are procurement strategy and personnel skills (F13, F25 and F14), all of which have high impact and influence to project delays. The high ranking of client variations (F13) as the most influencing factor to project delays, may suggest that there is minimal involvement of the client at the design stage which may imply a reference to the traditional procurement strategy. The other two factors (F25, F14), may suggest a lack of personnel capacity in the client organisations. The rest of the influencing risk factors to project delays are attributed to the consultant's attributes in the delivery of projects.

The main themes observed in the influencing attributes as driven by the consulting engineer which influence project delays are:

- Lack of experienced and qualified technical personnel that are involved in both design and construction supervision (F12, F19, F17, F15, F21, F27, F20).
- Communication within the consultant design team (F16).
- Lack of project management skills (F12, F19, F21, F27, F20).




| | F13 | F16 | F12 | F19 | F25 | F17 | F15 | F21 | F27 | F20 | F14 | F18 | F29 | F28 | F24 | F26 | F23 | F22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall Mean Score | 4.09 | 4.01 | 3.99 | 3.90 | 3.82 | 3.77 | 3.76 | 3.71 | 3.69 | 3.65 | 3.60 | 3.54 | 3.49 | 3.36 | 3.31 | 3.25 | 2.74 | 2.73 |
| Client group | 3.70 | 3.90 | 3.80 | 4.00 | 3.60 | 4.20 | 3.70 | 4.10 | 4.10 | 4.20 | 3.20 | 3.40 | 3.40 | 3.20 | 3.20 | 3.20 | 2.90 | 2.80 |
| Consultant group | 4.21 | 4.21 | 3.86 | 3.64 | 3.79 | 3.93 | 3.64 | 3.36 | 3.29 | 3.71 | 3.79 | 3.64 | 3.71 | 3.36 | 3.64 | 2.86 | 2.50 | 2.79 |
| Contractor group | 4.43 | 3.86 | 4.43 | 4.14 | 4.14 | 3.00 | 4.00 | 3.71 | 3.71 | 2.86 | 3.86 | 3.57 | 3.29 | 3.57 | 3.00 | 3.86 | 2.86 | 2.57 |

Figure 4.13 Ranked combined group perception to project delays

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Communication, which has been recognized by the consultant group as the most significant factor attributing to project delays (F16, MS=4.21), is supported by other research studies (Williams & Johnson, 2014; Suprapto *et al.*, 2015, 2016). They report that the absence of communication within the design process contributes to a large extent to the failure of many design projects. Similar studies influencing delays are presented in Table 2.6 in Chapter 2 (Literature review).

#### 4.5.2.2. Project cost overruns

Project cost overruns are a common occurrence in infrastructure projects with projects getting more unpredictable in terms of overall project cost estimation. Opinion was sought from all respondent groups to respond on a scale strongly disagree (1) to strongly agree (5) (Table D.1), the extent to which the given factors influence project cost overruns. Table 4.5 and Table 4.6 show the perception of respondents on the factors that can influence project cost overruns. A graphical presentation showing combined perception of the results are provided in Figure 4.14.

The data sets presented in Table 4.5 achieved the Cronbach's Coefficient Alpha value of 0.617, which is acceptable according to Creswell (2012: 606). Wang & Yuan (2011) citing Norusis (2005) additionally state that Cronbach's Coefficient Alpha value greater than 0.5 denotes a reliability of the measurement scale at 5% significance level hence an acceptable level for determining internal consistency. However Fellows & Liu (2015: 266) advises that Cronbach's Coefficient Alpha value of 0.7, demonstrates a critical level of reliability for data to be sufficiently correlated to yield a single latent concept. The variables, although showing consistency and exhibiting an acceptable average inter-item correlation of 0.18, are not sufficiently correlated.

It is observed that the ranked OMS are all greater than 3.51, suggesting that all the factors presented in Table 4.5, have high influence and impact on project cost escalation. However, on account of the perception of the three groups, and the interpretation provided in Table D.7, design errors (F34) have the highest influence and impact on project cost overruns (OMS=4.08). The analysis of the influencing factors also suggests that personnel skills influence to a large extent the correctness of design documentation, noting that all the eight factors, with the exception of F36, are attributed to personnel attributes.

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Table 4.5 Factors contributing to project cost overruns

| Factor No. | Factors contributing to project cost overruns | Rating | | | | |
|---|---|---|---|---|---|---|
| | | OMS | Rank | Group Mean Scores | | |
| | | | | Client group | Consultant group | Contractor group |
| F34 | Design errors or omissions | 4.08 | 1 | 4.31 | 3.71 | 4.29 |
| F30 | Increased scope due to design errors | 4.02 | 2 | 4.00 | 3.64 | 4.57 |
| F31 | Change in specifications due to design changes | 4.01 | 3 | 3.85 | 4.07 | 4.14 |
| F35 | Overall change orders by the client | 4.00 | 4 | 3.92 | 4.07 | 4.00 |
| F36 | Inadequate experience of contractor | 3.68 | 5 | 3.92 | 4.14 | 2.71 |
| F33 | Poorly written contracts | 3.64 | 6 | 3.85 | 3.71 | 3.29 |
| F32 | Inconsistencies in contract documents | 3.58 | 7 | 3.77 | 3.50 | 3.43 |
| F37 | Design resulting in poor constructability | 3.54 | 8 | 3.62 | 3.64 | 3.29 |

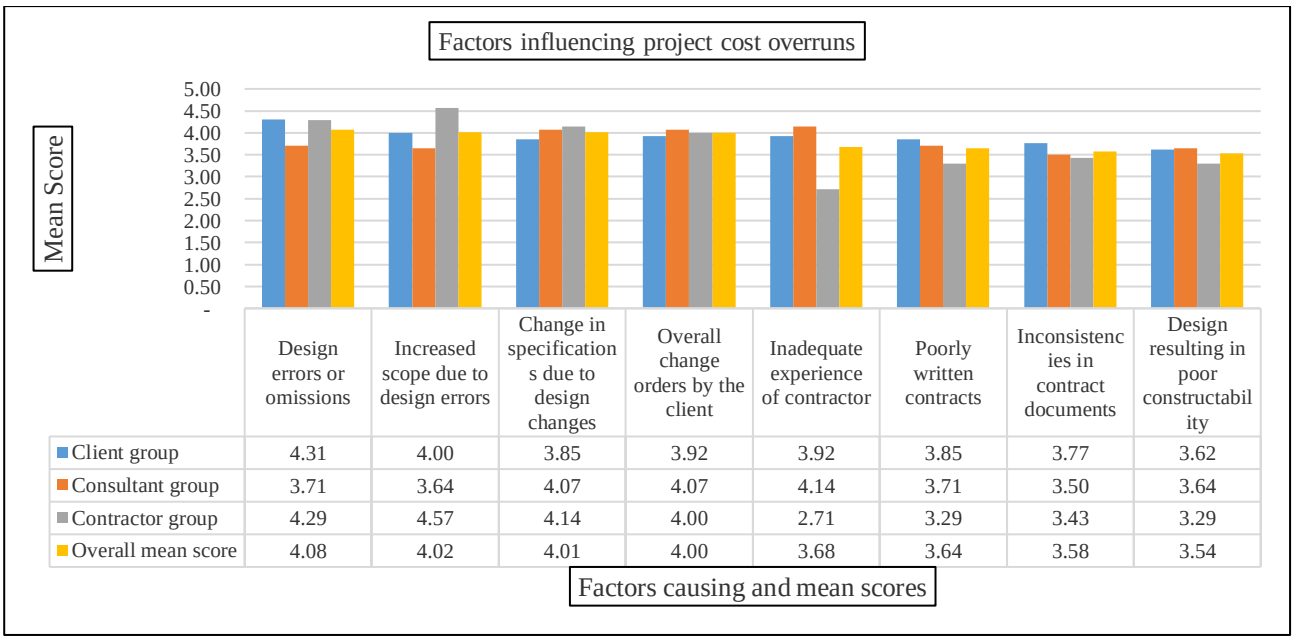


Figure 4.14 Group perception to factors influencing construction cost overruns

Inadequacies in the consultant personnel skills are reflected in poorly written contracts, inconsistencies in project documents and design drawings not conforming to construability. Respondents also agree that overall change orders initiated by the client significantly influences project cost increase. In instances where the client influences design changes, it may reflect that the client is seldom involved in the design phase, suggesting a preference of traditional design-bid-build

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procurement strategy. This may justify the need for more collaboration between the client and the consultant during the design stage. However, collaboration with the contractor is not possible with traditional design-bid-build procurement strategy by its nature. Other studies also argue that early contractor involvement compromises the competitiveness of the tender process (Heravi, Coffey & Trigunarsyah, 2015).

Although there is an overall agreement between the three stakeholders, there are some differences in the level of significance to the influencing factors (Table 4.6). The consultant group believes the contractor's capacity has the most significant influence in project cost overrun. This result is not consistent with most of the studies although, in the United Kingdom, it was revealed that non-performance of subcontractors had a significant influence on the project delivery time and cost (Yakubu & Sun, 2010). It is rather observed that that the lack of project management by the main contractor, and not the subcontractor influences the time of project delivery (Yakubu & Sun, 2010), which is consistent with the results of this survey that personnel attributes are the most influencing factors to project cost and time.

The results of a recent study in the Western Cape in South Africa by Smith (2016), show the magnitude of cost overruns in project delivery in South Africa. The findings show that 79% of projects are affected by cost overruns of the magnitude of 17% on average. 94.2% of projects are affected by schedule overruns with an average of 48% overruns. Design deficiencies, criteria change and unforeseen site conditions are recorded as some of the factors that influence variation orders citing 6.58% of variation orders per project (Smith, 2016). These findings support the results of the influencing factors to cost overruns in this study.

Studies with respect to factors influencing project cost overruns by scholars across the globe in support of the results are presented in Table 2.7 (Literature review).

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Table 4.6 Perception to influencing factors to project cost overruns by the three groups

| Client group | | | Consultant group | | | Contractor group | | |
|---|---|---|---|---|---|---|---|---|
| Item | Description | MS | Item | Description | MS | Item | Description | MS |
| F34 | Design errors or omissions | 4.31 | F36 | Inadequate experience of contractor | 4.1 | F30 | Increased scope due to design errors | 4.6 |
| F30 | Increased scope due to design errors | 4.00 | F31 | Change in specifications due to design changes | 4.1 | F34 | Design errors or omissions | 4.3 |
| F35 | Overall change orders by the client | 3.92 | F35 | Overall change orders by the client | 4.1 | F31 | Change in specifications due to design changes | 4.1 |
| F36 | Inadequate experience of contractor | 3.92 | F34 | Design errors or omissions | 3.7 | F35 | Overall change orders by the client | 4.00 |
| F31 | Change in specifications due to design changes | 3.85 | F33 | Poorly written contracts | 3.7 | F32 | Inconsistencies in contract documents | 3.4 |
| F33 | Poorly written contracts | 3.85 | F30 | Increased scope due to design errors | 3.6 | F33 | Poorly written contracts | 3.3 |
| F32 | Inconsistencies in contract documents | 3.77 | F37 | Design resulting in poor constructability | 3.6 | F37 | Design resulting in poor constructability | 3.3 |
| F37 | Design resulting in poor constructability | 3.62 | F32 | Inconsistencies in contract documents | 3.50 | F36 | Inadequate experience of contractor | 2.7 |

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### 4.5.3 Project documentation and project delivery

This section discusses project documentation by consultants with respect to project delivery. Sturts & (Bud) Griffis (2005) explain the challenges associated with measuring a good design and state that the intrinsic quality of a good design rest in the content and quality of the design. The section covers project design errors at implementation, project documentation by consultants, frequent design changes at implementation, consultancy services delivery and level of satisfaction by clients and contractors. Presentation of the results in this section is guided by Figure 4.15 which shows the chronology of the discussion in the findings.

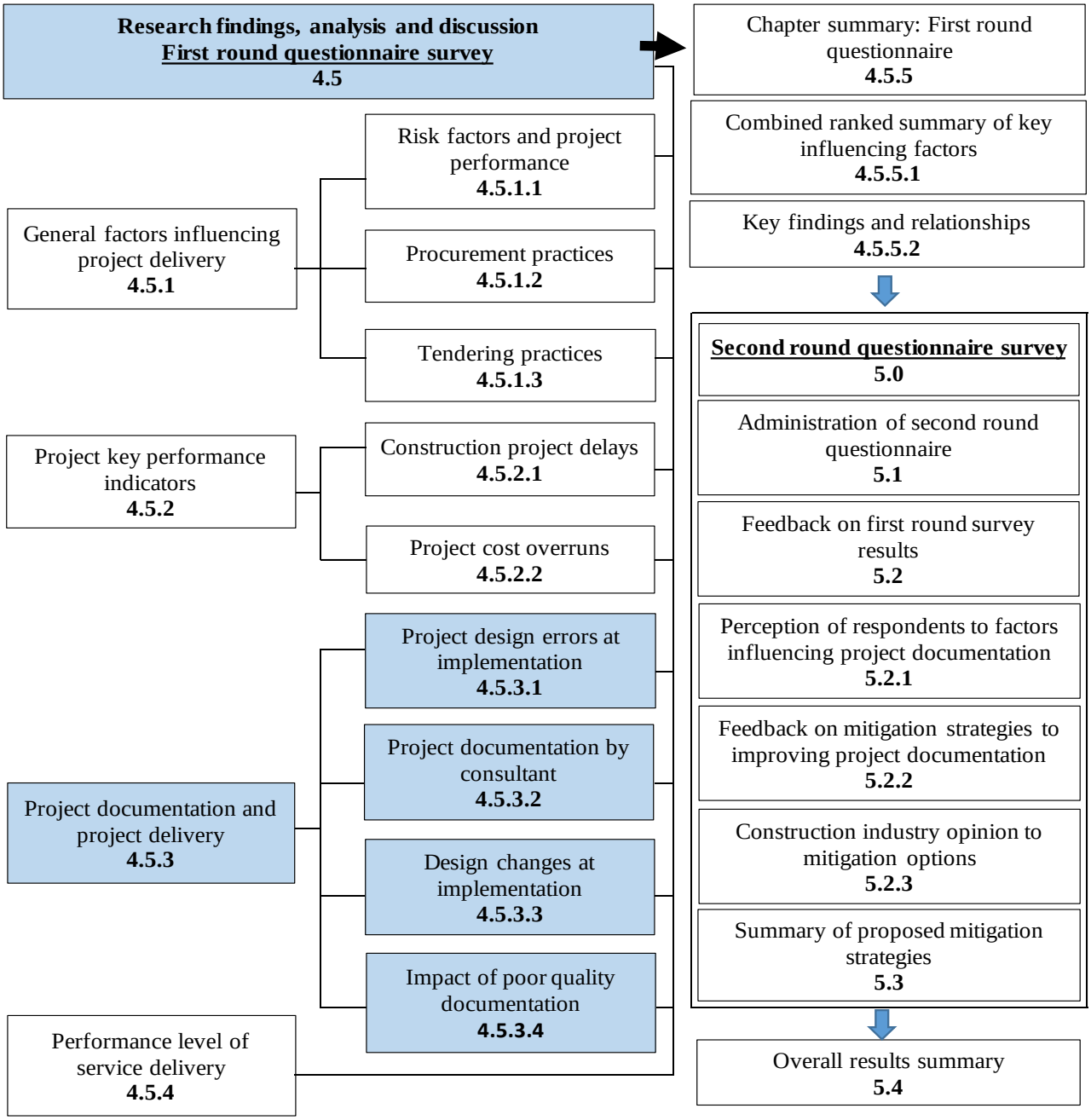


Figure 4.15 Project documentation and project delivery

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### 4.5.3.1 Project design errors at implementation

The recognition that most of the design errors are manifested at the project implementation phase, respondents were requested to rate on the scale of Strongly disagree (1) to Strongly agree (5) (Table D.1), on the factors that may influence design errors. This was against the background that design documentation often come with significant errors which impact on project objectives.

**(a) Factors influencing project design errors**

Factors influencing design errors are ranked using OMS and the results are presented in Table 4.7. A graphical presentation of the results for all the identified risk factors contributing to design errors are also presented in Figure 4.16, while individual group perceptions are presented in Table 4.8. The data sets presented in Table 4.7 show acceptable level for determining internal consistency, Cronbach's Coefficient Alpha value of 0.825. The variables, show consistency and exhibit acceptable average Inter-item correlation of 0.34, and are therefore sufficiently inter-correlated to combine into a single unit.

The results presented in Table 4.7 exhibit closer agreement in the perception of major influencing factors to design errors. The OMS for the two groups show that lack of skilled consultant technical personnel (F48) has the most influence and impact to design errors (OMS=4.17). Some factors have high influence and impact (OMS >3.51), F40, F43, F42, F38 and F41, with rest having moderate significance and influence to design errors (F39, F47, F44, F46 and F45) (OMS>. 2.51).

Main themes suggested by the findings in the factors influencing design errors are linked to personnel skills, inadequate fees, inappropriate procurement methods and support tools in form of modern design software. The main risk driver to the identified factors influencing design errors is the consultant, where inadequate personnel skills, lack of quality assurance systems, lack of experience and lack of innovation are important attributes. However, inhibiting factors that influence the performance of the consultant which are attributed to the client are linked to personnel and procurement strategy. These are reflected in the inability by the client to set clearly defined TORs, when setting project deliverables and time frames (F42, F39). The choice of a procurement strategy, in particular, the compensation model results in low professional fees (F41), where both the client and the consultant agree that, the factor has high influence and significance in influencing the consultant to commit design errors (OMS=3.71). Consequently, the consultant may not be motivated

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to use modern design software (F44), or the consultant may rely on generic design information or specifications, which may reflect a departure from value engineering (F45).

Table 4.7 Factors influencing design errors at project implementation

| Factor | Factors contributing to design errors | Rating | | | |
|---|---|---|---|---|---|
| | | OMS | Rank | Mean Scores | |
| | | | | Client group | Consultant group |
| F40 | Lack of skilled consultant technical personnel | 4.17 | 1 | 3.90 | 4.43 |
| F43 | Lack of quality assurance systems in consultant team | 4.02 | 2 | 3.90 | 4.14 |
| F42 | Terms of reference not consistent with expected deliverables | 3.84 | 3 | 3.90 | 3.79 |
| F38 | Lack of consultant experience | 3.77 | 4 | 3.90 | 3.64 |
| F41 | Low professional fees | 3.71 | 5 | 3.70 | 3.71 |
| F39 | Unrealistic contract durations imposed by client | 3.50 | 6 | 3.50 | 3.50 |
| F47 | Inaccurate or inappropriate procurement methods | 3.43 | 7 | 2.90 | 3.93 |
| F44 | Lack of use of modern design software | 3.41 | 8 | 3.00 | 3.79 |
| F46 | Owners irregular behaviour | 3.33 | 9 | 3.00 | 3.64 |
| F45 | Lack of innovation and design options due to low fees | 3.29 | 10 | 3.30 | 3.29 |

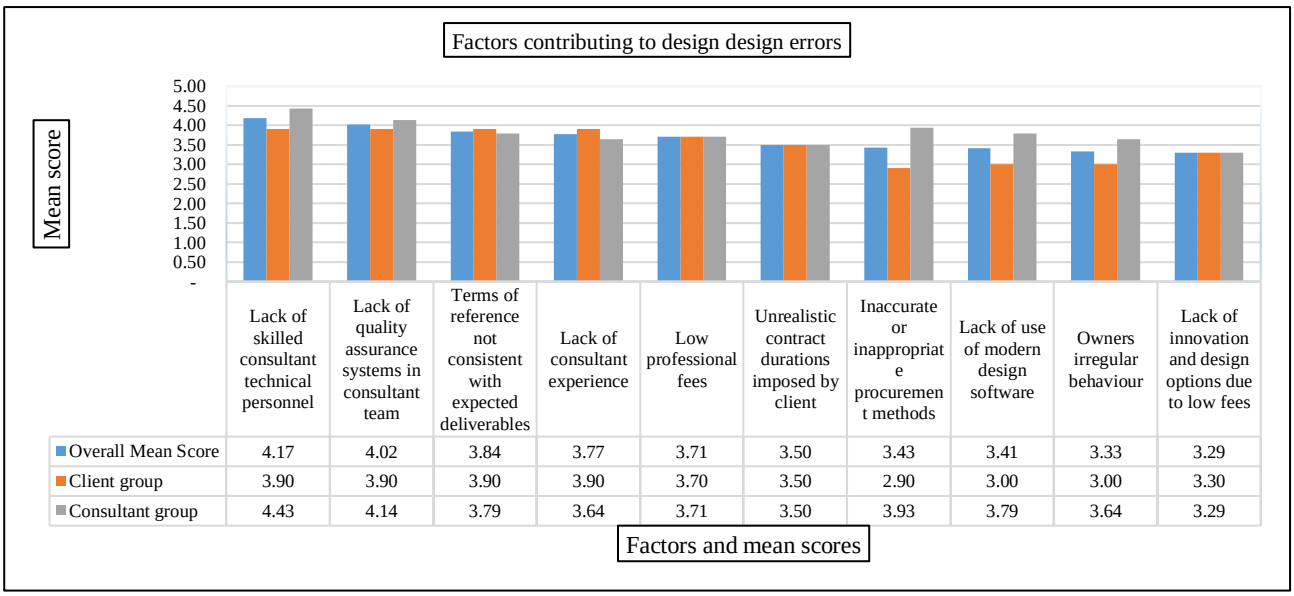


Figure 4.16 Level of agreement of client and consultant groups on causes for design errors

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Table 4.8 Comparison of individual group perception to influencing factors of design errors

| Client group perception | | | Consultant group perception | | |
|---|---|---|---|---|---|
| Item | Description | MS | Item | Description | MS |
| F38 | Lack of consultant experience | 3.90 | F40 | Lack of skilled consultant technical personnel | 4.43 |
| F40 | Lack of skilled consultant technical personnel | 3.90 | F43 | Lack of quality assurance systems in consultant team | 4.14 |
| F42 | Terms of reference not consistent with expected deliverables | 3.90 | F47 | Inaccurate or inappropriate procurement methods | 3.93 |
| F43 | Lack of quality assurance systems in consultant team | 3.90 | F42 | Terms of reference not consistent with expected deliverables | 3.79 |
| F41 | Low professional fees | 3.70 | F44 | Lack of use of modern design software | 3.79 |
| F39 | Unrealistic contract durations imposed by client | 3.50 | F41 | Low professional fees | 3.71 |
| F45 | Lack of innovation and design options due to low fees | 3.30 | F38 | Lack of consultant experience | 3.64 |
| F44 | Lack of use of modern design software | 3.00 | F46 | Owners irregular behaviour | 3.64 |
| F46 | Owners irregular behaviour | 3.00 | F39 | Unrealistic contract durations imposed by client | 3.50 |
| F47 | Inaccurate or inappropriate procurement methods | 2.90 | F45 | Lack of innovation and design options due to low fees | 3.29 |

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The FIDIC Risk Management Manual states that drawings are a means of communication between a consulting engineer and a contractor in the delivery of infrastructure projects. The manual holds that such communication should be elaborate and presented logically for ease of reference by the contractor (FIDIC, 1997: 65–77). The results of this study show that design errors compromise that communication process in the implementation of projects. Studies that have previously explored design errors in infrastructure project are presented in Table 2.8. The findings of the research somehow show similar trends to the significant driving attributes to design errors presented in Table 2.8.

