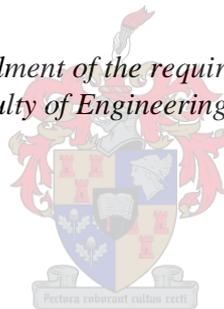


# **Consultant's Risk: An Investigation into the Impact of Discounted Professional Fees on the Risk Exposure of Civil and Structural Engineering Services Consultants in South Africa**

by  
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*Thesis presented in fulfillment of the requirements for the degree of Master of Science in the Faculty of Engineering at Stellenbosch University*



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December 2014

## **DECLARATION**

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

December 2014

## Abstract

Since the intervention of the Competition Commission and the abolition of the mandatory use of the government gazetted Engineering Council of South Africa (ECSA) fees scale, engineering services consultants in South Africa have been competing based on price for engineering contracts in both the public and private sectors. Discounts benchmarked against ECSA professional fees scale demanded by clients have resulted in declines in professional fees over the years. The capacity to deliver professional services that are of such high quality that it meets the client's expectation, professional and ethical standards when working at low fees is one of the biggest challenges facing consulting professionals today. This research studied the risks encountered by civil and structural engineering services consultants and the impact of discounted professional fees on their risk exposure.

The study included a review of literature, discussions with practicing engineers and a questionnaire based survey. A total of 23 practicing consulting engineers representing small, medium and large consulting engineering firms participated as respondents in the questionnaire survey.

The literature review identified project and organisational level risks particular to civil and structural engineering services consultants. The study compiled information on the discounting practices of civil and structural engineering services consultants in South Africa. It is found that the practice of discounting is widespread, affecting small, medium and large consulting firms. The range of discounts offered in the industry results in a significant decrease in the fee scale recommended by ECSA for various engineering project types. Respondents identified the primary reasons why they are forced to offer discounts and identified project and organisational risks most impacted by discounted fees in an order of perceived importance to them. Financial loss on the project, inadequate supervision and quality control on site and inability to perform value engineering were identified as project risks with the most impact on respondents' organisation. At the organisational level human resource issues such as training and mentoring of young engineers, ability to attract and retain quality/experienced staff and overall business sustenance were identified as risks most impacted by discounted fees. Measures adopted by respondents to mitigate risk associated with discounted fees on project were also identified and recommended.

## Opsomming

Sedert die ingryping van die Kompetisie Kommissie en die afskaffing van verpligte fooie soos gepubliseer deur die regerings koerant en Ingenieurs Raad van Suid Afrika (IRSA), het ingenieurs konsultante in Suid Afrika meegeding gebaseer op die prys van ingenieurs kontrakte in beide die publieke en private sektore. Afslag wat gemeet word teen professionele skale van ECSA word vereis deur kliënte. Onetiese tender gedrag deur kliënte en raadgevers het gelei tot daling in professionele fooie oor die jare. Die kapasiteit om professionele dienste te verskaf, wat van hoë kwaliteit is, kliënte se verwagtinge bereik en professionele en etiese standaarde bereik teen lae koste is een van die grootste uitdagings vir professionele raadgewende ingenieurs in vandag se mark. Hierdie tesis bestudeer die risiko's wat siviele en strukturele raadgewende ingenieurs ondervind, asook die impak wat afslag van professionele fooie het in terme van die blootstelling van risiko's.

Hierdie studie behels literatuur studie, gesprekke met ingenieurs in die praktyk en vraelys opname. Totaal van 23 raadgewende ingenieurs wat klein, medium en groot raadgewende ingenieurs instansies verteenwoordig het deelgeneem aan die vraelys opname.

Die literatuur studie het projek risiko's en risiko's op die organisasie vlak geïdentifiseer wat veral verband hou met siviele en strukturele raadgewende dienste. Die studie het informasie gegenereer oor die dalende uitvoering van siviele en strukturele raadgewende dienste in Suid-Afrika. Dit is bevind dat die beginsel van afslag in die algemeen klein, medium en groot raadgewende firmas beïnvloed. Die omvang van die afslag wat aangebied word in die ingenieurs bedryf het gelei tot beduidende afname in die fooi skaal wat aanbeveel word deur ECSA vir die verskeie ingenieurs projek tipes. Die verskeie deelnemers van die studie het gedui dat die primêre rede hoekom hulle gedwing word om afslag aan te bied en projek en organisasie risiko's identifiseer, is omdat afslag fooie voorafgestelde belang is vir hulle. Finansiële verliese op projek, onvoldoende toesig, kwaliteitsbeheer en die onvermoë om hoë gehalte ingenieurswese toe te pas was geïdentifiseer as die projek risiko's wat die meeste invloed het op die deelnemers se organisasies. By die organisasie vlak was menslike hulpbronne, soos opleiding en die mentorskap van jong ingenieurs, die vermoë om kwaliteit of ervare personeel te trek en te behou, en die algehele besigheid lewensmiddele geïdentifiseer as risiko's wat die meeste beïnvloed word deur afslag fooie. Maatreëls wat aangeneem is deur deelnemers aan die studie om risiko's wat verband hou met afslag fooie van projek te versag is geïdentifiseer en aanbeveel.