#### 4.5.3.2 Project documentation by consultants

Project documentation includes pieces of information prepared by consultants comprising drawings, specifications which detail work package instructions to communicate project information for the execution of a project (FIDIC, 1997). The question was specific to explore project documentation by consultants and sought opinion based on the rating of Strongly disagree (1) to Strongly agree (5) (Table D.1), from client and consultant groups, how each of the seven identified factors influence project documentation.

**(a) Factors influencing project documentation**

Perception of respondents on the factors influencing project documentation by the consultant are provided in Table 4.9 and Table 4.10. The factors have been ranked based on the OMS for the two groups. The individual group perceptions are further presented in Figure 4.17.

The results provided in Table 4.9 passed the internal reliability and significant agreement among the respondents with the Cronbach's Coefficient Alpha value of 0.712 and Inter-item correlation of 0.309. Observation on the findings shows that the all the factors have high influence and impact on the performance of the consultant in the preparation of project documentation (OMS>3.51).

The two groups agree that the most significant influencing factor to poor quality of project documentation by the consulting engineer is a lack of resources due to low professional fees (F50, OMS=4.09), with the mean score for the consultant being 4.31. The results suggest three main aspects that influence the quality of project documentation by consultants in South Africa; notably low professional fees (F50, F49), personnel skills (F48) and lack of quality systems in the design process (F53).

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The linkage and association between professional fees and project documentation may relate to resource mobilization and allocation. The low professional fees may suggest that the consultant may not be motivated to allocate adequate resources for example, use of advanced design software and assemble competent and experienced design staff. Other scholars are of the opinion that consultants tend to rely on generic information possibly due to lack of innovation as a consequence of low or inadequate professional fees and time constraints imposed by the client (Wulff *et al.*, 2000; Carr & Beyor, 2005; Philips-Ryder, Zuo & Jin, 2013).

Table 4.9 Factors contributing to quality of project documentation

| Factor | Factors contributing to poor quality documentation | Rating | | | |
|---|---|---|---|---|---|
| | | OMS | Rank | Mean Scores | |
| | | | | Client group | Consultant group |
| F50 | Lack of resources due to low fees | 4.09 | 1 | 3.85 | 4.31 |
| F48 | Inexperienced consultant personnel | 4.07 | 2 | 4.23 | 3.92 |
| F51 | Unavailability of personnel | 4.00 | 3 | 4.08 | 3.92 |
| F49 | Inadequate fees | 3.93 | 4 | 3.77 | 4.08 |
| F52 | Unrealistic time expectation by client | 3.86 | 5 | 3.54 | 4.15 |
| F54 | Lack of client capacity to check designs | 3.77 | 6 | 3.85 | 3.69 |
| F53 | Lack of checklist of project deliverables | 3.61 | 7 | 3.77 | 3.46 |

Table 4.10 Perception of respondents to factors influencing project documentation

| Client group | | | Consultant group | | |
|---|---|---|---|---|---|
| | Ranked influencing factors | MS | | Ranked influencing factors | MS |
| F48 | Inexperienced consultant personnel | 4.23 | F50 | Lack of resources due to low fees | 4.31 |
| F51 | Unavailability of personnel | 4.08 | F52 | Unrealistic time expectation by client | 4.15 |
| F50 | Lack of resources due to low fees | 3.85 | F49 | Inadequate fees | 4.08 |
| F54 | Lack of client capacity to check designs | 3.85 | F48 | Inexperienced consultant personnel | 3.92 |
| F49 | Inadequate fees | 3.77 | F51 | Unavailability of personnel | 3.92 |
| F53 | Lack of checklist of project deliverables | 3.77 | F54 | Lack of client capacity to check designs | 3.69 |
| F52 | Unrealistic time expectation by client | 3.54 | F53 | Lack of checklist of project deliverables | 3.46 |

However, the client influencing factors (F52, F54) in this study, are unrealistic time that is imposed by the client requirements and an inability by the client to scrutinize design documents significantly influence the ability of the consultant in the provision of project documentation. Therefore, secondary attributes influencing the performance of the consultant to appropriately manage the design function, attributed to the client personnel skills include:

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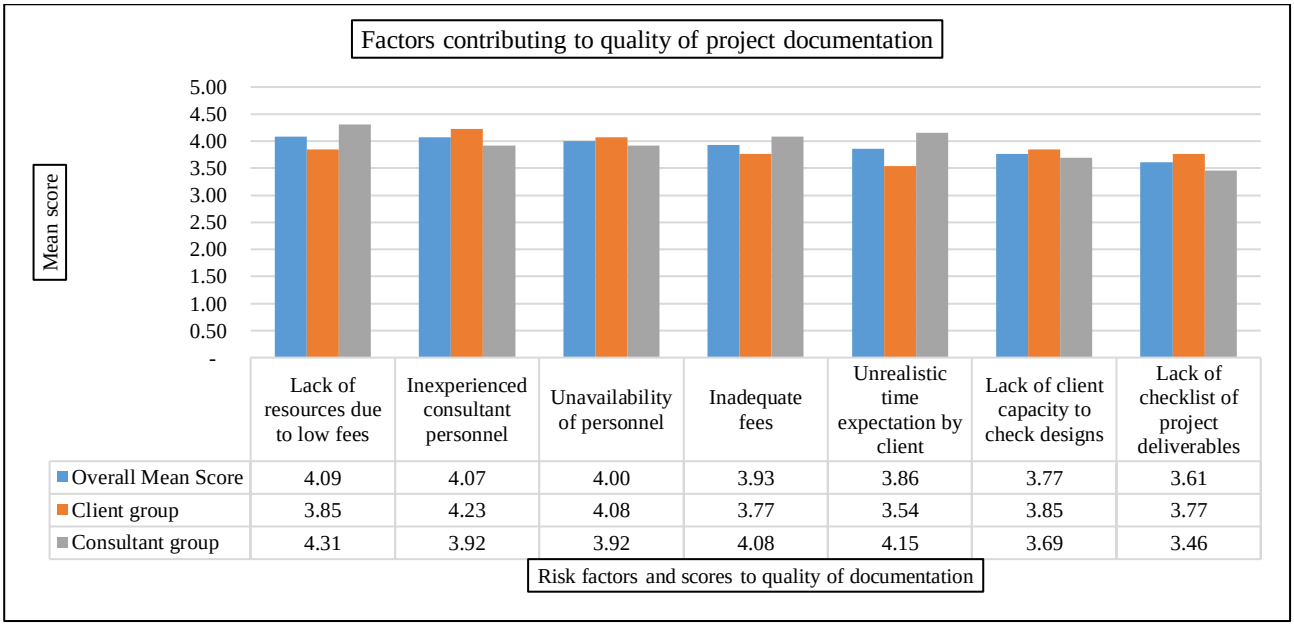
- Failure to determine appropriate project duration and the project deliverables.
- Inability to check project deliverables and outputs during the design phase,
- Lack of adoption of a procurement model which may offer more client involvement in the design phase.




| | Lack of resources due to low fees | Inexperienced consultant personnel | Unavailability of personnel | Inadequate fees | Unrealistic time expectation by client | Lack of client capacity to check designs | Lack of checklist of project deliverables |
|---|---|---|---|---|---|---|---|
| Overall Mean Score | 4.09 | 4.07 | 4.00 | 3.93 | 3.86 | 3.77 | 3.61 |
| Client group | 3.85 | 4.23 | 4.08 | 3.77 | 3.54 | 3.85 | 3.77 |
| Consultant group | 4.31 | 3.92 | 3.92 | 4.08 | 4.15 | 3.69 | 3.46 |

Figure 4.17 Perception of respondent to factors influencing quality of project documentation

Some comments recorded in the survey testify to the significance and prevalence of challenges linked to project documentation in the Western Cape in South Africa. Some respondents commented on the influencing factors attributed to the client and observed that:

> "*Quality of documentation is poor and design completeness is lacking at tender and construction stage.*"

> *"Client's lack of depth in certain projects."*

> "*Unrealistic time schedules imposed by clients, put consultants under extreme pressure to deliver which results in errors creeping in and being missed."*

> *"Having to compete with consultants who offer highly discounted prices and deliver substandard quality work, cut corners and do not comply with legislative requirements is resulting in many more design issues being experienced. Clients need to consider the potential poor quality service they will get (even from reputable companies) if they are offered highly discounted prices."*

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**(b) Quality of project documentation and project delivery**

Observations made from the results presented in Table 4.9, Table 4.10 and Figure suggest a relatively higher degree of agreement between respondents to the factors and the impact on project documentation by the consultant. The recognition of inexperienced consultant personnel as the major risk driver by the client as presented in Table 4.10 (F48, F51), underscores the reliance and significance of personnel skills on project documentation and consultancy services in general. The aspect is also fully recognized in the world Bank guidelines for the selection of consultancy services, where personnel attributes are allocated a maximum of 60% in the technical proposal evaluation criteria (Refer to Table 2.4) (World Bank, 2011: 19).

The results and comments, although coming from a minority of respondents in the construction sector in the Western Cape, suggest that quality of project documentation has a bearing in the delivery of infrastructure projects. Low professional fees and lack of skills are notable findings in the results of this study, and they are observed to significantly influence project documentation. However, some respondents argue that a consultant should deliver quality documentation irrespective of fees as a minimum requirement. It may be suggested that project managers, at the completion of a specific assignments should establish the actual inputs, in terms of man-hours. Such information could be useful to the client in drafting TORs for future similar assignments.

Supporting the findings in this research, Table 2.9 illustrates some of the research findings on the influencing factors relative to project documentation.

### 4.5.3.3 Frequent design changes at project implementation

Projects are often inevitably exposed to frequent changes in design during project implementation (Peansupap & Cheang, 2015), which may result in cost and schedule overrun. Through literature review, 18 factors were identified that could possibly influence frequent design changes during the project implementation phase. Respondents were requested on rating of Strongly disagree (1) to Strongly agree (5) (Table D.1), the extent to which the factors influence frequent design changes at project implementation.

The factors provided in Table 4.11 passed the internal reliability and significant agreement among the respondents with the Cronbach's Coefficient Alpha value of 0.81 and Inter-item correlation of 0.193.

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### (a) Factors influencing frequent design changes at project implementation

Design changes in the delivery of infrastructure projects may become essential and inevitable at project implementation phase which may originate from several scenarios. In either case, cognisance of the discrepancies in project documentation should be addressed by the consultant to achieve project objectives. It is also understood that it requires a qualified and experienced contractor to recognise such discrepancies.

Table 4.11 Frequent design changes at implementation

| Factor No. | Factors contributing to frequent changes in design | Rating | | | | |
|---|---|---|---|---|---|---|
| | | OMS | Rank | Group Mean Scores | | |
| | | | | Client group | Consultant group | Contractor group |
| F58 | Inaccurate bill of quantities | 4.11 | 1 | 4.23 | 4.00 | 4.10 |
| F60 | Insufficient data collection and survey data before design which impact constructability | 4.03 | 2 | 3.54 | 4.07 | 4.60 |
| F71 | Lack of skilled and experienced supervisory personnel | 4.00 | 3 | 4.23 | 4.07 | 3.60 |
| F59 | Delays in approving contractor submissions | 4.00 | 3 | 3.54 | 4.14 | 4.40 |
| F57 | Inconsistency in contract documents | 3.89 | 4 | 4.31 | 3.57 | 3.80 |
| F72 | Failure to track, evaluate and manage claims | 3.67 | 5 | 3.38 | 3.71 | 4.00 |
| F69 | Low speed of decision making involving all project teams | 3.65 | 6 | 3.23 | 3.86 | 3.90 |
| F55 | Client generated variations | 3.65 | 6 | 3.31 | 3.93 | 3.70 |
| F70 | Slow information flow between team members | 3.65 | 6 | 3.54 | 3.71 | 3.70 |
| F66 | Ambiguity in specifications resulting in conflicting interpretation by parties | 3.59 | 7 | 3.31 | 3.57 | 4.00 |
| F68 | Lack of communication between consultant and contractor | 3.52 | 8 | 3.54 | 3.29 | 3.80 |
| F56 | Slow decision from owner | 3.51 | 9 | 2.62 | 4.14 | 3.80 |
| F62 | Non-availability of design drawings on time | 3.46 | 10 | 2.85 | 3.43 | 4.30 |
| F65 | Consultant or architect' s reluctance for change | 3.43 | 11 | 3.69 | 3.00 | 3.70 |
| F61 | Misunderstanding of client requirement by design engineer | 3.32 | 12 | 2.92 | 3.21 | 4.00 |
| F63 | Lack of clarity in project scope | 3.32 | 13 | 2.31 | 3.77 | 4.00 |
| F64 | Delay in approval of completed work by consultant | 3.11 | 14 | 2.69 | 2.86 | 4.00 |
| F67 | Long waiting time for approval of test samples of materials | 2.81 | 15 | 2.15 | 2.86 | 3.60 |

With reference to the results presented in Table 4.11, the factors influencing frequent design changes would occur with respect to completeness, accuracy and conformity to project requirements as

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explained by Philips-Ryder *et al.*(2013). See also section 4.5.3.1, which discusses factors that influence design errors. Trigger events to the design changes could therefore result from the following:

- When errors or omissions are noted in design drawings.
- Lack of clarity in design drawings.
- There are inconsistences in the contract documents or specifications which are not consistent with design drawings.
- The client finds it necessary to modify the scope, which may entail introducing changes to the initial design.

The research findings in this study show that some of the factors are causes while others are effects of the frequent changes. The three respondent groups agree that inaccurate bills of qualities (F58, OMS=4.11) is the most influencing factor to frequent design changes. The contractor group considered insufficient data collection for the design function as the most significant factor influencing frequent design changes (F60, OMS=4.60). The two factors are somehow interrelated since insufficient data collection would inevitably result in an inaccurate schedule of quantities.

It is observed from Table 4.11 and Figure 4.18 that other than design changes that are initiated by the client, the rest of the influencing factors are attributed to the consulting engineer and the staff involved in the design process. Causative influencing factors to frequent design changes are therefore:

- Personnel competencies of the staff in the design team.
- Inadequacies in project management practice by the design team.

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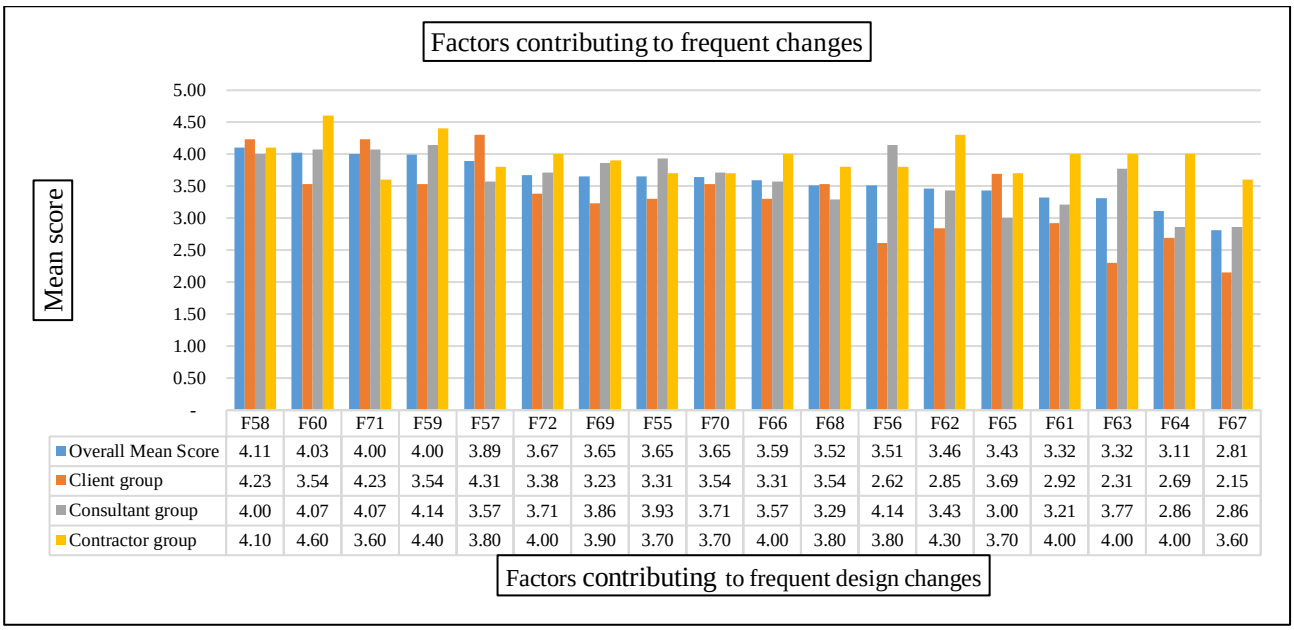


| | F58 | F60 | F71 | F59 | F57 | F72 | F69 | F55 | F70 | F66 | F68 | F56 | F62 | F65 | F61 | F63 | F64 | F67 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall Mean Score | 4.11 | 4.03 | 4.00 | 4.00 | 3.89 | 3.67 | 3.65 | 3.65 | 3.65 | 3.59 | 3.52 | 3.51 | 3.46 | 3.43 | 3.32 | 3.32 | 3.11 | 2.81 |
| Client group | 4.23 | 3.54 | 4.23 | 3.54 | 4.31 | 3.38 | 3.23 | 3.31 | 3.54 | 3.31 | 3.54 | 2.62 | 2.85 | 3.69 | 2.92 | 2.31 | 2.69 | 2.15 |
| Consultant group | 4.00 | 4.07 | 4.07 | 4.14 | 3.57 | 3.71 | 3.86 | 3.93 | 3.71 | 3.57 | 3.29 | 4.14 | 3.43 | 3.00 | 3.21 | 3.77 | 2.86 | 2.86 |
| Contractor group | 4.10 | 4.60 | 3.60 | 4.40 | 3.80 | 4.00 | 3.90 | 3.70 | 3.70 | 4.00 | 3.80 | 3.80 | 4.30 | 3.70 | 4.00 | 4.00 | 4.00 | 3.60 |

Figure 4.18 Frequent design changes during project implementation

**(b) Frequent design changes and their impact on project delivery**

The design errors and omissions, lack of completeness, accuracy and conformity to specific design requirements in the design, testifies to the existence of flawed project documentation (Philips-Ryder *et al.*, 2013; Westin & Sein, 2014). Design changes allow the project team to correct anomalies that are observed in the project documentation at the implementation stage. Observations from the literature reviewed agree with the acknowledgement that most project delays and cost overruns originate from scope and design changes.

Project management skills and personnel skills in the study are therefore perceived to influence the quality of project documentation which often lead to project delays and cost overruns. This agrees with findings by Birgonul, Dikmen & Bektas (2015) that lack of technical capacity may lead to project delays.

Lack of use of modern design software, F44 (Table 4.7), was recognized by the consultant group as a significant risk factor influencing design errors (MS=3.79). Research studies post that the application of software could mitigate design errors (Love, Edwards, *et al.*, 2011; Francom & Asmar, 2015; Love, Liu, Matthews, Sing & Smith, 2015; Wium, 2016). Other scholars, however, argue that design technological systems do not possess the necessary attributes to entirely eliminate human errors in the design process (Foord and Gulland, 2006 cited in Love, Edwards, *et al.*, 2011).

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It is not surprising, with this realisation, that lack of skilled technical personnel in this study, ranks high among the factors influencing project documentation as summarized below:

- General factors limiting project delivery (F10, OMS=3.84),
- Factors influencing project delays (F17, OMS=3.77).
- Factors influencing design errors (F40, OMS=4.17).
- Factors contributing to poor documentation (F48, OMS=4.07).
- Factors influencing in frequent changes in design at implementation (F71, OMS=4.0).

In summary, frequent design changes at project implementation are a direct consequence of lack of experience and unavailability of skilled personnel. Downstream effects of frequent design changes have the potential to significantly increase project costs and implementation schedule.

#### 4.5.3.4 Impact of poor quality of documentation

The three groups of respondents agree that the impact of poor quality of project documentation on the project delivery influences mostly cost overruns, time overruns and disputes. The impact of project documentation was tested on the rating of Strongly disagree (1) to Strongly agree (5) (Table D.1). Perception of the respondents on the impact are presented in Figure 4.19. This confirms SAICE reports in the Magazine of the South African Institution of Civil Engineering that 133 construction cases were reported between September 2009 and March 2015 (Johann du Plessis, 2015). The report indicated that the contractor was the complainant in 88% of these cases, which involved mediation, adjudication and arbitration (Johann du Plessis, 2015).

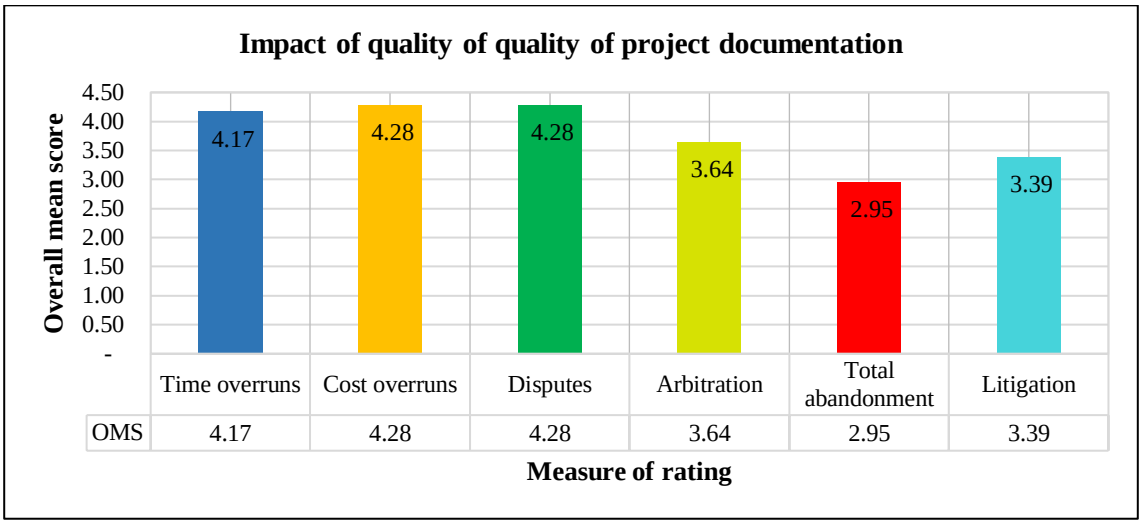


Figure 4.19 Impact of quality of project documentation on KPI

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The impact on project delivery by elements of project documentation, design errors, inconsistencies in contract documents, incomplete drawings, unclear drawings, have been discussed in some papers. Findings show that design errors significantly impact project delivery, which in most cases results in project delays and project cost overruns and accidents.

Other studies show that:

- Design error costs range from 6.85% to 7.36% of the contract amount and that most cost influencing events occurred in traditionally procured contracts (Lopez & Love, 2012).
- Design errors could influence cost increases of around 14.2% (Peansupap & Ly (2015) citing Lopez & Love, (2012); Love P.E.D., et al., (2014); Love P.E.D. et al., (2014)).
- Good information quality decreases project delays and cost overruns (Westin & Sein, 2014).
- Design errors can cause 60-90% of construction failures in infrastructure projects ( Han *et al.*, 2013 cited in Peansupap & Ly, 2015), e.g. collapse of I-35W Highway Bridge Minneapolis, Minnesota August 1, 2007, in the United States of America (National Transportation Safety Board (NTSB), 2008: 76)

### 4.5.4 Performance level and stakeholder satisfaction

The performance level and service delivery of the consultant and client are presented as shown in Figure 4.20.

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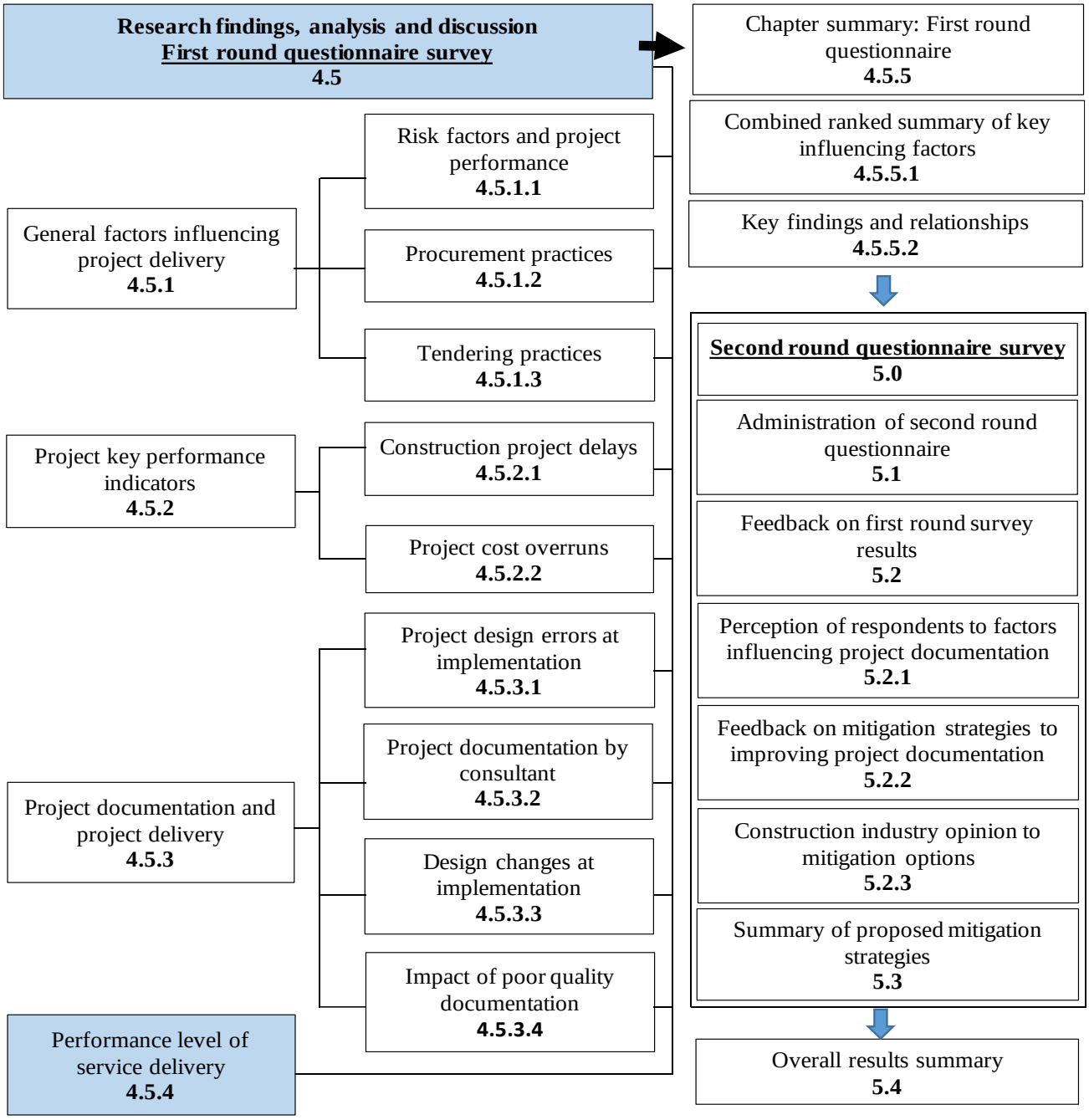


Figure 4.20 Performance level and stakeholder satisfaction

### (a) The client and contractor perception of performance of consultant

The role of the consulting engineer is to coordinate implementation of the requirements of the client in the delivery of infrastructure projects. Optimising project value engineering, developing effective technical performance and minimising delays and cost overruns in the delivery of infrastructure projects, are some expectations of other stakeholders, namely the client and contractors, from the consultant in this aspect.

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The client and consultant groups were therefore requested on the scale of always (5), mostly (4), sometimes (3), seldom (2) and never (1) (Table D.2), to measure the effectiveness with which the consultants optimise project value engineering, develop effective technical performance and minimise delays and cost overruns. The question was a self-evaluation for the consultant in the realisation of managing their consultancy services assignments.

Results presented in Figure 4.21 passed the internal reliability and significant agreement among the respondents with the Cronbach's Coefficient Alpha value of 0.614 and Inter-item correlation of 0.36. This is in accordance with Creswell (2012: 606). Wang & Yuan (2011) citing Norusis (2005) additionally state that Cronbach's Coefficient Alpha value greater than 0.5 denotes a 5% significance level of reliability of the measurement scale. However Fellows & Liu (2015: 266) advises that Cronbach's Coefficient Alpha value of 0.7, demonstrates a critical level of reliability for data to be sufficiently correlated to yield a single latent concept. The variables, although showing consistency and exhibiting an acceptable average inter-item correlation of 0.36, are not sufficiently correlated. In principle, it shows wider dissenting views on the three factors by the two groups which were expected of the three interest groups.

The results presented in Figure 4.21 considering ratings of "always" and "mostly" to suggest satisfactory level of performance, suggest that:

- 66.7% of the respondents are of the opinion that consultants optimize value engineering in the delivery of their services.
- 83.3% of the respondents are of the opinion that consultants demonstrate effective and technical performance in the delivery of their services.
- 87.5% of the respondents suggest that consultants are able to minimize delays and cost overruns.
- The overall perception on the general performance of the consultant, measured against the three attributes shows that 83.3% of the respondents are of the opinion that the consultant achieves the three attributes satisfactorily.

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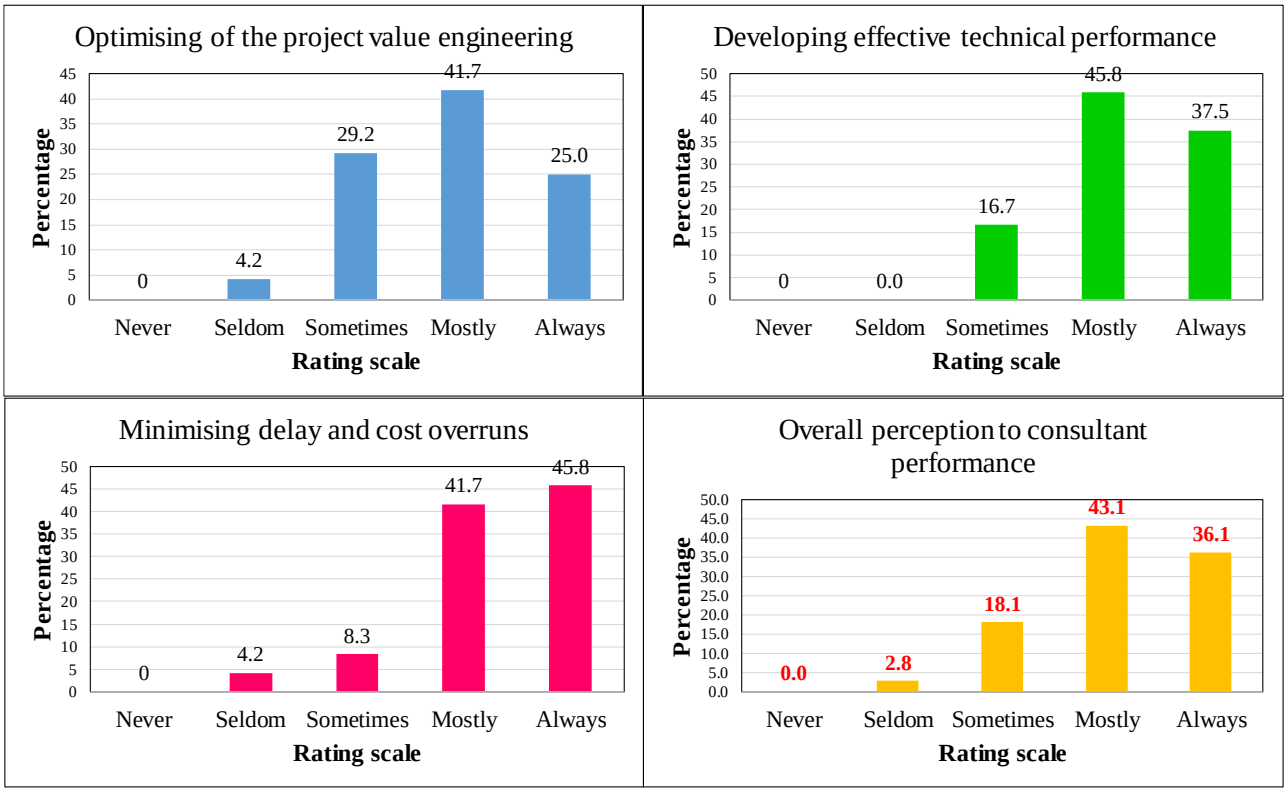


Figure 4.21 Measure of consultancy services performance

The findings could, therefore, suggest that:

- Adoption and application of value engineering in the delivery of services by engineering consultants is compromised, with 33.3% of the respondents supporting this assumption.
- 16.7% of respondents are of the opinion that there is a need to enhance the technical capacity by consultants to effectively discharge their role in the delivery of projects.
- 12.5% of respondents support the findings that some consultants lack the initiate to minimise project delays and cost overruns.

### (b) Client and contractor perception: consultant expert advice in service delivery

The client and contractor groups of respondents were requested on a scale of Strongly dissatisfied (1) to Strongly satisfied (5) (Table D.6), with the level of expert advice provided by consultants. The results somehow reflect the findings presented in Figure 4.21, technical capacity gaps, in the expert advice that the consultant gives in the delivery of their services as presented in Figure 4.22.

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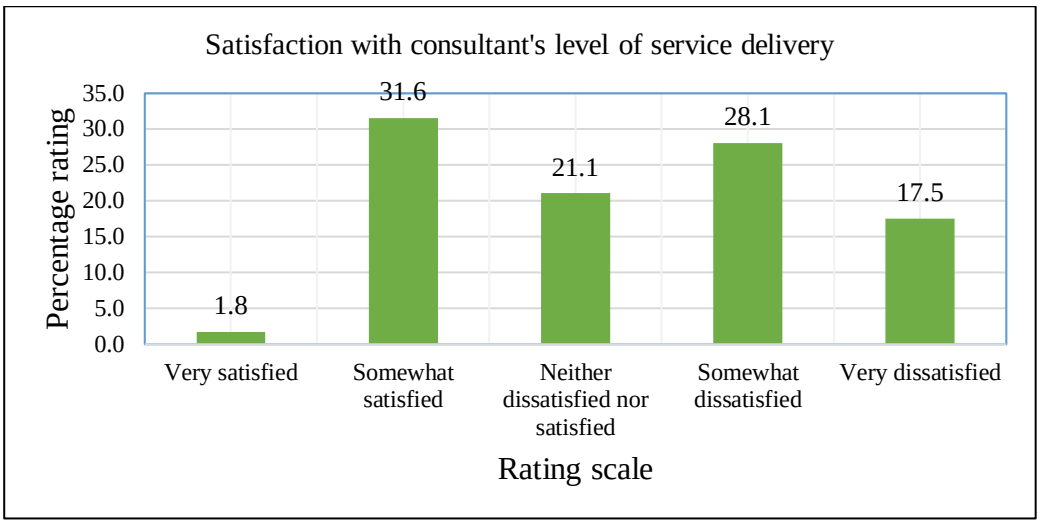


Figure 4.22 Consultancy services and other stakeholder satisfaction

### (c) Effectiveness of the client involvement in project delivery

The level of satisfaction of respondents on the overall client performance was checked with respect to the adjudication of contracts based on the traditional design-bid-build project strategy. The purpose was to measure the level of effectiveness and influence of client input in reducing frequent changes during the project implementation phase. The question was also a measure of self-assessment to ascertain how clients are satisfied with their own level of service delivery. The level of client influence was measured through client actions at the design, procurement, and implementation phases and management of claims and disputes.

The client and consultant groups were therefore requested on the scale of no input (1), to meet obligation (5) (Table D.3), during design, tendering, implementation phase and managing claims and disputes. The results presented in Figure 4.23 passed the internal reliability and significant agreement among the respondents with the Cronbach's Coefficient Alpha value of 0.858 and average Inter-item correlation of 0.613. The level of perception of respondents is provided in Figure 4.23.

In this respect, the overall results show that:

- 67% of respondents are satisfied with client input and influence in the design stage,
- 68% of respondents are satisfied with client input and influence at the tender stage,
- 77% of respondents are satisfied with client input at the implementation phase,
- 78% of respondents are satisfied with client input in managing claims and disputes.

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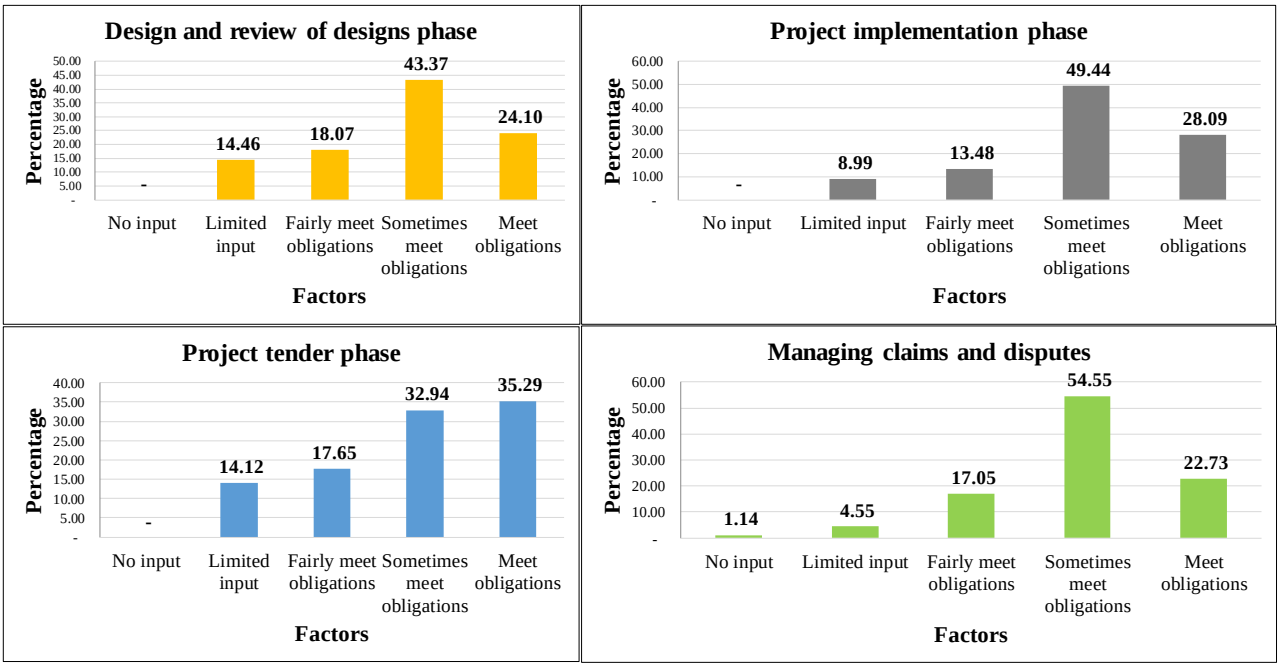


Figure 4.23 Consultant and client perception of client influence

The results suggest that 33% of respondents are dissatisfied with the level of client input at the design stage. This also supports results of the findings in this research that the client as a source of frequent design changes at implementation ranks sixth (F55) (Table 4.11), which significantly contribute to project cost overruns (Table 4.5). This is reflected in the 32% dissatisfaction of respondents that the client influence at tender stage may not assist to reduce the frequent changes at project implementation. Since most project claims are realized in the implementation phase, the results show that 23% of respondents are dissatisfied with the level of client input in minimising frequent changes at implementation.

In consideration that project changes are inevitable at project implementation (Yana & Wibowo, 2015), and where changes are introduced late into the project cycle, allocating additional funds by the client into the project becomes the remedy, leading to project cost increase. This is consistent with the project management theory, discussed in the literature review, which states that project schedule and costs can be influenced at the initial stages Figure 2.2, without significantly influencing the overall project cost.

The results of this survey have some resemblance to the CIDB construction industry indicators summary of results for 2015 (CIDB, 2015). The CIDB results indicate that 27% of respondents are

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dissatisfied with service delivery by a consultant in comparison to 21% in this study (Figure 4.21). 18% of the contractors are dissatisfied with client performance in general and 24% dissatisfied in the management of variations. The results of this study show that 22% of respondents are not satisfied with the client in the management of claims and disputes.

The results suggest that there is some discontent among the key stakeholders in the delivery of infrastructure projects. 21% of respondents are not satisfied with the level of service delivery of the consultant (Figure 4.21). The apparent lack of satisfaction with client performance by the consultant and contractor (Figure 4.23), is perceived from the realisation that the client contributes significantly to the performance of the other players. In the same context, Kilinc, Basak & Yitmen (2015), are in agreement with this assumption and states that the client should drive innovation in the project delivery through the creation and promotion of right project conditions.

### 4.5.5 Chapter summary

The summary of aggregate risk influencing factors discussed, which aimed at identifying the main risk factors influencing project delivery are summarized and presented as shown in Figure 4.24. The risk factors presented are drawn from the discussions presented as follows:

- Table 4.2, general factors limiting project delivery.
- Table 4.4, factors influencing project delays.
- Table 4.4Table 4.5, factors influencing project cost overruns.
- Table 4.7, factors influencing project design errors.
- Table 4.9, factors influencing quality of project documentation.
- Table 4.11, factors influencing frequent design changes.

The factors are ranked based on the OMS and the interpretation given in Table D.7, to establish the key risk influencing factors and they are presented as follows:

- Table 4.14, Summary of high influence risk factors attributed to the consultant, OMS>3.50.
- Table 4.15, Summary of moderate influencing risk factors attributed to the consultant, OMS<3.50.
- Table 4.12, Summary of high influence risk factors attributed to the client, OMS>3.50.
- Table 4.13, Summary of low influence risk factors attributed to the client, OMS<3.50.

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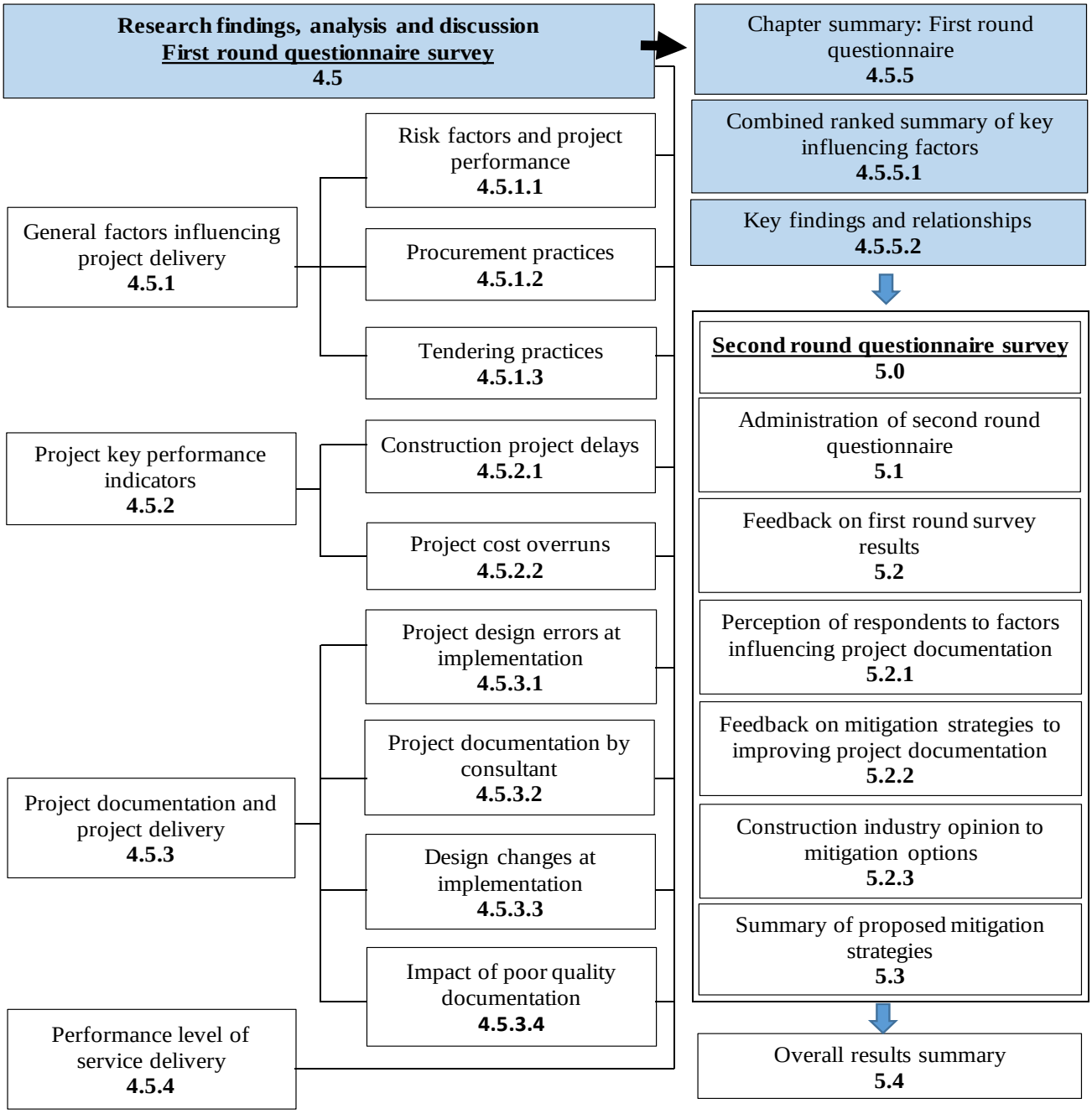


Figure 4.24 Summary of main influencing factors to project delivery

### 4.5.5.1 Combined ranked summary of key influencing risk factors

Table 4.14, Table 4.15, Table 4.12 and Table 4.13 provides an overall overview of the combined ranked risk factors influencing project delivery and they are grouped according to the risk driver. The results presented have focused on legislation, procurement strategy, project cost overruns, project delays, design errors, frequent design changes and project documentation. Factors influencing each of these aspects and their impact on project delivery have been analysed, presented and discussed.