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## List of Abbreviations

ACE	Association for Consultancy and Engineering
AEC	Architecture Engineering and Construction
ASCE	American Society of Civil Engineers
BIM	Building Information Modelling
BOK	Body of Knowledge
CAD	Computer Aided Design
CESA	Consulting Engineers of South Africa
CIDB	Construction Industry Development Board
CMP	Construction Management Programme
CPD	Continuous Professional Development
CPS	Construction Professional Services
CRO	Chief Risk Officer
ECSA	Engineering Council of South Africa
ERM	Enterprise Risk Management
ESRC	Economic and Social Research Council
FCM	Federation of Canadian Municipalities
FIDIC	International Federation of Consulting Engineers
FIFA	International Federation of Association Football
GCC	General Conditions of Contract
GDP	Gross Domestic Product
HRM	Human Resource Management
ICT	Information Communication Technology
IT	Information Technology
JBCC	Joint Building Contract Committee
KBS	Knowledge Based Services
KIBS	Knowledge Intensive Business Services
NBR	National Building Regulations
NEC	New Engineering Contract
PI	Professional Indemnity
PROCSA	Professional Consultants Services Agreement Committee
QA	Quality Assurance
QBS	Quality Based Selection
QCBS	Quality and Cost Based Selection
R&D	Research and Development
RBS	Risk Breakdown Structure
SAICE	South Africa Institute of Civil Engineers
SANS	South African National Standards

SUCP Standard for Uniformity in Construction Procurement

UK United Kingdom

USA United States of America

## CHAPTER 1 INTRODUCTION

### 1.1 Introduction

Consulting engineers are liable for the professional advice they give to their clients; the ability of consulting engineers to continually provide sound professional advice in the face of declining professional fees engendered by price based competition prevalent in the industry is often questioned. The subject of this research is an investigation into the impact of discounted professional fees on the risk exposure of consulting engineers practicing in South Africa.

This chapter aims to introduce the research conducted by providing a background to the research topic and the reasons why this research is relevant. This will lead to the development of the research problem statement and the objectives for the research. Steps taken in the conduct of the research will also be outlined.

### 1.2 Background

Risk and reward are two fundamental considerations for every business decision. The greater the risk an investor is willing to take, the more the possible rewards should be. The ability to identify risks and plan for them has become an integral part of many modern businesses (Fraser & Simkins, 2009:88).

The construction industry is subject to more risk, conflict and uncertainty when compared to many other industries (Flanagan & Norman, 1993; Black, Akintoye, Fitzgerald, 2000); the principal role players on construction projects include project owners, construction contractors and construction related Knowledge Based Services (KBS) firms who provide their services as consultants. The general perception in the industry is that the burden of construction risks are apportioned between the project owner and the contractor, with the project owner paying for the risks and the contractor copes with the consequences of such risks (Flanagan & Norman, 1993). The position of consultants in the context of their exposure to construction risk is however scantily investigated in the literature. While much research have been undertaken on construction industry risks from the standpoint of the client and the contractor, very little work has however been done on the risk characteristics of the other professionals, in general, within the construction industry such as the surveyors, architects, and various engineering consulting professionals. Lu, Ye, Flanagan & Jewell (2013) list previous research carried out in the field of Construction Professional Services (CPS) and segmented the focus areas into the following subject categories; competitiveness of CPS firms, characteristics of CPS firms, impact of Information Technology on CPS firms, management practices of CPS firms and, procurement methods of the CPS industry. This

submission by Lu et al and a perusal of literature reveals that the subject of risk as it relates to the CPS industry has received very little attention.