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## (a) Factors attributed to the client

Table 4.12 Summary of high influence risk factors attributed to the client

| Factor | Description of factor | OMS |
|---|---|---|
| F13 | Client variations leading to changes in scope | 4.09 |
| F6 | The procurement methods by government departments influence the level of service of key project participants | 4.08 |
| F35 | Overall change orders by the client | 4.00 |
| F71 | Lack of skilled and experienced supervisory personnel | 4.00 |
| F52 | Unrealistic time expectation by client | 3.86 |
| F42 | Terms of reference not consistent with expected deliverables | 3.84 |
| F25 | Unrealistic contract duration imposed by client | 3.82 |
| F54 | Lack of client capacity to check designs | 3.77 |
| F4 | New forms of contracts (NEC3, Design and Build, PPP) empower project participants in the services they provide | 3.76 |
| F36 | Inadequate experience of contractor | 3.68 |
| F69 | Low speed of decision making involving all project teams | 3.65 |
| F55 | Client generated variations | 3.65 |
| F70 | Slow information flow between team members | 3.65 |
| F14 | Delays in approving drawings by client | 3.60 |
| F66 | Ambiguity in specifications resulting in conflicting interpretation by parties | 3.59 |
| F18 | Adversarial/confrontational culture | 3.54 |
| F7 | Clients often have unrealistic requirements which limit performance of key project participants | 3.52 |
| F56 | Slow decision from owner | 3.51 |

Table 4.13 Summary of low influence risk factors attributed to the client

| Factor | Description of factor | OMS |
|---|---|---|
| F39 | Unrealistic contract durations imposed by client | 3.50 |
| F29 | Delay in progress payment by client | 3.49 |
| F47 | Inaccurate or inappropriate procurement methods | 3.43 |
| F3 | Traditional forms of procurement (Design Bid and Build) limit key participants in the services they provide | 3.43 |
| F28 | Interference by client/owner in construction operations | 3.36 |
| F46 | Owners irregular behaviour | 3.33 |
| F5 | There is too little participation of client at project design phase | 3.32 |
| F24 | Excessive bureaucracy in project owner operations | 3.31 |
| F1 | Legislation on award of contracts limits a contractor or consultant in the delivery of services | 3.19 |
| F64 | Delay in approval of completed work by consultant | 3.11 |
| F23 | Unrealistic inspection and testing methods proposed in contract | 2.74 |
| F2 | Traditional contract forms is a limitation to contracting services | 2.65 |

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## (b) Factors attributed to the consultant

Table 4.14 Summary of high influence risk factors attributed to the consultant

| Factor | Description of factor | OMS |
|---|---|---|
| F11 | Exceptionally low fees due to competition | 4.41 |
| F40 | Lack of skilled consultant technical personnel | 4.17 |
| F58 | Inaccurate bill of quantities | 4.11 |
| F50 | Lack of resources due to low fees | 4.09 |
| F34 | Design errors or omissions | 4.08 |
| F48 | Inexperienced consultant personnel | 4.07 |
| F60 | Insufficient data collection and survey data before design which impact constructability | 4.03 |
| F43 | Lack of quality assurance systems in consultant team | 4.02 |
| F30 | Increased scope due to design errors | 4.02 |
| F31 | Change in specifications due to design changes | 4.01 |
| F16 | Lack of communication among the project participants | 4.01 |
| F8 | Inadequate experience of contractor/consultant result in poor delivery of service | 4.00 |
| F59 | Delays in approving contractor submissions | 4.00 |
| F51 | Unavailability of personnel | 4.00 |
| F12 | Many design changes at implementation | 3.99 |
| F49 | Inadequate fees | 3.93 |
| F19 | Unclear and inadequate details in drawings | 3.90 |
| F57 | Inconsistency in contract documents | 3.89 |
| F10 | Lack of technical skills among contractors and consultants | 3.84 |
| F9 | Contractor's/consultant's lack of project management practices | 3.81 |
| F17 | Lack of skilled and experienced technical personnel | 3.77 |
| F38 | Lack of consultant experience | 3.77 |
| F15 | Inadequate experience of the consultant | 3.76 |
| F21 | Poor site management and supervision by the consultant | 3.71 |
| F41 | Low professional fees | 3.71 |
| F27 | Mistakes and discrepancies in contract documents | 3.69 |
| F72 | Failure to track, evaluate and manage claims | 3.67 |
| F20 | Lack of quality control | 3.65 |
| F33 | Poorly written contracts | 3.64 |
| F53 | Lack of checklist of project deliverables | 3.61 |
| F32 | Inconsistencies in contract documents | 3.58 |
| F37 | Design resulting in poor constructability | 3.54 |
| F68 | Lack of communication between consultant and contractor | 3.52 |

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Table 4.15 Summary of moderate influencing risk factors attributed to the consultant

| Factor | Description of factor | OMS |
|---|---|---|
| F62 | Non availability of design drawings on time | 3.46 |
| F65 | Consultant or architect' s reluctance for change | 3.43 |
| F44 | Lack of use of modern design software | 3.41 |
| F61 | Misunderstanding of client requirement by design engineer | 3.32 |
| F63 | Lack of clarity in project scope | 3.32 |
| F45 | Lack of innovation and design options due to low fees | 3.29 |
| F26 | Slow response by the consulting engineers in performing testing and inspection | 3.25 |
| F67 | Long waiting time for approval of test samples of materials | 2.81 |
| F22 | Poor definition of payment milestones | 2.73 |

### 4.5.5.2 Key findings and relationships

The key influencing factors influencing performance of the consultant and consequently impacting project delivery are hereby summarised.

**(a) Low or inadequate professional fees**

Low professional fees are perceived to have overall influence in the delivery of service by the consultant (F11, MS=4.79) and an OMS of 4.41 as presented in Table 4.2. The influence of low professional fees is also observed as limiting the consultant's performance in the following;

- Influencing design errors, Table 4.7, (F41, MS=3.71).
- The influence in the quality of project documentation, Table 4.9, (F49, MS=4.08, F50, MS=4.31).

**(b) Quality of project documentation**

Factors that define the quality of project documentation, in this research describe those factors that limit consistent progression of construction works by the contractor and exhibited in the following:

- Design errors or omissions, F34, OMS=4.08.
- Unclear and inadequate details in drawings, F19, OMS=3.90.
- Inconsistencies in contract documents, F57, OMS=3.89.
- Mistakes and discrepancies in contract documents, F27, OMS=3.69.
- Poorly written contracts, F33, OMS=3.64.
- Design resulting in poor constructability, F37, OMS=3.54.

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### (c) Factors influencing quality of project documentation

In addition to low professional fees, other inhibiting factors influencing consultants' performance, which also have high influence and high impact on quality of project documentation are:

- Lack of skilled and experienced technical personnel, F40, OMS=4.17.
- Lack of quality assurance systems, F43, OMS=4.02.
- Lack of communication among project participants, F31, OMS=4.01.
- Unavailability of personnel, F59, OMS=4.0.
- Unrealistic time expectation by the client, F25, OMS=3.82.
- Lack of client capacity to check designs, F54, OMS=3.77.
- Inadequate experience of the consultant, F15, OMS=3.76.
- Lack of checklist of project deliverables, F53, OMS=3.61.

### (d) Impact of project documentation in project delivery

Findings in the research show that flaws in the quality of project documentation influence project cost increase, time overruns, disputes (Figure 4.19) and efficiency and effectiveness of project delivery as listed below:

- Factor influencing project delays, Table 4.4; (F12, F19, F27).
- Factors influencing cost overruns, Table 4.5; (F34, F30, F33, F32).
- Factors influencing frequent changes in design at project implementation, Table 4.11; (F58, F60, F57, F66).

The relationships that are exhibited in the findings between quality of project documentation, factors influencing quality of project documentation and KPIs are further presented in Table 4.16 and Figure 4.25. The findings and relationships formed the basis for the second round questionnaire survey and the results are discussed in Chapter 5.

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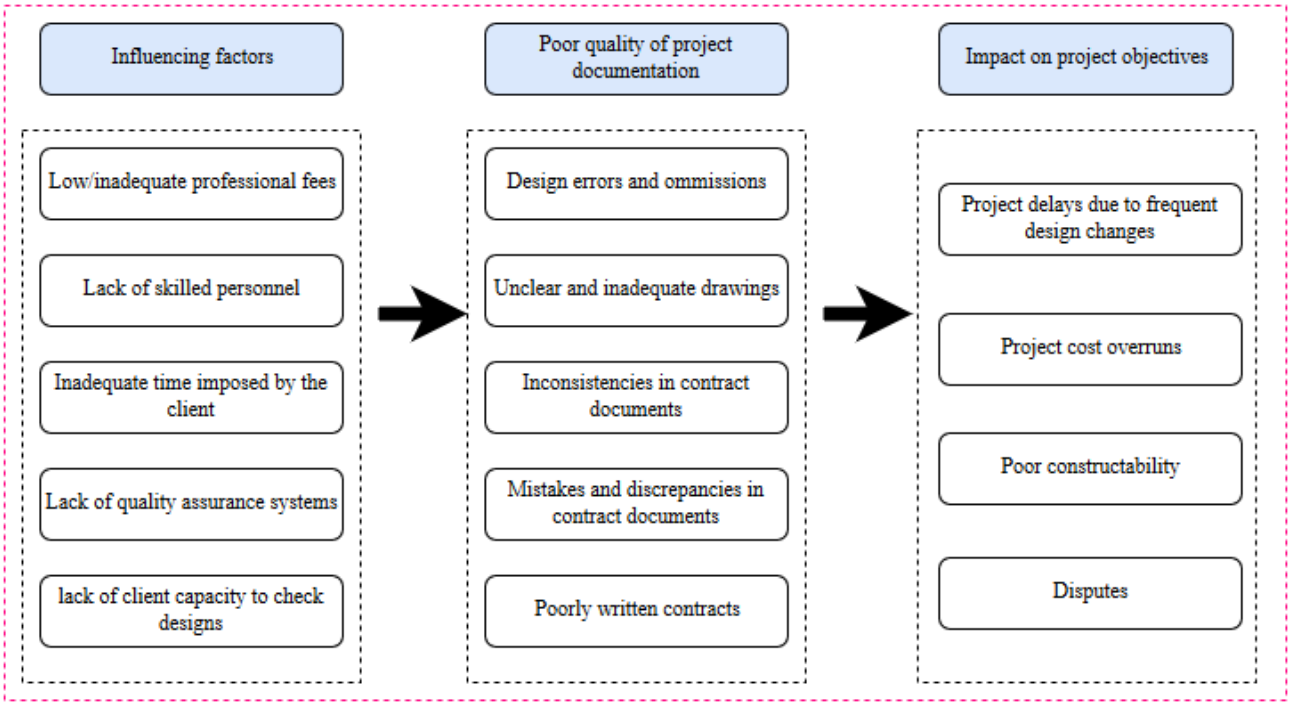


Figure 4.25 Quality of project documentation and project outcomes

Table 4.16 Client and consultant relationship and project documentation

| Client influencing factors | Consultant influencing factors | Impact on project objectives |
|---|---|---|
| **Procurement and legislation**<br>• Adherence to government legislation by government departments.<br>**Project management skills and personnel skills**<br>• Lack of client capacity to check designs.<br>• Inaccurate or inappropriate procurement methods.<br>• Too little participation of client at the project design phase.<br>• Personnel skills and capacity to draft TORs which are coherent with realistic time frames, clarity of project scope and project deliverables.<br>• Bureaucratic tendencies in client establishments leading to delays in making important decisions. | **Professional fees**<br>• Lack of resources due to low fees, lack of use of modern design software.<br>• Lack of innovation and design options due to low fees.<br>**Project Management and personnel skills**<br>• Lack of skilled and experienced technical personnel.<br>• Unavailability of experienced personnel.<br>• Insufficient data collection before design which impact constructability.<br>• Lack of checklist of project deliverables.<br>• Failure to implement quality assurance systems.<br>• Failure to interpret TORs and general client requirements.<br>• Failure to set up communication links within the consultant set up | • Many design changes at implementation<br>• Increased scope due to design errors<br>• Poorly written contracts resulting in disputes.<br>• Poor designs resulting in poor constructability.<br>• Changes in specifications due to design changes.<br>• Poor site management and supervision by the consultant.<br>• Non availability of design drawings on time. |

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# Chapter 5 Second round of questionnaire survey

Data presented in Table 4.16 has presented the relationships between project objectives, project outputs and the influence of key project stakeholders based on the results obtained in the survey. However, to ascertain the correctness and reliability of the relationships between factors constraining key performance indicators relative to project documentation, the second round of the questionnaire was administered. The researcher further sought to confirm these relationships and then seek comments on the proposed strategies to improve on the quality of project documentation.

## 5.1 Administration of the second round questionnaire

The second round of questionnaire was performed to probe further into the findings of the first round. The first round of the survey identified risk factors, which have the potential to impact the quality of project documentation and project delivery. The key findings summarized in Table 4.16 and Figure 4.25 were then presented to the same respondents for their further comments.

The questionnaire in the second round was divided into three sections. The first section provided feedback to respondents on the major findings of the factors influencing KPIs from the first round and sought comments from the construction industry experts. The idea was to seek comments on the relevance of the identified influencing factors regarding the influence of project documentation by consultants.

The second section provided a list of factors that had been identified as having a significant impact on project documentation. Respondents were asked to provide the frequency of influence of the each of the factors to project documentation based on the scale often, seldom and never (Table D.4).

The third section comprised of a list of ten (10) mitigation strategies that the author proposed based on the literature reviewed, and findings of the first round of the questionnaire survey. Respondents were asked to rate the proposals for their suitability and application to improving the quality of project documentation. The rating used were agree, disagree and not sure as presented in (Table D.5).

The guide to the discussion of the second round of the questionnaire survey is presented in Figure 5.1.

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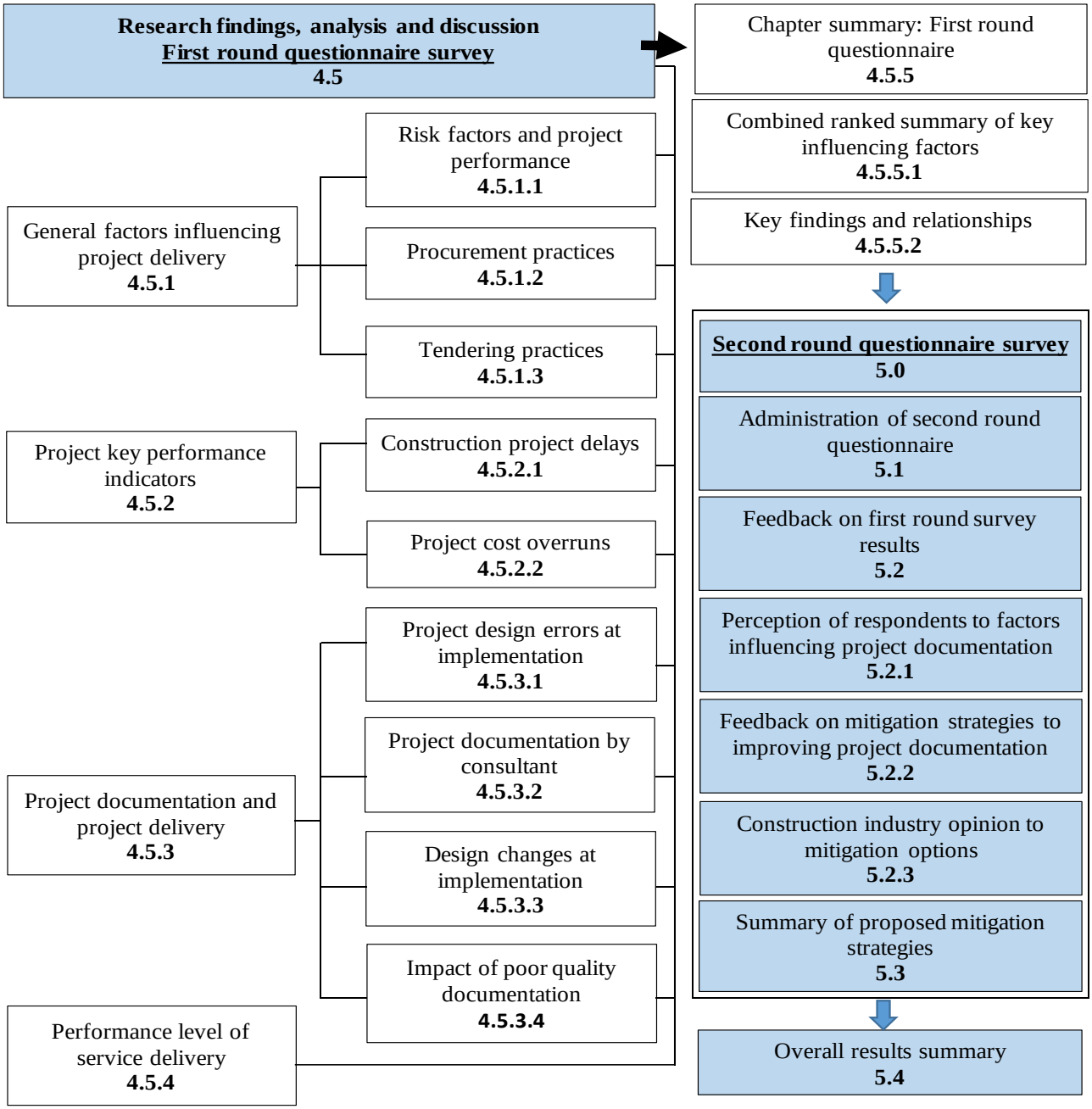


Figure 5.1 Second Round of questionnaire survey

## 5.2 Feedback on the first round survey results

### 5.2.1 Comments on research findings from the first round survey

The survey in the second round generated both quantitative and qualitative data. The response rate for the questionnaire surveys have been discussed in Section 4.4.2. The detailed comments made by respondents on the research findings with respect to factors impacting the quality of project documentation and proposed mitigating strategies to reducing flaws in project documentation are

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provided in Table E.1 in Appendix E. The comments were decoded into eight sub sections and analysed into risk influencing factors that were addressed that also influence quality project documentation and project delivery as presented in Table 5.1.

Table 5.1 Summary of comments of respondents and risks addressed

| Item | Risk influencing factor addressed | Number of comments received | Percentage of total comments |
|---|---|---|---|
| 1 | Ineffective communication between design teams and client | 3 | 3.03% |
| 2 | Scope definition and clarity | 14 | 14.14% |
| 3 | Inadequate fees and discounting | 8 | 8.08% |
| 4 | Procurement and service delivery | 13 | 13.13% |
| 5 | Clarity and definition of roles and responsibilities of key project participants | 8 | 8.08% |
| 6 | Quality control and service delivery by consultants | 11 | 11.11% |
| 7 | Checklist and project deliverables | 13 | 13.13% |
| 8 | Personnel skills | 24 | 24.24% |
| 8 | Legislation (registration, monitoring, enforcement) | 5 | 5.05% |
| | Total Number of comments | 99 | 100.00% |

It was observed from the comments below that low professional fees significantly influence project delivery by the consultants. Remuneration may influence the quality of personnel that the consultant may engage in undertaking professional services as reflected in the comments on personnel skills in Table E.1. This is also perceived from the comments extracted as observed by some respondents:

> *"Inadequate fees due to fee discounting can be a big problem in practice and should be legally prohibited again, as is was in the "old days" when charging fees lower than the gazetted fees was not allowed.*"

> *"Due to fee discounting consulting teams are stretched and the necessary amount of time is spent on the projects. Checking is also neglected due to unrealistic delivery timeframes imposed on design teams."*

> *"We find ourselves in times where everyone wants more for less. That in combination with poor retention of key staff and talent development across industry, is a recipe for disaster. Procurement processes are constantly under scrutiny, but little has taken affect. The internal client knowledge of procurement processes and understanding of project flows are a tremendous challenge at the moment."*

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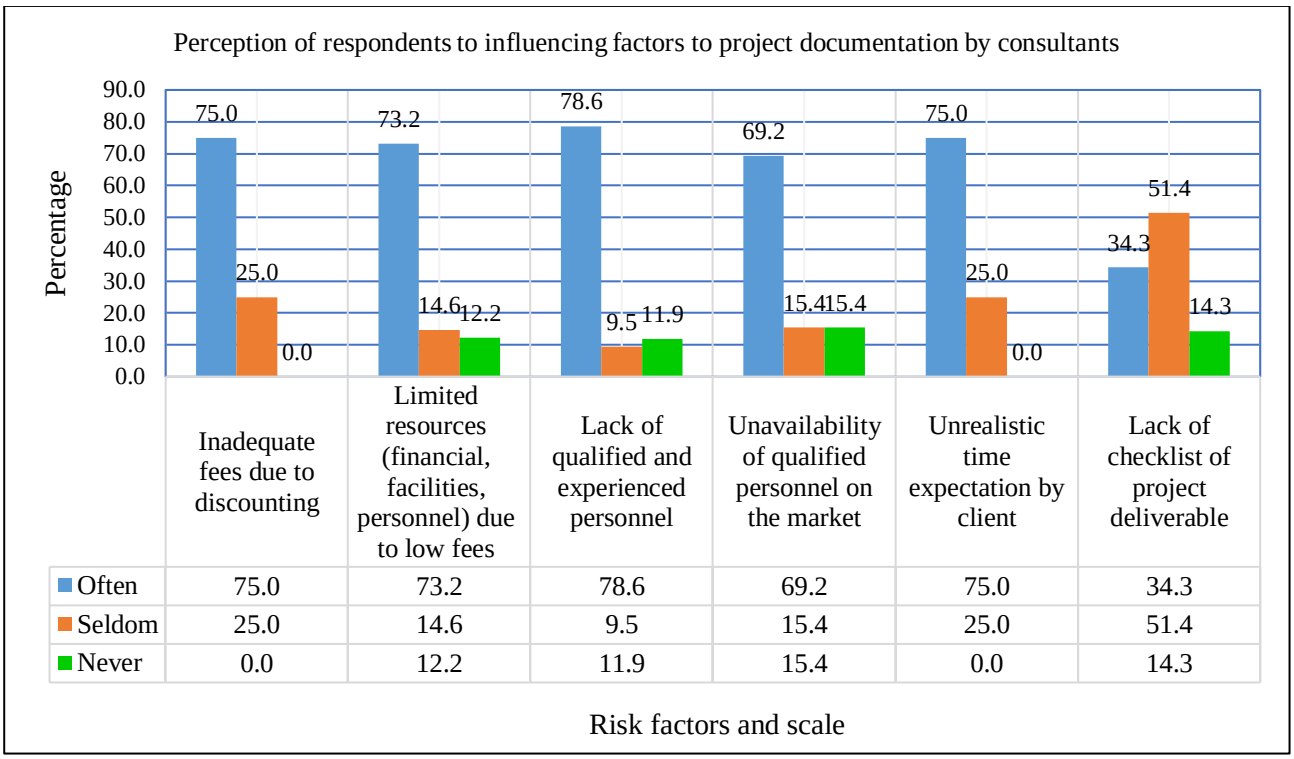
### 5.2.2 Perception of respondents to factors influencing project documentation

The opinion of the respondents on the factors influencing project documentation was requested on a scale Often (3), Seldom (2) and Never (1) (Table D.4). The results are presented in Figure 5.2 and they show some divergent views on one of the factors although the findings show that respondents do agree with the results of the first round with 70% of the respondents in agreement with the influencing factors.

It can be deduced that inadequate fees, lack of qualified personnel, and unrealistic time frames set by the client significantly influence the quality of project documentation. Based on these results, it can also be deduced that in some cases, the absence of a checklist of project deliverables to a lesser extent may influence the quality of project documentation. In the absence of a checklist, it is probable that confirmation of a final list of expected deliverables cannot be achieved. The main findings confirm prior findings in the first round of the questionnaire survey.




| | Inadequate fees due to discounting | Limited resources (financial, facilities, personnel) due to low fees | Lack of qualified and experienced personnel | Unavailability of qualified personnel on the market | Unrealistic time expectation by client | Lack of checklist of project deliverable |
|---|---|---|---|---|---|---|
| Often | 75.0 | 73.2 | 78.6 | 69.2 | 75.0 | 34.3 |
| Seldom | 25.0 | 14.6 | 9.5 | 15.4 | 25.0 | 51.4 |
| Never | 0.0 | 12.2 | 11.9 | 15.4 | 0.0 | 14.3 |

Figure 5.2 Frequency and factors contributing to quality of project documentation

The unavailability of qualified personnel received more comments and the highest percent rating by respondents which may suggest that personnel skills play a significant role in the performance of the

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consultants in the delivery of infrastructure projects. This also confirms previous studies which had observed that availability of skills is a challenge in public sector establishments in South Africa (Construction Industry Development Board (CIDB), 2007a, 2011; Lawless, 2007; Bowen, Edwards & Cattell, 2012; Emuze & Smallwood, 2012).

### 5.2.3 Feedback on mitigation strategies to improving project documentation

Mitigation strategies to the identified risk factors contributing to the quality of project documentation were proposed as a feedback to the respondents based on the results of the first round of the questionnaire survey. Respondents were requested on a scale of agree (3), not sure (2) and disagree (1) (Table D.5), on the effectiveness of each of the proposed strategies. Table 5.2 and Figure 5.3 show results as perceived by respondents of the proposed mitigation strategies to the poor quality of project documentation.

Table 5.2 Proposed mitigating factors and perception of respondents

| Proposed strategy | | Percentage agreement | | |
|---|---|---|---|---|
| | | Agree | Not Sure | Disagree |
| MF1 | Allocating a contingency amount by the client for design changes which may be sanctioned by the client. | 71.4 | 28.6 | - |
| MF2 | Devise a mechanism to allocate additional design activities. | 55.3 | 42.1 | 2.6 |
| MF3 | Consideration to remunerate a consultant under either FIDIC conditions of contract using the Yellow Book OR by using the New Engineering Contract (NEC). | 55.3 | 42.1 | 2.6 |
| MF4 | Formulation of restrictive contractual provisions to influence the design consultant to deliver high quality project documentation. | 33.3 | 37.0 | 29.6 |
| MF5 | Allow for a detailed verification of the competency of the proposed consultant team of experts for the design and supervision services. | 88.6 | 9.1 | 2.3 |
| MF6 | Selection of consulting services should start with the prequalification process so that only qualified firm should participate in the tender process in addition to the criteria for the lowest priced proposal. | 100.0 | - | - |
| MF7 | Allow for the review of project documentation by an independent group of experts in the design stage. | 46.9 | 37.5 | 15.6 |
| MF8 | Allow for a period before site handover for the contractor to comment on the design and project documentation. | 93.3 | 4.4 | 2.2 |
| MF9 | The project team leader of the consulting engineer should develop a checking procedure to assist in enforcing internal quality monitoring during the design phase. | 73.0 | 16.2 | 10.8 |
| MF10 | Build a database on the performance of consulting engineers as may be reported by clients and contractors which should be hosted by either major clients or to be in the public domain. | 85.7 | 9.5 | 4.8 |

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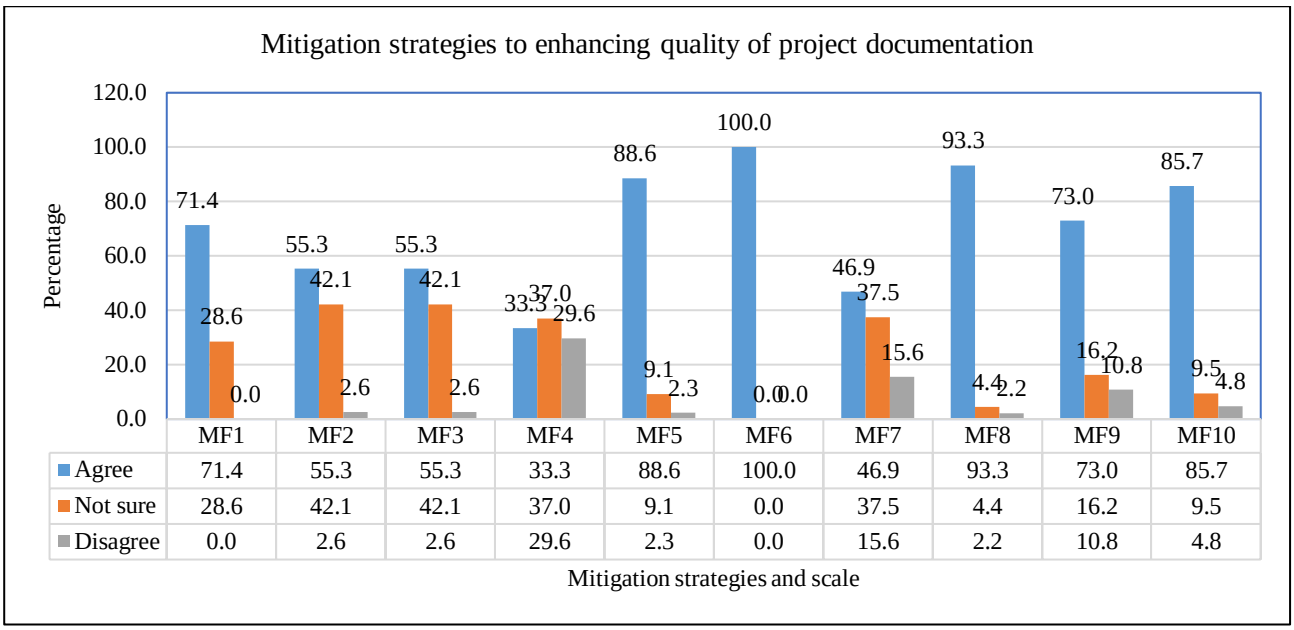


Figure 5.3 Perception of respondents to mitigating poor quality project documentation

### 5.2.4 Construction industry opinion to proposed mitigation options

The section discusses proposed mitigation strategies in line with the feedback from the construction industry. Respondents mostly agree with eight of the ten proposed solutions based on the percentage ratings to improving the quality of project documentation as presented in Figure 5.3. In view of the results, it could be implied that professional fees, personnel skills, and improved project management skills could enhance the quality of project documentation.

The aspects are further detailed below to provide an insight into the relationships between the influencing factors and mitigation strategies.

#### (a) Remuneration, competency and innovation

Client generated variations have been perceived to be a major factor influencing the quality of project documentation, with respect to design changes. Respondents believe that the client should set aside a contingency amount for design changes motivated by the client, with 71.4% in agreement with the proposal. However, this proposal may only apply where the changes initiated by the client are significant necessitating additional remuneration.

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**(b) Consultant selection, remuneration and project delivery**

The agreement that competency of the proposed consultant team is an essential attribute for the design and construction supervision may suggest the acceptance by respondents that personnel attributes impact significantly to the level of quality of project documentation. In this respect the prequalification may complement the need for verification of competency in the selection of the consultant (MF5). Essentially, the prequalification process does not provide a solution for professional fees discounting by the consultant, and it remains a problem of the consultant although it also remains a challenge in the construction sector. The World Bank, for example, advocate the selection of consultants to commence with the prequalification process. However, this is complemented by a well-structured professional fees determination and does not include fees discounting as is the case in South Africa.

**(c) Project management, skills and project delivery**

Allowing for design review of related project documentation by the contractor (MF8), is acceptance by respondents that design errors are unavoidable and this technique would reduce delays if such errors are detected prior to commencement. Although 93.3% agree with the proposal, other respondents suggested that this practice may prejudice fair competition where a contractor's proposal significantly increases the tendered sum. The client may give consideration if the contractor's proposal can prove to be cost effective. It therefore remains the obligation of the consultant to provide internal quality checks as suggested by some respondents (MF9), during the design process to minimise design errors. This can only be achieved with the engagement of experienced and knowledgeable staff.

**(d) Performance monitoring and evaluation, and project delivery**

The construction industry has a role in developing a database of the performance of consulting engineers as agreed by respondents (MF10). 85.7% agree with the proposal and this in effect would assist in building a data base of capable entities and penalise those firms who consistently underperform. This is consistent with roles and responsibilities of the CIDB as discussed under section 2.1.2.2.

Two factors are not considered plausible solutions to improving the quality of project documentation based on the low-level ratings they received (MF4, MF7). Formulation of restrictive contractual

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provisions to influence the design consultant to deliver high quality project documentation (MF4) and allowing for the review of project documentation by an independent group of experts in the design stage (MF7). In the South African context, personnel skills appear to be an important aspect such that the two proposals may not mitigate factors influencing the quality of project documentation. The two factors are also linked to personnel and procurement with respect to remuneration. This is not consistent with some of the proposals and mitigation strategies (e.g Rybka & Bondar-Nowakowska, 2013). Respondents in this study do not agree that restrictive contractual provisions can motivate the consultants to practice value engineering in the face of inadequate and highly discounted fees in South Africa.

In summary, it is perceived that there are linkages and associations between the identified influencing factors, quality of project documentation and attainment of KPIs. For example, remuneration alone may not influence reduced design flows, although it is arguably a motivation for successful service delivery by the consultant. This is equally true with all other influencing factors; whose combined application may enhance the quality of project documentation. One respondent observed that the model of implementation, is not so important and it may just shift responsibilities and risks to the contractor. This is also acknowledged by Rybka & Bondar-Nowakowska (2013), and explain that although it is accepted that a project delivery model may not guarantee the quality of the final product, it is generally accepted that time and cost overruns could be greatly mitigated. Philips-Ryder *et al.*(2013), allude to observations by Lin and Poh (2008) that, for instance in Australia, some client institutions are no longer attracted to some alternative procurement. They observe that some alternative procurement methods have delivered project outcomes similar to projects delivered under the traditional approach.

## 5.3 Summary of proposed mitigation strategies

The proposed strategies focus on factors that hinder the consultants from performing their services with respect to project documentation. Proposed mitigating strategies to poor quality documentation are founded on the comments and perceptions of respondents and they are presented for each of the identified risk influencing factors listed below:

- Low and inadequate professional fees, Table 5.3.
- Unavailability and lack of qualified and experienced technical personnel, Table 5.4.
- Unrealistic time expectation by the client, Table 5.5.
- Lack of client capacity to check designs, Table 5.6.

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- Lack of a checklist on project deliverables, Table 5.7.
- Design errors, mistakes and omissions, Table 5.8.

Table 5.3 Project documentation, low professional fees and project delivery

| | | | |
|---|---|---|---|
| | Risk source<br>**Lack of resources due to low fees or inadequate fees** | | |
| | Client strategy and tasks | | Consultant strategy and tasks |
| | | | |
| a | Limit fee discounting and consider the award of consultant services contracts based on quality considerations. | a | The consultant should strive to engage qualified and experienced personnel. Where appropriate a senior qualified engineer should supervise less qualified personnel in the design process and supervision phases. |
| b | Selection of consulting services should start with a prequalification process so that only qualified firms participate in the tender process in addition to the criteria for the lowest price. | b | A prudent Consultant should deliver quality irrespective of fees by putting into the project adequate and appropriate resources. |
| c | Consideration to remunerate a consultant under either FIDIC conditions of contract using the Yellow Book OR by using the New Engineering Contract (NEC). | | |
| | **Comments and motivation**<br><br>**Proposals are based on results and comments from respondents**<br>○ 71.4% agree that fees discounting has significant effect Figure 5.2 (item a)<br>○ 100% of respondents agree to the proposal (MF6-Figure 5.2)-client task-item b<br>○ Figure 5.2 (55.3% agree, 42.1% not sure and 2.6% disagree). Comments are however in support of the proposal - Client task-Item c<br><br>Based on comments and the ranking: F11 (Table 4.2), F41 (Table 4.7), F50 and F49 (Table 4.9) | | |

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Table 5.4 Project documentation, unavailability of personnel and project delivery

| | | | |
|---|---|---|---|
| Risk source<br>**Unavailability of experienced technical personnel** | | | |
| | Client strategy and tasks | | Consultant strategy and tasks |
| | | | |
| a | The client should provide training to own staff to enhance client capacity for effective participation in both project conception, design and construction supervision. | a | The Consultant should appoint an external expert or independent internal expert to check the agreed design criteria and procedures prior to commencing design process. |
| b | Detailed verification of competency of the consultant design and supervisory personnel by the client and should engage equally qualified personnel in the same field to undertake this task. | b | The consultant's qualified and experienced personnel who is not part of the design team shall conduct internal quality checks during design process. |
| c | Consideration to remunerate a consultant under either FIDIC conditions of contract using the Yellow Book OR by using the New Engineering Contract (NEC). | c | A list of such quality checks shall be prepared by the project team leader in collaboration with the appointed quality assurance person. |
| | | d | Checks shall be closely linked to the company's internal quality assurance scheme and should include details of information archiving, for ease of retrieval should design revisions become necessary. |
| | | e | The consultant should discharge his duties albeit with difficulties where Employer input is not forthcoming due to lack of communication between the client and the consultant. |
| **Comments and motivation**<br>**Proposals are based on results and comments from respondents**<br>○ Client capacity- F54 (Table 4.9) Client task-item a<br>○ 88.6% agreement to proposal, MF5, Client task-Item b, Figure 5.2<br>○ Consultant-Item a (Figure 5.2, Item MF7)<br>• 46.9% agree<br>• 37.5% not sure<br>• 15.6% disagree | | | |

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Table 5.5 Project documentation, unrealistic time allocation and project delivery

| | | | |
|---|---|---|---|
| | Risk source<br>**Unrealistic time expectation imposed by the client** | | |
| | Client strategy and tasks | | Consultant strategy and tasks |
| | | | |
| a | The employer should engage appropriate expertise in drafting TORs and should be clear in defining the project objectives. | a | An experienced consultant should allocate more skilled personnel to counter the supposedly inadequate time set by the client. |
| b | The client should use expert judgement and related similar projects when determining the estimated project duration. | | |
| c | The client should change the concept of annual funds that cannot be transferred to a subsequent year, including internal evaluation procedures. | | |
| | **Comments and motivation**<br><br>**Proposals are based on results and comments from respondents**<br><br>a The comments recorded below are relative to contractor on this risk<br>o *The period stated in tender documents should be commented on by the consultant at tender stage and provide a justified method statement in addition to the one that is consistent with client assumptions.*<br>o *The consultant should allocate resources accordingly in accordance with the time set by the client.* | | |

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Table 5.6 Project documentation, client capacity and project delivery

| | Risk source<br>**Lack of client capacity to check design errors, mistakes, omissions and clarity of scope** | |
|---|---|---|
| | Client strategy and tasks | Consultant strategy and tasks |
| | | |
| a | The client should provide for adequate time for design and provide for a necessary review to check for the design completeness. Tenders should not be rushed before ascertaining completeness of the design and correctness of the bidding documents. | a The consultant should engage a competent team of experts and should be motivated to have a quality assurance policy in the design process. The quality assurance plan should be submitted to the client prior to commencement of the services. |
| b | Appropriate remedial measures should be put in place for identified errors after award of the contract and design error should be corrected before they affect implementation. The client should develop in-house capacity to check that errors are minimised as they tend to cause claims rather than affect progress. | |
| c | The client should change the concept of annual funds that cannot be transferred to a subsequent year, including internal evaluation procedures. | |
| | **Comments and motivation**<br><br>**Proposals are based on results and comments from respondents**<br><br>Mistakes and discrepancies in contract documents:<br><br>o These should be identified by the contractor and they should be corrected before they affect implementation, and the contractor should have the competency to identify any discrepancies and report accordingly | |

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Table 5.7 Project documentation, checklist to project deliverables and project delivery

| | | | |
|---|---|---|---|
| | Risk source<br>**Lack of checklist of project deliverables**<br>**Terms of reference not consistent with expected deliverables or facets of work** | | |
| | Client strategy and tasks | | Consultant strategy and tasks |
| | | | |
| a | The client should ensure that project deliverables are clearly and concisely stated in the Terms of Reference and within appropriate time frames. | a | An experienced consultant should discuss Terms of Reference with client and advise where there are inconsistencies with expected deliverables prior to commencement of services. |
| b | The client should ensure prompt payments for completed services, and avoid interference with the implementation schedule and restrain from initiating inappropriate design changes. | c | Confirmation of ToR before commencement with client will mitigate future problems. |
| c | The client should exercise due diligence in the selection of consultants with quality attributes given priority in the selection process. | | |
| d | The client should make provision for incentives in the contract if the consultant demonstrates innovation and reduces cost overruns on a project. | | |

**Comments and motivation**

**Proposals are based on results and comments from respondents**

- 100% agree with prequalification as the client action of item b and c, Figure 5.2
- 71.4% agree on the client action for item d, Figure 5.2
- Client initiated changes: F13 (Table 4.4), F55 (Table 4.11)

- The comments below are to counter the risk from the contractor's perception

  - *Prior to commencement, provision for time should be made for contractor to comment on the design and constructability to allow for any suggestions which can be incorporated*

  - *Ambiguity in specifications should be reported and recorded by Contractor and seek clarification ahead of construction*

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Table 5.8 Project documentation, design errors, omissions, clarity and project documentation

| | | | |
|---|---|---|---|
| Risk source<br>**Design errors, mistakes, omissions and lack of clarity** | | | |
| | Client strategy and tasks | | Consultant strategy and tasks |
| | | | |
| a | Appropriate remedial measures should be put in place for identified errors after award of the contract and errors should be corrected before they affect implementation. | a | Once commissioned, the design team must agree on the requirements of the TORs and revisit the main tasks and seek client clarification if necessary. |
| b | The client should develop in-house capacity to enable checking of design documents to minimise occurrence of design errors. | b | The consultant should confirm availability of skills to carry out assignment and established deliverables. |
| c | The client should ensure that project deliverables are clearly and concisely stated in the TORs and within appropriate time frames. | c | Establish design criteria and procedures. |
| | | d | Formulate structure and categories of reports Outline methods for field investigations. |
| | | e | Establish special technical specifications based on available materials and client requirements. |
| | | f | Prepare a list of drawings required to fully present the outcome of designs, standard specifications to be adopted and present to contractor ahead of construction works. |
| | | g | Formulate reporting schedule against important milestones. |
| **Comments and motivation**<br><br>**Proposals are based on results and comments from respondents** | | | |

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## 5.4 Overall results summary

Chapter 4 and Chapter 5 presented results and analysis of main attributes which influence project documentation by consulting Engineers in the Western Cape in South Africa. Two rounds of questionnaire surveys were presented, with results from the first round provided to respondents as feedback. Comments and proposals were sought from respondents on the proposed solutions to mitigating poor quality of project documentation. By analysing the influencing factors that impact key project objectives, and project documentation by consultants, the results show that there is a linkage between project documentation and delivery of key project objectives. Descriptive statistics have been used in the data analysis and key findings explored are presented hereunder.

### (a) Quality of project documentation

Project documentation includes drawings, contract documents and contract specifications. A measure of the quality of project documentation includes completeness, accuracy, and conformity to project deliverables. The quality of project documentation is therefore defined and presented below in their order of importance:

- Design errors or omissions.
- Unclear and inadequate details in design drawings.
- Inconsistencies in contract documents.
- Mistakes and discrepancies in contract documents.
- Poorly written contracts.
- Poor design resulting in poor constructability.

### (b) Factors influencing quality of project documentation

Project documentation by consultants has been observed to influence design changes, cost overruns and project delays. Factors influencing the quality of project documentation have been analysed and discussed. Low professional fees are perceived to have overriding influence in the delivery of service by consultants and significantly limit their performance which results in design errors and flawed quality of project documentation. The results show that factors influencing quality of project documentation, in order significance, in addition to low professional fees include:

- Lack of skilled and experienced technical personnel.
- Lack of quality assurance systems.