Construction projects involve multi-party collaboration and for this reason, risk on construction projects is usually viewed from the perspective of the various project participants, and the overall management of project risks are usually carried out in a fragmented manner. However, when projects fail to meet schedule, budget and quality objectives on account of the risks from any party, all parties (clients, consultants and contractors) and the public suffer the consequences.

Procurement of consulting engineering services by public and private clients in South Africa is mostly by competitive tendering in line with government and Construction Industry Development Board (CIDB) procurement guidelines. The implication of this is that contracts are awarded to the firm that quotes the lowest price to provide the service. This has resulted in price based competition in the industry rather than competition based on quality of service. Competitive tendering and the practice of discounting professional fees benchmarked against professional fees scale published by the Engineering Council of South Africa (ECSA) are partly responsible for the decline in professional fees over the years in South Africa (CESA, 2007).

Professional bodies such as the Consulting Engineers South Africa (CESA) have maintained at various forums that consulting engineering services is not a commodity and as such the use of competitive tendering procurement methods based on price is inappropriate (Abe, 2014). This argument is based on the fact that while it is possible to draft specifications against which the quality of commodities (physical goods) will be evaluated, such specifications cannot be easily drawn up for consulting services. Therefore, different consulting professionals could anticipate different levels of service quality if selection is based on price. The use of price as a basis for selection compromises the ability of consulting engineering firms to innovate, attract and train young engineers, all factors which are critical to the subsistence of the consulting engineering profession/industry.

This research aims to investigate risks to the consulting engineer's practice with particular focus on the impact of discounted professional fees (benchmarked against ECSA published fees scale) on the South African consulting engineers' practice. Focus will be on the risk implications for civil and structural engineering services consultants. The research employs triangulation of qualitative and quantitative data obtained from the review of literature, interviews and a questionnaire based survey.

The sections below will discuss the justification for the research, leading to the development of the research problem statement. Research objectives will be drawn from the problem statement and the steps taken in the conduct of the research will be discussed.

### 1.3 Justification for Research

Construction risks range from risk to the client, risk to the consultant and risk to the contractor. It has been established that construction risk cannot be ignored but rather it is transferred among the project participants (Latham, 1994). This is because the relationship between the project participants is such that risk created by one project participant will usually have an influence on the risk experienced by other project participants.

The negative impact of risk imposed on one party by another party on a project often leads to an adversarial relationship between project participants, thus the propensity for claims and litigation within the industry and this ultimately impacts projects negatively. The cost associated with construction risks, claims and litigations could be quite significant; the failure of construction enterprises resulting from their inability to manage the negative impact of risks means that employees of these firms become unemployed.

The consulting engineer's responsibilities on a project includes project planning, design and in many cases supervision and management, and subsequent handover of a functional facility to the client upon project completion. These duties are fundamental in determining project success or failure. Risk generated or not anticipated by the consulting engineer is bound to plague the entire project cycle and will influence the risk experienced by other project participants. Consulting Engineers will mostly generate project risk by poor designs, poor technical information to contractors, negligent advice to clients and inadequate supervision during construction. These risks may be as a result of deficiencies in competencies and experience within the consulting engineer's organization or due to other factors beyond his control that are imposed by other contracting parties.

It is often argued that Consulting engineers carry very little risk because the nature of their services is mainly advisory (providing professional advice to clients). However, clients have shown a willingness to sue consultants for damages when they have suffered loss as a result of negligent advice or defective designs. Over the years, claims and lawsuits against professionals have increased both in quantum and frequency and professional indemnity insurance premiums have become more expensive (Flanagan & Norman, 1993). Many consulting firms have gone under as a result of damages awarded against them to parties that have suffered loss from such negligent advice. Ninety five percent of complaints received by ECSA involve structural engineering practices and most of the complaints relate to technical advice rather than business practices (Watermeyer & Smith, 2014). A few professional engineers have had their licenses either temporarily or permanently suspended on account of these complaints. All this suggests that the consulting engineer does face considerable risk and that these risks also come at a cost to him.

Changes in the construction industry in the last decade have added new challenges for consulting engineers. These challenges include:

- New methods of project delivery such as design-build contracting and the attendant reversal of roles for the consulting engineer
- Abolishment of professional fee scales, competitive tendering and the resultant reduction in fees while more responsibilities are being assumed by consulting engineers on projects
- Shortage of experienced engineers and competition from other professionals in some market segments
- Globalisation and advances in Information Technology

The impact of these on the consulting engineering practice in South Africa may yet be clearly understood.