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- Lack of communication among project participants.
- Unavailability of qualified technical personnel.
- Unrealistic time expectation for project delivery by the client.
- Lack of client capacity to check design documents.
- Inadequate experience of the consultants.
- Lack of checklist of project deliverables.

**(c) Impact of documentation in project delivery project**

Findings in the research suggest that weaknesses in the quality of project documentation have significant influence on project cost increase, time overruns, disputes and efficiency and effectiveness of project delivery.

**(d) Mitigating strategies to improving quality of project documentation**

The mitigation strategies have been presented based on the findings and comments of construction industry experts consulted in the research. Actions of key project participants have direct influence on the quality of project documentation.

Regarding the contractor attributes, it was found out that technical experience, managerial ability and capacity to mobilize resources are the major considerations. The contractor's related weaknesses are normally dealt with through appropriate contractual provisions (Lo *et al.*, 2006; Mahamid, 2012), and these have not been discussed in detail as this was outside the scope of the research objectives.

Main factors attributed to the employer relate to project management ability, procurement, skills and scope definition (design stage), which also apply to the implementation phase.

Actions that can assist in the mitigation of poor quality of project documentation include the appointment of the consultant based on capacity and not professional fees only. However, limiting fee discounting, training of client personnel to enhance client capacity in procurement and project management in general, would have a positive influence in the delivery of services by the consultants. Training would enable public sector clients to acquire technical skills in drafting TORs, setting realistic time frames for project delivery and setting up of monitoring mechanisms in the

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implementation of infrastructure projects. Public sector clients should therefore push for adoption of procurement strategies through appropriate legislation to enable adoption of strategies that can promote collaboration. The enactment of the Standard for Infrastructure Procurement and Delivery Management may support such an initiative.

The consultants' main attributes are low professional fees, project management, quality assurance and skills related factors. Lack of knowledge and experience are the key attributes with the lack of knowledge directly linked to poor quality of project documentation. It was observed in the research that lack of technical skills, inadequate personnel experience, and absence of quality assurance systems in the consultancy services were key influencing risk factors. Despite low professional fees shown as a key factor influencing project documentation, personnel skills are essential. Fees may provide a motivation for consultants to mobilise appropriate resources and enhance their capacity to engage experienced and skilled personnel. Through the engagement of engineers having appropriate personnel skills, the consultants should develop the capacity to relate TORs, anticipated project deliverable, reporting schedules, and quality assurances systems within available resources and timelines set by the client.

Conclusions and recommendations drawn from the research are presented in Chapter 6.

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# Chapter 6 Conclusions and recommendations

The research focused on the evaluation of the influence of quality of project documentation on the delivery of infrastructure projects in South Africa. Literature was consulted and two rounds of questionnaire surveys were conducted involving construction industry experts to understand the influence and impact of quality of project documentation on project KPIs. Respondents consulted in the research included professionals in the client, consultant and contractor organisations.

The research findings have been presented, the data was analysed and discussed to determine the main findings relative to the influence of quality of project documentation in the attainment of project objectives. Descriptive statistics was used in the data analysis and mean scores and overall mean scores were used to measure the relevance and ranking of the key influencing factors. The results of the first round of the questionnaire survey were presented to respondents as feedback for their comments, and to seek from the respondents their views on the proposed mitigation strategies on the influencing factors that have the potential to inhibit the quality of project documentation by consultants.

The main findings of the research suggest that quality of project documentation significantly influence project outcomes. Poor quality of project documentation cause project delays, cost overruns and increases the possibility of adversarial relationships which may lead to disputes. Inaccurate project documentation could result in poorly constructed assets, and may also affect constructability. The findings agree with most of the literature reviewed and with project management theoretical concepts for key influencing factors to project implementation.

The conclusions drawn in the research findings are presented as guided by the research objectives. The research was set to define and explore the attributes relating to the quality of project documentation in the delivery of infrastructure projects in South Africa. Four main themes explored through the questionnaire survey were:

- Defining factors that constitute the quality of project documentation by consulting engineers throughout the project lifecycle.
- Exploring factors influencing the quality of project documentation by consultants.

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- Examining the impact and relationships that exist between the quality of project documentation and project outcomes.
- To propose mitigating strategies that can influence the improvement of the quality of project documentation.

## 6.1 Summary of key research findings

The key research findings in this study are presented as follows:

- Low or inadequate professional fees are the main factor influencing poor quality of project documentation by consulting engineers.
- Inadequate personnel skills influence project management skills of the consultant team thereby resulting in failure to use appropriate project management concepts and quality assurance systems.
- Design errors, omissions, completeness, inappropriate specifications, and lack of clarity of project documentation potentially impact project cost, time and quality. Other factors that are affected are reduced efficiency and effectiveness of project delivery which are also driven by time schedule imposed by the client and low professional fees.
- Design changes influence scope changes which result into projects cost escalation and significantly increases the project duration. Client initiated design changes have the largest influence in the South Africa construction sector.
- There is a lack of personnel skills in some client organisations which result in poor scope definition and expected project deliverables, inappropriate choice of procurement strategies and limited capacity in checking design documents.

## 6.2 Conclusions from the research findings

The conclusions are founded on the roles and responsibilities of the key project participants in the delivery of infrastructure projects. Analysis of the factors that impact project KPIs have assisted in establishing and defining elements that constitute project documentation. Understanding of the impact of quality of project documentation and the comments from the respondents have assisted in the development of mitigation strategies to improving quality of project documentation as outlined below:

### 6.2.1 Poor quality of project documentation

In addressing the first research objective, project documentation in the context of this research imply, all design data which include design drawings, tender documents, specifications, contract documents

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and all applicable data that the consultant prepares for either tendering or construction purposes. The quality of project documentation by a consultant is measured by correctness, completeness and applicability of the documentation to specific project needs. A departure from the anticipated quality in the project documentation include prevalence of design errors and omissions, mistakes and discrepancies in contract documents, poorly written contract documents, lack of coherence of specification to facets of work, and insufficient design data.

Findings in the research suggest that design errors and omissions have the largest influence to project delivery as they tend to increase project cost. The ranked influencing factors in order of importance are therefore as listed below:

- Design errors or omissions, F34, OMS=4.08.
- Unclear and inadequate details in drawings, F19, OMS=3.90.
- Inconsistencies in contract documents, F57, OMS=3.89.
- Mistakes and discrepancies in contract documents, F27, OMS=3.69.
- Poorly written contracts, F33, OMS=3.64.
- Design resulting in poor constructability, F37, OMS=3.54.

### 6.2.2 Factors influencing quality of project documentation

It can therefore be concluded from the research findings that low professional fees are the main risk influencing factor to quality of project documentation. These factors address the second research objective and they are summarised as follows:

- The quality of project documentation significantly influences project cost, time and quality of constructed assets.
- The quality of project documentation is significantly influenced by low professional fees as shown by the consultant group's rating of the factor F11, MS of 4.79, against the OMS of 4.41.
- The quality of project documentation is influenced by the consultant attributes, suggesting that the lack of personnel skills directly influences the quality of project documentation.
- Lack of client personnel skills in the determination of scope and time of project delivery significantly influences the quality of project documentation.

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### 6.2.3 Quality of project documentation and project objectives: correlation

The research findings show that there is positive correlation between quality of project documentation and project outcomes. Poor quality of project documentation leads design changes and project cost escalation in addition to poor constructability and disputes. This addresses the third research objective which focused on examining the impact and relationship between quality of project and project outcomes which are presented in Figure 4.25. The relationship demonstrates that quality of project documentation significantly influences project delivery.

### 6.2.4 Recommendations to mitigating poor quality documentation from research findings

The South African construction industry can through the findings in this study, enhance project performance through improved project documentation by consultants. The proposed strategies address the fourth objective of the research. Actions that can be considered entail proactive participation of all key project players, with the client driving the innovation through the provision of a conducive operating environment as outlined below.

- The consultants can influence project delivery through enhanced project documentation by adoption of the following summarised proposed strategies:
    - Consultants should strive to prepare and submit realistic financial proposals for professional services they provide based on a thorough project risk analysis and understanding of project objectives.
    - The consultants should strive to deliver quality project documentation irrespective of professional fees.
    - Submission of quality assurance systems should be mandatory in the preparation of technical and financial proposals by consulting engineers.
    - The consultants should develop a checklist and reporting schedule that is consistent with the TORs and project deliverables.
    - The consultants should adopt the use of appropriate technologies to assist in the design process e.g. Building Information Models.
    - To ensure quality delivery of infrastructure projects, the consultant should engage experienced and skilled personnel in the management of designs. Experienced personnel should also be engaged to mentor and supervise young engineers and the design assignments in general.

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- The client may influence project delivery and project documentation through:
    - Limiting professional fees discounting, through active engagement of ECSA, CESA and all other relevant institutions and stakeholders of the impact of professional fees discounting on project delivery.
    - Adoption of procurement strategies that can promote collaboration in the delivery of infrastructure projects.
    - The client organisations, in liaison with the available regulatory institutions should review the effectiveness of available legislation and suggest appropriate recommendations, specifically in the selection of consultants to provide an enabling environment for efficient project delivery.
    - Provision of in-house training to enhance capacity in project management skills. In line with World Bank financed projects, the client can consider providing funds for targeted training of personnel through the consultancy services contracts.
    - Consideration for adoption of remuneration of consultants that is consistent with international practices, where remuneration is based on actual inputs and project deliverables.
    - The prequalification process as agreed by respondents, would assist the client organisations to evaluate proposals from only reputable and capable firms. It could be suggested that the prequalified firms may have the same capacity to understand particular project risks and prepare financial proposals which are consistent with the project demands.
    - Provide risk management training and making risk management mandatory and applying its principles to all projects.

## 6.3 Recommendations for further research

Although the study was done in the Western Cape region, with a target population limited to top management level attendants to the CMP courses, albeit the sample size being relatively small, the results suggest that the trends revealed in the study may reflect trends in the construction sector in South Africa. The findings are consistent with project management theory and some research findings in South Africa and the studies done in other countries.

The research has explored aspects that define the quality of project documentation by consultants, influencing factors that limit the quality of project documentation and proposed mitigation strategies for improving the quality of project documentation. Through the research, the impact of quality of

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project documentation by consultants in the attainment of project KPIs, has been explored, analysed and presented. It is ascertained through the research findings, that there is a direct relationship between quality of project documentation and project KPIs.

Despite the findings in this research revealing that there is a direct linkage between quality of project documentation and project delivery, the findings have not conclusively shown such a relationship in quantitative terms. Future research can therefore extend the research and explore further aspects which are presented below:

- Low professional fees have been identified as a key influencing factor to poor quality of project documentation. The missing link that this research has not determined is the quantitative linkage between fees and project documentation.
- The association between professional fees, service delivery and project size to establish the sufficiency of professional fees.
- The linkage between project cost overruns and level of professional remuneration in terms of time inputs. This can assist stakeholders to answer the question: "Can clients incur less project cost overruns through some level of defined remuneration and improved project documentation and constructability?"
- The association between use of modern design software application and the influence on time input required by the team of experts in the design assignments.

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# Appendices

## Appendix A Form of consent for participation in the survey

Dear Respondent

I am a postgraduate student pursuing a Master's Degree in Construction and Management at Stellenbosch University and I would like to invite you to participate in a research project entitled *The quality of project documentation as a major risk source in infrastructure projects in South Africa*.

As part of this research, I am administering questionnaires to professionals in client and consultant organisations, and to contractors involved in civil engineering infrastructure projects, to learn more from their expertise on the subject matter.

The attached PDF document provides information on the project and conditions of the survey. If you have any questions or concerns about the research, please feel free to contact Prof. J A Wium, the study leader at Stellenbosch University (Contact: email:janw@sun.ac.za) or the researcher, Moses Malinda (Contact: +27794874644, email: 19760310@sun.ac.za).

The terms of consent to participate in this survey are contained in the attachment which are subject to your review should you wish to do so. By clicking "YES" to the first question in the survey you agree to the conditions and to participate in the survey, and you are not required to scan and return the consent form that is part of the PDF document. To proceed with the questionnaire, click one of the following links which is relevant to you (For Client, Consultant or Contractor):

https://www.surveymonkey.com/r/Contractor-1

https://www.surveymonkey.com/r/Client-2

https://www.surveymonkey.com/r/Consultant-3

I sincerely thank you for your acceptance to work on the questionnaire

Kinds Regards

Moses Malinda

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**STELLENBOSCH UNIVERSITY**
**CONSENT TO PARTICIPATE IN RESEARCH**

**TITLE OF THE RESEARCH PROJECT:** The quality of project documentation as a major risk source in infrastructure projects in South Africa

**REFERENCE NUMBER:** **SU-HSD-001230**

**RESEARCHER:** Moses Malinda (SU No. 19760310)

**ADDRESS:** Stellenbosch University**,** Department of Civil Engineering, Private Bag X, Matieland 7602, South Africa

**CONTACT NUMBER:** +27794874644

Dear prospective respondent

I am a postgraduate student pursuing a Master's Degree in Construction and Management at Stellenbosch University and I would like to invite you to participate in a research project entitled *The quality of project documentation s as a major risk source in infrastructure projects in South Africa.*

Please take some time to read the information presented here, which will explain the details of this project and contact me if you require further explanation or clarification of any aspect of the study. Your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Humanities Research Ethics Committee (HREC) at Stellenbosch University** and will be conducted according to accepted and applicable national and international ethical guidelines and principles.

As part of my research, I am investigating how the quality of documentation provided by consultants affect the performance of contractors in infrastructure projects in South Africa. As part of this research, I am administering questionnaires to professionals in client and consultant organisations and contractors involved in civil engineering infrastructure projects, to learn more from their expertise on the subject matter.

The questionnaires will cover aspects of project management in general covering the entire project life cycle. Any data obtained shall not be coded or identifiable and shall be securely stored and accessed by the researcher only.

I will be using data obtained from questionnaires to write my Master's Thesis with the possibility of publishing a paper in an academic journal on the study.

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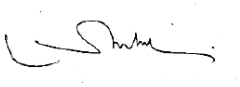
Once again, your privacy, anonymity and confidentiality will be completely protected. There are no anticipated risks to you from participating in the study.

If you have any questions or concerns about the research, please feel free to contact Prof. J A Wium, the study leader of the researcher at Stellenbosch University (Contact: email:janw@sun.ac.za) and that of the Researcher, Moses Malinda (Contact: +27794874644, email: 19760310@sun.ac.za)

**RIGHTS OF RESEARCH PARTICPANTS:** You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.
You have right to receive a copy of the Information and Consent form.

**If you are willing to participate in this study please sign the attached Declaration of Consent which you may scan and return.**

Yours sincerely



Moses Malinda
**Principal Investigator**

Stellenbosch University https://scholar.sun.ac.za

## DECLARATION BY PARTICIPANT

By signing below, I ..... agree to take part in a research study entitled The quality of project documentation s as a major risk source in infrastructure projects in South Africa and conducted by Moses Malinda.

I declare that:

- I have read the attached information leaflet and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.
- All issues related to privacy and the confidentiality and use of the information I provide have been explained to my satisfaction.

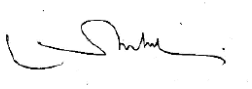
Signed at (*place*) ..... on (*date*) ..... 2015.

.....

**Signature of participant**

## SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to respondents and were encouraged and given ample time to ask me any questions. This conversation was conducted in English and no translator was used in this conversation.



_____ September 2015

**Signature of Investigator** **Date**

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# Appendix B First round questionnaire

## Questionnaire for the client group of respondents

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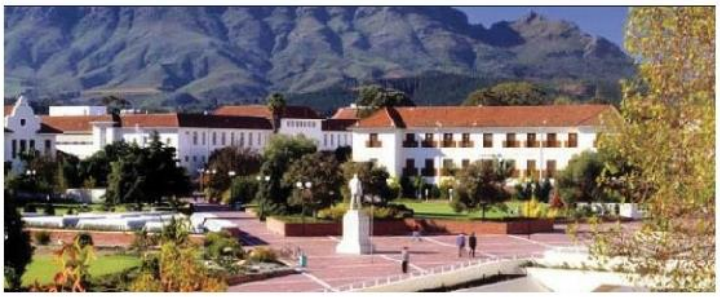

**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Client)**

### 1. CONSENT TO PARTICIPATE IN SURVEY

Thank you for participating in my survey. Your feedback is important and appreciated.

Moses Malinda
Stellenbosch University

**1. The terms of consent to participate in this survey are contained in the PDF attachment to the e-mail and are subject to your review should you wish to do so. By clicking "YES" you agree to the conditions and to participate in the survey and you are not required to scan and returnthe consent form that is attached. Following the "YES", you may kindly proceed with the rest of the questionnaire.**

- ◯ Yes
- ◯ No

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# The quality of project documentation as a major risk source in infrastructure projects in South Africa (Client)

## 2. SECTION 1

DETAILS OF RESPONDENT

**2. Indicate the type of organisation**

- ◯ Client
- ◯ Consulting Engineer
- ◯ Contractor
- ◯ Other (please specify)

**3. Indicate the type of industry**

- ◯ Civil Engineering
- ◯ Building
- ◯ Other (please specify)

**4. Indicate your age**

- ◯ 25-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-66
- ◯ >66

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**5. Indicate your highest level of education**

- ◯ Diploma
- ◯ Degree
- ◯ Postgraduate degree
- ◯ Other (please specify)

**6. Your work designation**

- ◯ Top management
- ◯ Middle management
- ◯ Operational

**7. Years of experience in construction industry**

- ◯ 1-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ >20 years

**8. The size of your organisation**

- ◯ <50 people
- ◯ 50-200 people
- ◯ >200

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**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Client)**

## 3. SECTION B

RISK FACTORS IMPACTING ON CONTRACTOR PERFORMANCE

**9. There are several factors which influence the performance of a contractor or consultant on a project.**
**For each of the following statements, tick the box that most closely matches your experience in relation to success or failure of a project.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Legislation on award of contracts limits a contractor or consultant in the delivery of services | ○ | ○ | ○ | ○ | ○ |
| b. Traditional contract forms is a limitation to contracting services | ○ | ○ | ○ | ○ | ○ |
| c. Traditional forms of procurement (Design Bid and Build) limit key participants in the services they provide | ○ | ○ | ○ | ○ | ○ |
| d. New forms of contracts (NEC3, Design and Build, PPP) empower project participants in the services they provide | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| e. There is too little participation of client at project design phase | ○ | ○ | ○ | ○ | ○ |
| f. The procurement methods by government departments influence the level of service of key project participants | ○ | ○ | ○ | ○ | ○ |
| g. Clients often have unrealistic requirements which limit performance of of key project participants | ○ | ○ | ○ | ○ | ○ |
| h. Inadequate experience of contractor/consultant resultant in poor delivery of service | ○ | ○ | ○ | ○ | ○ |
| i. Contractor's/consultant's lack of project management practices | ○ | ○ | ○ | ○ | ○ |
| j. Lack of technical skills among contractors and consultants | ○ | ○ | ○ | ○ | ○ |
| k. Exceptionally low bids due to competition | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

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**10. The following procurement methods are widely used in the infrastructure projects. For each of the following statements, tick the box that most closely matches your experience in relation to procurement method of contracts awarded in the last 5 Years.**

| | Never | Seldom | Sometimes | Mostly | Always |
|---|---|---|---|---|---|
| a. Traditional (design-Bid-Build) | ○ | ○ | ○ | ○ | ○ |
| b. Construction Management | ○ | ○ | ○ | ○ | ○ |
| c. Design and Build | ○ | ○ | ○ | ○ | ○ |
| d. New forms of contracts (NEC3, Design and Build, PPP) make consultant more able in providing services | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

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**11. Client organisations adopt different tendering processes best suited to the particular organisation and in accordance with prevailing legislation.**
**For each of the statement below, tick that most closely matches<u>procurement practices</u> as experienced in your organisationbased on the shown scale.**

| | Always | Mostly | Sometimes | Seldom | Never |
|---|---|---|---|---|---|
| a. Consultancy services contracts are advertised though open tendering procedures | ○ | ○ | ○ | ○ | ○ |
| b. Works contracts are advertised through open tender procedures | ○ | ○ | ○ | ○ | ○ |
| c. Most of the consultancy services contracts are awarded based on quality and cost | ○ | ○ | ○ | ○ | ○ |
| d. Works contracts are mostly awarded based on lowest price | ○ | ○ | ○ | ○ | ○ |
| e. Works contracts are awarded without factoring in other attributes | ○ | ○ | ○ | ○ | ○ |
| f. Detailed engineering design is done in house with available expertise | ○ | ○ | ○ | ○ | ○ |
| g. Most services are outsourced due to lack of capacity in client organisation | ○ | ○ | ○ | ○ | ○ |

**12. Consultants play a critical role in project delivery of the entire project cycle. However, several factors impact on the performance of the contractors resulting from consultant actions. For each of the following statements, tick the box that most closely matches your experience as <u>causes of delay</u> based on the shown scale.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Many design changes at implementation | ○ | ○ | ○ | ○ | ○ |

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**11. Client organisations adopt different tendering processes best suited to the particular organisation and in accordance with prevailing legislation.**
**For each of the statement below, tick that most closely matchesprocurement practices as experienced in your organisationbased on the shown scale.**

| | Always | Mostly | Sometimes | Seldom | Never |
|---|---|---|---|---|---|
| a. Consultancy services contracts are advertised though open tendering procedures | ○ | ○ | ○ | ○ | ○ |
| b. Works contracts are advertised through open tender procedures | ○ | ○ | ○ | ○ | ○ |
| c. Most of the consultancy services contracts are awarded based on quality and cost | ○ | ○ | ○ | ○ | ○ |
| d. Works contracts are mostly awarded based on lowest price | ○ | ○ | ○ | ○ | ○ |
| e. Works contracts are awarded without factoring in other attributes | ○ | ○ | ○ | ○ | ○ |
| f. Detailed engineering design is done in house with available expertise | ○ | ○ | ○ | ○ | ○ |
| g. Most services are outsourced due to lack of capacity in client organisation | ○ | ○ | ○ | ○ | ○ |

**12. Consultants play a critical role in project delivery of the entire project cycle. However, several factors impact on the performance of the contractors resulting from consultant actions. For each of the following statements, tick the box that most closely matches your experience as causes of delay based on the shown scale.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Many design changes at implementation | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| b. Client variations leading to changes in scope | ○ | ○ | ○ | ○ | ○ |
| c. Delays in approving drawings by client | ○ | ○ | ○ | ○ | ○ |
| d. Inadequate experience of the consultant | ○ | ○ | ○ | ○ | ○ |
| e. Lack of communication among the project participants | ○ | ○ | ○ | ○ | ○ |
| f. Lack of skilled and experienced technical personnel | ○ | ○ | ○ | ○ | ○ |
| g. Adversarial/confrontational culture | ○ | ○ | ○ | ○ | ○ |
| h. Unclear and inadequate details in drawings | ○ | ○ | ○ | ○ | ○ |
| i. Lack of quality control | ○ | ○ | ○ | ○ | ○ |
| j. Poor site management and supervision by the consultant | ○ | ○ | ○ | ○ | ○ |
| k. Poor definition of payment milestones | ○ | ○ | ○ | ○ | ○ |
| l. Unrealistic inspection and testing methods proposed in contract | ○ | ○ | ○ | ○ | ○ |
| m. Excessive bureaucracy in project owner operations | ○ | ○ | ○ | ○ | ○ |
| n. Unrealistic contract duration imposed by client | ○ | ○ | ○ | ○ | ○ |
| o. Slow response by the consulting engineers in performing testing and inspection | ○ | ○ | ○ | ○ | ○ |
| p, Mistakes and discrepancies in contract documents | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| q. Interference by client/owner in construction operations | ○ | ○ | ○ | ○ | ○ |
| r. Delay in progress payment by client | ○ | ○ | ○ | ○ | ○ |

**13. Project Cost overruns are a common phenomenon in infrastructure projects and the construction industry does not have a good reputation for this aspect.**
**In your opinion, how would you rate each of the following as reasons for project cost overruns.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Increased scope due to design errors | ○ | ○ | ○ | ○ | ○ |
| b. Change in specifications due to design changes | ○ | ○ | ○ | ○ | ○ |
| c. Inconsistencies in contract documents | ○ | ○ | ○ | ○ | ○ |
| d. Poorly written contracts | ○ | ○ | ○ | ○ | ○ |
| e. Design errors or omissions | ○ | ○ | ○ | ○ | ○ |
| f. Overall change orders by the client | ○ | ○ | ○ | ○ | ○ |
| g. Inadequate experience of contractor | ○ | ○ | ○ | ○ | ○ |
| h. Design resulting in poor constructability | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

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**14. During implementation phase, it has been observed that designs often come with significant errors which impact on project objectives. Indicate the extent to which you agree or disagree with each of the statements listed below as contributing to errors during the design stage using the scale provided.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Lack of consultant experience | ○ | ○ | ○ | ○ | ○ |
| b. Unrealistic contract durations imposed by client | ○ | ○ | ○ | ○ | ○ |
| c. Lack of skilled consultant technical personnel | ○ | ○ | ○ | ○ | ○ |
| d. Low professional fees | ○ | ○ | ○ | ○ | ○ |
| e. Terms of reference not consistent with expected deliverables | ○ | ○ | ○ | ○ | ○ |
| f. Lack of quality assurance systems in consultant team | ○ | ○ | ○ | ○ | ○ |
| g. Lack of use of modern design software | ○ | ○ | ○ | ○ | ○ |
| h. Lack of innovation and design options due to low fees | ○ | ○ | ○ | ○ | ○ |
| i. Owners irregular behaviour | ○ | ○ | ○ | ○ | ○ |
| j. Inaccurate or inappropriate procurement methods | ○ | ○ | ○ | ○ | ○ |

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**15. The consulting engineer has to satisfy the requirements of the client in the management of infrastructure projects.**
**Indicate the importance that you attach to each of the following aspects by using the rating below.**

| | Never | Seldom | Sometimes | Mostly | Always |
|---|---|---|---|---|---|
| a. Optimising of the project value engineering | ○ | ○ | ○ | ○ | ○ |
| b. Developing effective technical performance | ○ | ○ | ○ | ○ | ○ |
| c. Minimising delay and cost overruns | ○ | ○ | ○ | ○ | ○ |

**16. Quality of documentation in designs could include poor or incomplete drawings, inconsistencies in work specifications and contradictory information in contract documents.**
**In your opinion, how would you rate each of the following factors as contributing to poor quality documentation.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a, Inexperienced consultant personnel | ○ | ○ | ○ | ○ | ○ |
| b. Inadequate fees | ○ | ○ | ○ | ○ | ○ |
| c. Lack of resources due to low fees | ○ | ○ | ○ | ○ | ○ |
| d. Unavailability of personnel | ○ | ○ | ○ | ○ | ○ |
| e. Unrealistic time expectation by client | ○ | ○ | ○ | ○ | ○ |
| f. Lack of checklist of project deliverables | ○ | ○ | ○ | ○ | ○ |
| g. Lack of client capacity to check designs | ○ | ○ | ○ | ○ | ○ |

**17. Projects often suffer frequent changes in design during implementation which often result in cost and time overrun. Several reasons have been suggested for frequent changes in the supervision phase of projects.**
**For each of the following statements, indicate the extent to which you agree or disagree and tick the box that most closely matches your experience as reasons for frequent changes.**

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| | Strongly disagree | disagree | neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a, Client generated variations | ○ | ○ | ○ | ○ | ○ |
| b. Slow decision from owner | ○ | ○ | ○ | ○ | ○ |
| c. Inconsistency in contract documents | ○ | ○ | ○ | ○ | ○ |
| d. Inaccurate bill of quantities | ○ | ○ | ○ | ○ | ○ |
| e. Delays in approving contractor submissions | ○ | ○ | ○ | ○ | ○ |
| f. Insufficient data collection and survey data before design which impact constructability | ○ | ○ | ○ | ○ | ○ |
| g. Misunderstanding of client requirement by design engineer | ○ | ○ | ○ | ○ | ○ |
| h. Non availability of design drawings on time | ○ | ○ | ○ | ○ | ○ |
| i. Lack of clarity in project scope | ○ | ○ | ○ | ○ | ○ |
| j. Delay in approval of completed work by consultant | ○ | ○ | ○ | ○ | ○ |
| k. Consultant or architect' s reluctance for change | ○ | ○ | ○ | ○ | ○ |
| l. Ambiguity in specifications resulting in conflicting interpretation by parties | ○ | ○ | ○ | ○ | ○ |
| m. Long waiting time for approval of test samples of materials | ○ | ○ | ○ | ○ | ○ |
| n. Lack of communication between consultant and contractor | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | disagree | neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| o. Low speed of decision making involving all project teams | ○ | ○ | ○ | ○ | ○ |
| p. Slow information flow between team members | ○ | ○ | ○ | ○ | ○ |
| q. Lack of skilled and experienced supervisory personnel | ○ | ○ | ○ | ○ | ○ |
| r. Lack to track, evaluate and manage claims | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

**18. In the traditional type of contracts (Design, Bid and Build), client involvement may reduce the frequent changes during the implementation phase of a project. In your opinion, to what extent do clients actually at present meet these obligations using the rating shown below.**

| | No input | Limited input | Fairly meet obligations | Sometimes meet obligations | Meet obligations |
|---|---|---|---|---|---|
| a. Design stage - review of designs | ○ | ○ | ○ | ○ | ○ |
| b. Tendering stage | ○ | ○ | ○ | ○ | ○ |
| c. Implementation stage | ○ | ○ | ○ | ○ | ○ |
| d. Managing claims and disputes | ○ | ○ | ○ | ○ | ○ |

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**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Client)**

## 4. SECTION C

EFFECTS OF QUALITY OF DOCUMENTATION BY CONSULTANTS IN PROJECT IMPLEMENTATION

**19. In your opinion, how does poor quality of documentation influence each of the following statements listed below and using the scale shown.**

| | Never | Seldom | Sometimes | Mostly | Always |
|---|---|---|---|---|---|
| a. Time overruns | ○ | ○ | ○ | ○ | ○ |
| b. Cost overruns | ○ | ○ | ○ | ○ | ○ |
| c. Disputes | ○ | ○ | ○ | ○ | ○ |
| d. Arbitration | ○ | ○ | ○ | ○ | ○ |
| e, Total abandonment | ○ | ○ | ○ | ○ | ○ |
| f. Litigation | ○ | ○ | ○ | ○ | ○ |

**20. The consultant as the client representative undertakes to provide expert advise to both parties (client and contractor) in managing infrastructure projects.**
**In your opinion, to what extent do consultants satisfy this objective based on projects you have undertaken in the last five years using the shown scale.**

- ○ Very satisfied
- ○ Somewhat satisfied
- ○ Neither dissatisfied nor satisfied
- ○ Somewhat dissatisfied
- ○ Very dissatisfied

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# Questionnaire for the consultant group of respondents

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**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Consultant)**

1. Welcome to My Survey
CONSENT TO PARTICIPATE IN SURVEY

Thank you for participating in my survey. Your feedback is important and appreciated

Moses Malinda
Stellenbosch University

**1. The terms of consent to participate in this survey are contained in the PDF attachment to the e-mail and are subject to your review should you wish to do so. By clicking "YES" *you* agree to the conditions and to participate in the survey and you are not required to scan and returnthe consent form that is attached. Following the "YES", you may kindly proceed with the rest of the questionnaire**

- ◯ Yes
- ◯ No

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# The quality of project documentation as a major risk source in infrastructure projects in South Africa (Consultant)

## 2. SECTION 1

DETAILS OF RESPONDENT

**2. Indicate the type of organisation**

- ◯ Client
- ◯ Consulting Engineer
- ◯ Contractor
- ◯ Other (please specify)

**3. Indicate the type of industry**

- ◯ Civil Engineering
- ◯ Building
- ◯ Other (please specify)

**4. Indicate your age**

- ◯ 25-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-66
- ◯ >66

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**5. Indicate your highest level of education**

- ◯ Diploma
- ◯ Degree
- ◯ Postgraduate degree
- ◯ Other (please specify)

**6. Your work designation**

- ◯ Top management
- ◯ Middle management
- ◯ Operational

**7. Years of experience in construction industry**

- ◯ 1-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ >20 years

**8. The size of your organisation**

- ◯ <50 people
- ◯ 50-200
- ◯ >200

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**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Consultant)**

## 3. SECTION B

RISK FACTORS IMPACTING ON CONTRACTOR PERFORMANCE

**9. There are several factors which influence the performance of main project players on a project . For each of the following statements, indicate the extent to which you agree or disagree with each of these statements and how they impact on key players in achieving project objectives.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Legislation on award of contracts limits consultants in the services they provide | ○ | ○ | ○ | ○ | ○ |
| b. Traditional contract forms is a limitation to professional services contracts | ○ | ○ | ○ | ○ | ○ |
| c. Traditional form of procurement (Design Bid and Build) limit the consultants in the services they provide | ○ | ○ | ○ | ○ | ○ |
| d. New forms of contracts (NEC3, Design and Build, PPP) empower consultants in providing services | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| e. There is too little participation of client at project design phase | ○ | ○ | ○ | ○ | ○ |
| f. The procurement methods by Government departments influence the level of consulting services | ○ | ○ | ○ | ○ | ○ |
| g. Clients have unrealistic requirements which limit consultant service performance | ○ | ○ | ○ | ○ | ○ |
| h. Inadequate experience of the consultant often results in poor delivery of services | ○ | ○ | ○ | ○ | ○ |
| i. Consultant's lack of project management practices | ○ | ○ | ○ | ○ | ○ |
| j. Lack of technical skills among consultant personnel | ○ | ○ | ○ | ○ | ○ |
| k. Exceptionally low bids due to discounting of fees limit consultant's performance | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

**10. Consultants play a critical role in project delivery of the entire project cycle and there are several factors which impact on the successful completion of a project. For each of the following statements, tick the box that most closely matches your experience as causes of delay based on the shown scale.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Many design changes at implementation | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| b. Client variations leading to changes in scope | ○ | ○ | ○ | ○ | ○ |
| c. Delays in approving drawings by clients | ○ | ○ | ○ | ○ | ○ |
| d. Inadequate experience of the consultant | ○ | ○ | ○ | ○ | ○ |
| e. Lack of communication among the project participants | ○ | ○ | ○ | ○ | ○ |
| f. Lack of skilled technical personnel | ○ | ○ | ○ | ○ | ○ |
| g. Adversarial/confrontational culture | ○ | ○ | ○ | ○ | ○ |
| h. Unclear and inadequate details in drawings | ○ | ○ | ○ | ○ | ○ |
| i. Lack of quality control of design | ○ | ○ | ○ | ○ | ○ |
| j. Poor site management and supervision by the consultant | ○ | ○ | ○ | ○ | ○ |
| k. Poor definition of payment milestones | ○ | ○ | ○ | ○ | ○ |
| l. Unrealistic inspection and testing methods proposed in contract | ○ | ○ | ○ | ○ | ○ |
| m. Excessive bureaucracy in project owner operations | ○ | ○ | ○ | ○ | ○ |
| n. Unrealistic contract duration imposed by client | ○ | ○ | ○ | ○ | ○ |
| o. Slow response by consulting engineer in performing testing and inspection | ○ | ○ | ○ | ○ | ○ |
| p. Mistakes and discrepancies in contract documents | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| q. Interference by owner/client in construction operations | ○ | ○ | ○ | ○ | ○ |
| r. Delay in progress payment by client | ○ | ○ | ○ | ○ | ○ |

**11. Project Cost overruns are a common phenomenon in infrastructure projects and the construction industry does not have a good reputation for this aspect.**
**In your opinion, how would you rate each of the following factors as reasons for project cost overruns.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Increased scope due to design errors | ○ | ○ | ○ | ○ | ○ |
| b. Change in specifications due to design changes | ○ | ○ | ○ | ○ | ○ |
| c. Inconsistencies in construction contract documents | ○ | ○ | ○ | ○ | ○ |
| d. Poorly written contracts | ○ | ○ | ○ | ○ | ○ |
| e. Design errors or omissions | ○ | ○ | ○ | ○ | ○ |
| f. Overall change orders by the client | ○ | ○ | ○ | ○ | ○ |
| g. Inadequate experience of contractor | ○ | ○ | ○ | ○ | ○ |

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**12. During implementation, it has often been observed that designs come with significant errors which impact on project objectives. Indicate the extent to which you agree or disagree with each of the statements listed below as contributing to errors during the design stage using the scale provided.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Lack of consultant experience | ○ | ○ | ○ | ○ | ○ |
| b. Unrealistic contract durations imposed by client | ○ | ○ | ○ | ○ | ○ |
| c. Lack of skilled consultant technical personnel | ○ | ○ | ○ | ○ | ○ |
| d. Low professional fees | ○ | ○ | ○ | ○ | ○ |
| e. Terms of reference not consistent with expected deliverables | ○ | ○ | ○ | ○ | ○ |
| f. Lack of quality assurance systems in consultant team | ○ | ○ | ○ | ○ | ○ |
| g. Lack of use of modern design software | ○ | ○ | ○ | ○ | ○ |
| h. Lack of innovation and design options due to low fees | ○ | ○ | ○ | ○ | ○ |
| i. Owner's irregular behaviour | ○ | ○ | ○ | ○ | ○ |
| j. Inaccurate or inappropriate procurement methods | ○ | ○ | ○ | ○ | ○ |

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**13. The consulting engineer has to satisfy client requirements in the management of infrastructure projects.**
**Indicate the importance that you attach to each of the following aspects by using the rating below.**

| | Never | Seldom | Sometimes | Mostly | Always |
|---|---|---|---|---|---|
| a. Optimising of the project value engineering | ○ | ○ | ○ | ○ | ○ |
| b. Developing effective technical performance | ○ | ○ | ○ | ○ | ○ |
| c. Minimising delay and cost overruns | ○ | ○ | ○ | ○ | ○ |

**14. In the traditional type of contracts (Design, Bid and Construct), client involvement may reduce the frequent changes during the implementation phase of a project. In your opinion, to what extent do clients at present actually meet these obligations using the rating shown below.**

| | No input | Limited input | Fairly meet obligations | Sometimes meet obligations | often meet obligations |
|---|---|---|---|---|---|
| a. Design stage - review of designs | ○ | ○ | ○ | ○ | ○ |
| b. Tendering stage | ○ | ○ | ○ | ○ | ○ |
| c. Implementation stage | ○ | ○ | ○ | ○ | ○ |
| d. Managing claims and disputes | ○ | ○ | ○ | ○ | ○ |

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**15. Quality of documentation in designs could include poor or incomplete drawings, inconsistencies in work specifications and contradictory information in contract documents. In your opinion, how would you rate each of the following factors as contributing to poor quality documentation.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Inexperienced consultant personnel | ○ | ○ | ○ | ○ | ○ |
| b. Inadequate fees | ○ | ○ | ○ | ○ | ○ |
| c. Lack of resources due to low fees | ○ | ○ | ○ | ○ | ○ |
| d. Unavailability of personnel | ○ | ○ | ○ | ○ | ○ |
| e. Unrealistic time expectation by client | ○ | ○ | ○ | ○ | ○ |
| f. Lack of checklist of project deliverables | ○ | ○ | ○ | ○ | ○ |
| g. Lack of client capacity to check designs | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

**16. Projects often suffer frequent changes in design during implementation which often result in cost and time overrun. Several reasons have been suggested for frequent changes in the supervision phase of projects.**
**For each of the following statements, indicate the extent to which you agree or disagree and tick the box that most closely matches your experience as reasons for frequent changes.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Client generated variations | ○ | ○ | ○ | ○ | ○ |
| b. Slow decision from owner | ○ | ○ | ○ | ○ | ○ |
| c. Inconsistency in contract documents | ○ | ○ | ○ | ○ | ○ |
| d. Inaccurate bills of quantities | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| e. Delays in approving contractor submissions | ○ | ○ | ○ | ○ | ○ |
| f. Insufficient data collection and survey before designs | ○ | ○ | ○ | ○ | ○ |
| g. Misunderstanding of client requirement by design engineer | ○ | ○ | ○ | ○ | ○ |
| h. Verbal instructions due to non availability of design drawings | ○ | ○ | ○ | ○ | ○ |
| i. Lack of clarity in project scope | ○ | ○ | ○ | ○ | ○ |
| j. Delay in approval of completed work by consultant | ○ | ○ | ○ | ○ | ○ |
| k. Consultant or architect's reluctance for change | ○ | ○ | ○ | ○ | ○ |
| l. Ambiguity in specifications resulting in conflicting interpretation by parties | ○ | ○ | ○ | ○ | ○ |
| m. Long waiting time for approval of test samples of materials | ○ | ○ | ○ | ○ | ○ |
| n. Lack of communication between client and consultant | ○ | ○ | ○ | ○ | ○ |
| o. Low speed of decision making involving all project teams | ○ | ○ | ○ | ○ | ○ |
| p. Slow information flow between team members | ○ | ○ | ○ | ○ | ○ |
| q. Lack of skilled and experienced supervisory personnel | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| r. Failure to track, evaluate and manage claims | ○ | ○ | ○ | ○ | ○ |

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**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Consultant)**

## 4. SECTION C

EFFECTS OF QUALITY OF DOCUMENTATION BY CONSULTANTS IN PROJECT IMPLEMENTATION

**17. In your opinion, how does poor quality of documentation influence each of the following statements listed below and using the scale shown.**

| | Never | Seldom | Sometimes | Mostly | Always |
|---|---|---|---|---|---|
| a. Time overruns | ○ | ○ | ○ | ○ | ○ |
| b. Cost overruns | ○ | ○ | ○ | ○ | ○ |
| c. Disputes | ○ | ○ | ○ | ○ | ○ |
| d. Arbitration | ○ | ○ | ○ | ○ | ○ |
| e, Total abandonment | ○ | ○ | ○ | ○ | ○ |
| f. Litigation | ○ | ○ | ○ | ○ | ○ |

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# Questionnaire for contractor group of respondents

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**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Contractor)**

## 1. CONSENT TO PARTICIPATE IN SURVEY

Thank you for participating in my survey. Your feedback is important and appreciated.

Moses Malinda
Stellenbosch University

**1. The terms of consent to participate in this survey are contained in the PDF attachment to the e-mail and are subject to your review should you wish to do so. By clicking "YES" you agree to the conditions and to participate in the survey and you are not required to scan and returnthe consent form that is attached. Following the "YES", you may kindly proceed with the rest of the questionnaire.**

- ◯ Yes
- ◯ No

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# The quality of project documentation as a major risk source in infrastructure projects in South Africa (Contractor)

## 2. SECTION 1

DETAILS OF RESPONDENT

**2. Indicate the type of organisation**

- ◯ Client
- ◯ Consulting Engineer
- ◯ Contractor
- ◯ Other (please specify)

**3. Indicate the type of industry**

- ◯ Civil Engineering
- ◯ Building
- ◯ Other (please specify)

**4. Indicate your age**

- ◯ 25-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-66
- ◯ >66

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**5. Indicate your highest level of education**

- ◯ Diploma
- ◯ Degree
- ◯ Postgraduate degree
- ◯ Other (please specify)

**6. Your work designation**

- ◯ Top management
- ◯ Middle management
- ◯ Operational

**7. Years of experience in construction industry**

- ◯ 1-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ >20 years

**8. The size of your organisation**

- ◯ <50 people
- ◯ 50-200 people
- ◯ >200

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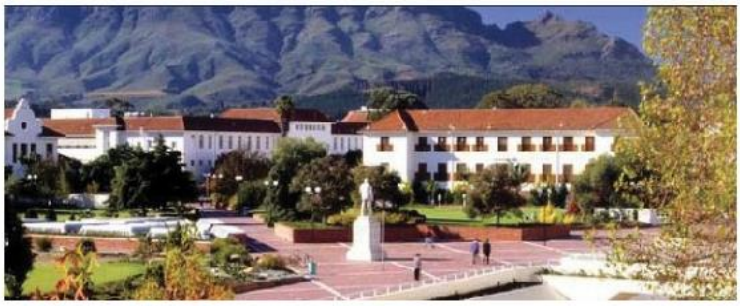

**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Contractor)**

## 3. SECTION B

RISK FACTORS IMPACTING ON CONTRACTOR PERFORMANCE

**9. There are several factors which influence the performance of a contractor on a project. For each of the following statements, tick the box that most closely matches your experience in relation to success or failure of project using the shown rating.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Legislation on award of contracts limits contractor's performance | ○ | ○ | ○ | ○ | ○ |
| b. Traditional contract forms is a limitation to contracting services | ○ | ○ | ○ | ○ | ○ |
| c. Traditional form of procurement (Design Bid and Build) limit the contractors in the services they provide | ○ | ○ | ○ | ○ | ○ |
| d. New forms of contracts (NEC3, Design and Build, PPP) provide more incentives in managing risks | ○ | ○ | ○ | ○ | ○ |
| e. Inadequate capacity of the contractor | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| f. The procurement methods by Government departments influence the level of contractor performance | ○ | ○ | ○ | ○ | ○ |
| g. Clients have unrealistic requirements which limits contractor's performance | ○ | ○ | ○ | ○ | ○ |
| h. Inadequate experience of the contractor often engaged on projects results in poor delivery of services | ○ | ○ | ○ | ○ | ○ |
| i. Contractor's lack of project management practices | ○ | ○ | ○ | ○ | ○ |
| j. Lack of technical skills among contractor's personnel | ○ | ○ | ○ | ○ | ○ |
| k. Exceptionally low bids due to competition | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

**10. Most projects experience delays which often lead to extension of time. However, several factors(Controllable) impact on the performance of the contractor throughout the project cycle. For each of the following statements, tick the box that most closely matches your experience as a cause of delay based on the shown scale.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Many design changes at implementation | ○ | ○ | ○ | ○ | ○ |
| b. Client variations leading to changes in scope | ○ | ○ | ○ | ○ | ○ |
| c. Delays in approving drawings by consultants | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| d. Inadequate experience of the consultant | ○ | ○ | ○ | ○ | ○ |
| e. Lack of communication among the project participants | ○ | ○ | ○ | ○ | ○ |
| f. Lack of skilled and experienced technical personnel on the contractor's team | ○ | ○ | ○ | ○ | ○ |
| g. Adversarial/confrontational culture | ○ | ○ | ○ | ○ | ○ |
| h. Unclear and inadequate details in drawings | ○ | ○ | ○ | ○ | ○ |
| i. Lack of quality control | ○ | ○ | ○ | ○ | ○ |
| j. Poor site management and supervision by the consultant | ○ | ○ | ○ | ○ | ○ |
| k. Poor definition of payment milestones | ○ | ○ | ○ | ○ | ○ |
| l. Unrealistic inspection and testing methods proposed in contract | ○ | ○ | ○ | ○ | ○ |
| m. Excessive bureaucracy in project owner operations | ○ | ○ | ○ | ○ | ○ |
| n. Unrealistic contract duration imposed by client | ○ | ○ | ○ | ○ | ○ |
| o. Slow response by the consultant Engineer in performing testing and inspection | ○ | ○ | ○ | ○ | ○ |
| p. Mistakes and discrepancies in contract documents | ○ | ○ | ○ | ○ | ○ |
| q. Interference by owner/client in construction operations | ○ | ○ | ○ | ○ | ○ |
| r. Delay in progress payment by client | ○ | ○ | ○ | ○ | ○ |

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**11. Project Cost overruns are a common occurrence in infrastructure projects and the construction industry does not have a good reputation for this aspect.**
**In your opinion, how do you rate each of the following statements relating to the performance of consultant with regard to project cost increase based on the shown scale?**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Increased scope due to design errors or omissions | ○ | ○ | ○ | ○ | ○ |
| b. Change in specifications due to design changes | ○ | ○ | ○ | ○ | ○ |
| c. Inconsistencies in contract documents | ○ | ○ | ○ | ○ | ○ |
| d. Poorly written contracts | ○ | ○ | ○ | ○ | ○ |
| e. Design errors or omissions | ○ | ○ | ○ | ○ | ○ |
| f. Overall change orders by the client | ○ | ○ | ○ | ○ | ○ |
| g. Inadequate experience of contractor | ○ | ○ | ○ | ○ | ○ |
| h. Design resulting in poor constructability | ○ | ○ | ○ | ○ | ○ |

**12. Projects often suffer frequent changes in design during implementation which often result in cost and time overrun. Several reasons have been suggested for frequent changes in the supervision phase of projects.**
**For each of the following statements, indicate the extent to which you agree or disagree and tick the box on the shown scale that most closely matches your experience as causes of frequent changes.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Client generated variations | ○ | ○ | ○ | ○ | ○ |
| b. Slow decision from owner | ○ | ○ | ○ | ○ | ○ |
| c. Inconsistency in contract documents | ○ | ○ | ○ | ○ | ○ |
| d. Inaccurate Bill of Quantities | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| e. Delay in approving contractor submissions | ○ | ○ | ○ | ○ | ○ |
| f. Insufficient data collection and survey before design which impact constructability | ○ | ○ | ○ | ○ | ○ |
| g. Misunderstanding of client requirements by design engineer | ○ | ○ | ○ | ○ | ○ |
| h. Non availability of design drawings on time | ○ | ○ | ○ | ○ | ○ |
| i. Lack of clarity in project scope | ○ | ○ | ○ | ○ | ○ |
| j. Delay in approval of completed work by consultant | ○ | ○ | ○ | ○ | ○ |
| k. Consultant or architect's reluctance for change | ○ | ○ | ○ | ○ | ○ |
| l. Ambiguity in specifications resulting in conflicting interpretation by parties | ○ | ○ | ○ | ○ | ○ |
| m. Long waiting time for approval of test samples of materials | ○ | ○ | ○ | ○ | ○ |
| n. Lack of communication between client and consultant | ○ | ○ | ○ | ○ | ○ |
| o. Low speed of decision making involving all project teams | ○ | ○ | ○ | ○ | ○ |
| p. Slow information flow between team members | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| q. Lack of skilled and experienced supervisory personnel | ○ | ○ | ○ | ○ | ○ |
| r. Failure to track and evaluate claims | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

**13. The Procurement strategy adopted by the client has been perceived as undermining the performance of the contractor. Indicate the extent to which you agree with this statement as they relate to contractor performance by ticking the appropriate box on the given scale.**

| Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

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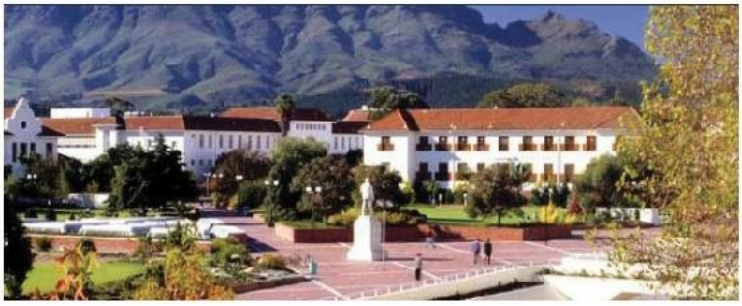

**The quality of project documentation as a major risk source in infrastructure projects in South Africa (Contractor)**

## 4. SECTION C

EFFECTS OF QUALITY OF DOCUMENTATION BY CONSULTANTS IN PROJECT IMPLEMENTATION

**14. In your opinion, how does poor quality of documentation influence each of the following statements listed below and using the scale shown.**

| | Strongly disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|
| a. Time overruns | ○ | ○ | ○ | ○ | ○ |
| b. Cost overruns | ○ | ○ | ○ | ○ | ○ |
| c. Disputes | ○ | ○ | ○ | ○ | ○ |
| d. Arbitration | ○ | ○ | ○ | ○ | ○ |
| e, Total abandonment | ○ | ○ | ○ | ○ | ○ |
| f. Litigation | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

**15. The consultant as the client representative undertakes to provide expert advise to both parties (client and contractor) in managing infrastructure projects.**
**In your opinion, to what extent do consultants satisfy this objective based on projects you have undertaken in the last five years using the shown scale.**

| Very satisfied | Somewhat satisfied | Neither satisfied nor dissatisfied | Somewhat dissatisfied | Strongly dissatisfied |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

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# Appendix C Second round questionnaire

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## Department of Construction Engineering and Management

## Quality of project documentation as a major risk source in infrastructure projects in South Africa

Feedback and follow up on the questionnaire survey

**Moses Malinda**

Email: 19760310@sun.ac.za

Contact: +27 794874644

29th April 2016

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# FEEDBACK ON FIRST SURVEY

1 **Major risk factors impacting project performance**

The survey has identified factors which are major risks attributed to quality of project documentation, which impact on the performance of the contractor. The main factors have been attributed to the consultant and the employer. Controllable factors that impact on project performance attributed to the contractor have not been included in the research.

**The risk factors were summarised into three main categories and these are those factors causing project delay, project cost overrun, and those affecting quality of project. The main factors attributed to quality of project documentation are**:

1 Unrealistic time expectation imposed by the employer
2 Terms of reference which are not consistent with the expected deliverables
3 Slow decision and issuance of information by either consultant or the employer
4 Lack of clarity in project scope and ambiguity in specifications resulting into conflicting interpretation
5 Lack of communication between the consulting engineer and the client
6 Inadequate experience of the consultant
7 Inadequate fees due to discounting
8 Lack of qualified and experienced personnel in the consultant design team
9 Unavailability of qualified technical personnel
9 Lack of qualified and experienced technical personnel in the consultant design team
11 Poor site management and supervision by the consultant
12 Poorly written contracts
13 Lack of checklist of project deliverables which are consistent with client requirements
14 Lack of innovation and design options due to low fees

Feel free to provide your opinion on the main causes of the risk factors and also how they relate to Government policies, regulations, operating environment, award of tenders and the role that other regulatory bodies can play in the implementation of projects.

**Comment:**

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## SURVEY PART 1

2 **Factors contributing to quality of project documentation by consulting engineers**

Quality of project documentation by engineering consultants has been suggested to have in impact on the project delivery which consequently leads to cost and time overruns and poor quality. Some examples of poor quality documentation include specifications not consistent with scope or facets of work, design errors, incomplete and unclear drawings, inadequate quality assurance systems or inaccurate bills of quantities.

Using the rating provided, how does each of the listed factors impact on quality of project documentation based on your experience?

| Please indicate type of your organisation | Client ☐ Consultant ☐ Contractor ☐ |
|---|---|

| Factors contributing to poor quality documentation | Please put a cross on your selection | | |
|---|---|---|---|
| | Often | Seldom | Never |
| 1. Inadequate fees due to discounting | ☐ | ☐ | ☐ |
| 2. Limited resources (financial, facilities, personnel) due to low fees | ☐ | ☐ | ☐ |
| 3. Lack of qualified and experienced personnel | ☐ | ☐ | ☐ |
| 4. Unavailability of qualified personnel on the market | ☐ | ☐ | ☐ |
| 5. Unrealistic time expectation by client | ☐ | ☐ | ☐ |
| 6. Lack of checklist of project deliverable | ☐ | ☐ | ☐ |

*Comment*

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## SURVEY PART II

### 3 Suggestions to mitigating poor quality project documentation

The following are some suggested internal checks to ensure that the design process is carried out within provisions of the Terms of Reference as provided by the client (error free, complete drawings and consistent with specifications). To what extent do you agree with each of the factors as possible solutions to enhancing quality of project documentation by consultants using the rating provided.

| Proposed solutions to enhancing quality of project documentation | Please put a cross on your selection: Agree | Not Sure | Disagree |
|---|---|---|---|
| 1. Allocating a contingency amount by the client for design changes which may be sanctioned by the client | ☐ | ☐ | ☐ |
| 2. Devise a mechanism to allocate additional design activities | ☐ | ☐ | ☐ |
| 3. Consideration to remunerate a consultant under either FIDIC conditions of contract using the Yellow Book OR by using the New Engineering Contract (NEC) | ☐ | ☐ | ☐ |
| 4. Formulation of restrictive contractual provisions to influence the design consultant to deliver high quality project documentation | ☐ | ☐ | ☐ |
| 5. Allow for a detailed verification of the competency of the proposed consultant team of experts for the design and supervision services | ☐ | ☐ | ☐ |
| 6. Selection of consulting services should start with the prequalification process so that only qualified firm should participate in the tender process in addition to the criteria for the lowest priced proposal | ☐ | ☐ | ☐ |
| 7. Allow for the review of project documentation by an independent group of experts in the design stage | ☐ | ☐ | ☐ |
| 8. Allow for a period before site handover for the contractor to comment on the design and project documentation. | ☐ | ☐ | ☐ |
| 9. The project team leader of the consulting engineer should develop a checking procedure to assist in enforcing internal quality monitoring during the design phase | ☐ | ☐ | ☐ |
| 10. Build a database on the performance of consulting engineers as may be reported by clients and contractors which should be hosted by either major clients or to be in the public domain | ☐ | ☐ | ☐ |

**Comments**

SURVEY PARTIII

Additional comments if any

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# Appendix D Scales and interpretation of data

Table D.1 Likert scale option1 and interpretation

| Rating | Scale | Frequency | Significance/Influence |
|---|---|---|---|
| Strongly disagree | 1 | Very low | Very Low |
| Disagree | 2 | Moderate, apply to some extent | Low |
| Neither disagree nor agree | 3 | Relatively significant to some extent | Moderate |
| Agree | 4 | High, very likely | High |
| Strongly agree | 5 | Very high, most likely | Very High |

Table D.2 Likert scale option 2 and interpretation

| Rating | Scale | Frequency | Significance/Influence |
|---|---|---|---|
| Never | 1 | Very low | Very Low |
| Seldom | 2 | Moderate, apply to some extent | Low |
| Sometimes | 3 | Relatively significant to some extent | Moderate |
| Mostly | 4 | High, very likely | High |
| Always | 5 | Very high, most likely | Very High |

Table D.3 Likert scale option 3 and interpretation

| Rating | Scale | Frequency | Significance/Influence |
|---|---|---|---|
| No input | 1 | Very low | Very Low |
| Limited input | 2 | Moderate, apply to some extent | Low |
| Fairly meet obligation | 3 | Relatively significant to some extent | Moderate |
| Sometimes meet obligation | 4 | High, very likely | High |
| Often meet obligation | 5 | Very high, most likely | Very High |

Table D.4 Likert scale option 4 and interpretation

| Rating | Scale | Frequency | Significance/Influence |
|---|---|---|---|
| Never | 1 | Very low | None |
| Seldom | 2 | Relatively significant to some extent | Moderate |
| Often | 3 | Very high, most likely | Very High |

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Table D.5 Likert scale option 5 and interpretation

| Rating | Scale | Frequency | Significance/Influence |
|---|---|---|---|
| Disagree | 1 | Very low | None |
| Not sure | 2 | Relatively significant to some extent | Moderate |
| Agree | 3 | Very high, most likely | Very High |

Table D.6 Likert scale option 6 and interpretation

| Rating | Scale | Frequency | Significance/Influence |
|---|---|---|---|
| Very satisfied | 5 | Very high, most likely | Very Low |
| Somewhat satisfied | 4 | High, very likely | Low |
| Neither dissatisfied nor satisfied | 3 | Relatively significant to some extent | Moderate |
| Somewhat dissatisfied | 2 | Moderate, apply to some extent | High |
| Very dissatisfied | 1 | Very low | Very High |

Table D.7 Interpretation of ranking of scores (OMS and MS)

| Interval scale | Frequency | Significance/Influence |
|---|---|---|
| < 1.5 | Very low | Low |
| 1.51 - 2.50 | Moderate, apply to some extent | Not so influential |
| 2.51 - 3.50 | Relatively significant to some extent | Moderate |
| 3.51 - 4.50 | High, very likely | High |
| > 4.50 | Very high, most likely | Severe |

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# Appendix E Comments from second round survey

Table E.1 Comments: project documentation and mitigation strategies

| Item | Respondents' Comments and observations | Factor addressed |
|---|---|---|
| 1 | Lack of client brief/requirements causing reduction in design duration. | Scope definition |
| 2 | Slow decision from owner (may not apply to all situations, main effect is possible cost increase) | Communication |
| 3 | Lack of communication between client and consultant. The consultant will discharge his duties albeit with difficulties where employer input is not forthcoming | Communication |
| 4 | Low speed of decision making involving all project teams. This is especially true with the Consultant | Communication |
| 5 | After project specifications, inaccurate Bills of Quantities Greatly affect project time and cost | Deliverables |
| 6 | Price – No way someone can offer required service at 40% plus discount levels. | Fees |
| 7 | Inadequate fees due to fee discounting can be a big problem in practice and should be legally prohibited again, as is was in the "old days" when charging fees lower than the gazetted fees was not allowed. | Fees |
| 8 | Low consultant fees the root cause of all the issues above. (factors contributing to quality of project documentation) | Fees |
| 9 | Inadequate fees are due to over competitive tendering and generally the consultants "problem" | Fees |
| 10 | Lack of innovation and design options due to low fees (It could be true for certain Consultants, but a prudent Consultant will deliver quality irrespective of fees) | Fees and deliverables |
| 11 | Due to fee discounting consulting teams are stretched and the necessary amount of time is not spent on the projects. Checking is also neglected due to unrealistic delivery timeframes imposed on design teams. | Fees and deliverables |
| 12 | We find ourselves in times where everyone wants more for less. That in combination with poor retention of key staff and talent development across industry, is a recipe for disaster. Procurement processes are constantly under scrutiny, but little has taken affect. The internal client knowledge of procurement processes and understanding of project flows are a tremendous challenge at the moment. | Fees, skills, procurement |
| 13 | No clear indication if National building regulations or Construction regulations are applicable especially with regards to responsibility on site. | Legislation |
| 14 | How often are CESA consulted by the client/s? The suggestions are all on the consultant, where can the client and contractor influence outcome? | Legislation |
| 15 | Executing project under FIDIC conditions of contract, Yellow book, Contractor design and executes in accordance with client requirement Or the NEC3 for implementation of contract Model of is not so crucial. It may shift responsibilities to the Contractor but may not guarantee quality of final product. However, time and cost overruns are normally greatly mitigated | Procurement |
| 16 | Detailed verification of competency of consultant design and supervisory personnel impossible to do because the verifier has to be extremely qualified in same field. An impossibility | Procurement |

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| Item | Respondents' Comments and observations | Factor addressed |
|---|---|---|
| 17 | The information and level of detail of information required at the various stages of a project should be standardised. | Procurement and deliverables |
| 18 | Where clients have standard documentation there is less potential for problems (e.g. City of Cape Town, Western Cape Provincial Government Roads and Transport, SANRAL). Problems normally occur with other clients where the consultant has carte blanche to determine the project documentation format. | Procurement documentation |
| 19 | Restrictive contractual control works but favours the large established often international consultants. SANRAL policies work because they have strict control and experienced personnel. They have also opened a portion of their projects (20%) to small entrants which improves the smaller consultants' opportunities. Many clients cannot do this because of inexperienced personnel. | Procurement, skills and legislation |
| 20 | A checklist could assist but again the lack of experience in adopting the checklist could impact on a realistic output. | Project deliverables |
| 21 | What about poor input documentation? Process design at 30% but expecting detailed civil/structural design? Or, lack of architectural and tenant designs while project is already at construction stage. Poor architectural information | Project deliverables and scope definition |
| 22 | Deliverables from each consultant at the various stages of a project is ill defined. E.g. for an Engineer to compile a tender design for a building there is no clear description of the information he requires from an architect and what the level of detail of this information should be | Project deliverables and scope definition |
| 23 | Our industry may need to step up and recognise these challenges and adapt as quickly as we can to provide good products within fair time frames. | Project deliverables and time expectations |
| 24 | We see more and more that clients delay the initial start of projects (including the detailed design/planning). Then the project starts late, but the client expects the end date to remain as per the original time lines. This puts massive pressure on the entire team and initially on the design engineers, because they need to produce drawings for construction so that the contractors can perform. We also find that the general level of competency of client teams (including the design engineers) is falling. | Project deliverables and time expectations |
| 25 | It is of utmost importance that there are realistic time lines for the entire life cycle of the project. This includes preliminary feasibility studies, financing, tender process, award process, detailed design and execution. It should not always be the cheapest consultant, but rather the team who are capable, experienced, and available. Value engineering where the entire team, including the contractor, participate is very valuable and can save lots of time and money during construction. | Project deliverables and time expectations |
| 26 | Mistakes and discrepancies in contract documents (These can be corrected before they affect implementation, they tend to cause claims rather than affect progress) | Quality control |
| 27 | Analysis of project documentation by contractor before project commencement. It conflicts with rules of fair play since the documentation must be ready at tender stage and all bidders must have equal opportunity | Quality control |
| 28 | Once commissioned, the design team must meet and agree on the requirements of the ToR, revisit the main tasks, design criteria and procedures, structure of reports, methods for field investigations, list of drawings required to fully present the outcome of designs, standard specifications to be adopted, special technical specifications based on materials availability and local skills, etc. and reporting schedule. | Quality control |

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| Item | Respondents' Comments and observations | Factor addressed |
|---|---|---|
| 29 | The Consultant should appoint an external expert to check the agreed design criteria and procedures prior to commencing designs. Thereafter one of the consultant's qualified and experienced personnel who is not part of the design team shall conduct internal quality checks during design. A list of such checks shall be prepared by the Project Team Leader in collaboration with the appointed quality assurance person. This should also be closely linked to the Company's internal QA scheme and should include details of information archiving | Quality control |
| 30 | Inconsistent adoption of Building Information Modelling (BIM) also creates numerous problems on projects. There should be a clear regulatory framework defining a roadmap for the implementation of BIM in the industry as a whole. | Quality monitoring and deliverables |
| 31 | Inadequate / Incorrect base information to compile engineering deliverables | Scope definition |
| 32 | Knowledge of what constitutes appropriate documentation is a big factor | Scope definition |
| 33 | Ambiguity in specifications resulting in conflicting interpretation by parties. Most contracts require contractor to pick up discrepancies and seek clarification ahead of construction | Scope definition |
| 34 | Get better sign-off after each stage (for all involved). What constitute e.g. a concept design? Do not refer to 30% complete as this means nothing. Allow consultant to be reimbursed for additional work without prejudice. Limit fee discounts. Clearly define roles and responsibilities between consultant and contractor when it comes to quality control and quality assurance. | Scope definition and deliverables |
| 35 | There is also a large pool of inexperienced and/or young engineers being supervised in many instances by either unskilled people or skilled people with too much on their plate. | Skills |
| 36 | Qualified personnel are available but are often "over-priced" Smaller consultants struggle with this | Skills |
| 37 | Consultant ratings like contractor CIDB ratings are probably already in the pipeline for the future. Would help | Skills |
| 38 | Lack of experienced personnel is both a problem on the consultants and the clients team | Skills |
| 39 | Lack of understanding of differences between responsibility of designer and contractor. | Terms of Reference |
| 40 | Terms of reference not consistent with expected deliverables (An experienced Consultant will discuss this prior/during design) | Terms of reference |
| 41 | Confirmation of ToR before commencement will mitigate future problems | Terms of Reference |
| 42 | Unrealistic contract durations imposed by client (An experienced Consultant will allocate more skilled personnel to counter this) | Time expectation |
| 43 | Unrealistic time frames are often a case of "hurry up and wait" where realistic time frames are available but client does not know how to manage the time frame due to political pressure or inexperience. | Time expectation |
| 44 | Period is usually stated in tender documents and Contractors will comment or allocate resources accordingly | Time expectation |