Many have argued that competitive tendering benefit the construction industry including the consulting engineer as it has forced consulting engineering firms to be efficient and effective in their operations. However, evidence from previous research has shown a decrease in quality of professional service provided to clients when professional fees have been low (Hoxley, 2000), it then suggest that low fees impacts on the consulting engineer's ability to provide sound professional services.

The risk for clients when they engage professional services providers at low fees has been well researched and identified to include low quality of service resulting in increased lifecycle cost of the project, and project delays resulting from reworks and poor contract documentation (Hoxley, 2000; Ling, 2004; Love & Edwards, 2004). The implication of low fees on the risk exposure of the consulting engineering professional appears not to have enjoyed as much interest from researchers and needs to be investigated.

#### **1.4 Statement of the Problem**

Weidemann (2014) pointed out that engineers in South Africa are struggling *"in an industry racked by discounting, tendering, lack of knowledge and skills"*.

In a business environment where government policies allow cost based selection methods for the procurement of professional consulting services, prices are determined by market forces. In times of stiff competition, consulting engineering firms may be required to lower their fees to survive the competition. Price based competition amongst consulting engineering firms has becomes a business survival strategy in today's consulting business in South Africa. Some practicing engineers interviewed stated that they compete for

appointments with inappropriately qualified engineers working at increasingly discounted fees and against market forces.

Competition in tendering is a function of the prevailing economic conditions. At periods of low work competition is stiff and prices low, when availability of work has increased, prices usually goes up. The prevalence of lowest cost bidding for the procurement of consulting services in South Africa have also exacerbated the problem of price based competition by consulting engineers and the process is often manipulated by clients to their advantage. Discounts benchmarked against approved ECSA professional fees scales are demanded by clients and unethical tender practices by clients and consulting engineers have resulted in declines in professional fees over the years. The Bi-annual Economic and Capacity Survey report published by CESA, have consistently reported declines in fee level between 2009 and 2012 partly due to competition and discounts occasioned by the low availability of work within the South African construction space. The tendering process for consulting services is costly, time consuming, and the high level of competition increases the risk for the consulting firm (CESA, 2007). Although the CIDB guideline for procurement of consultancy services prescribes the consideration of quality (competence and capability) as well as cost in the selection of consultants, the same guideline appears to lean more in favour of cost than quality.

A study of how clients in the United Kingdom (UK) select surveyors shows that even though clients do not consider the level of fees to be top priority, level of fees however ranks above competence considerations such as personnel's experience, experience on similar projects and reputation of firm (Hoxley, 1995). Many clients are incapable of judging quality of services and may not be able to appreciate the risk involved with accepting incompetent services at a lower price (Hoxley, 2000). Hoxley (2000) in his study of the British construction industry found that even though lower fees have not led to a decline in clients' perception of quality, evidence however suggests a compromise in professionalism and unethical conduct among professional services providers on account of lower fees.

Over the years, the responsibilities of civil and structural engineering consultants on projects, especially building projects have increased in scope especially with regards to supervisory obligations because of the increasing complexity and sophistication of construction projects. This means that consulting engineers have had to take up more responsibilities for lower fees; this may have fuelled unethical practices (such as professional negligence) within the profession (Bowen, Akintoye, Pearl & Edwards, 2007).

Consulting engineers are often the first points of contact a client has with the construction industry. The relationship between the consulting engineer and the client is unlike that between the contractor and the client; the nature of the consulting engineer's service is that

of a trusted adviser and therefore the relationship between the client and the consulting engineer should be that of mutual respect and trust. Gamesmanship and the tactic of claims that already characterise client/contractor relationship are undesirable in the client/consultant relationship. The nature of the consulting engineer's service is such that it determines the lifecycle cost of the project and accounts for only about 1% of the entire project lifecycle cost (Shrestha & Mani, 2013). How well the consulting engineer discharges his duties will be judged by the downstream impact of their professional services on the lifecycle cost of the project as well as the safety and comfort of the end users.

Paragraph 3(2)(B) of ECSA's rule of conduct forbids the engineer from doing work under terms and conditions that compromise the engineer's ability to carry out his responsibilities in accordance with acceptable professional standards; discounted fees can be interpreted to compromise the engineer's ability to provide quality service. A consulting engineer providing his professional service at unrealistically low fees can be argued to be in contravention of this regulation. The capacity to deliver professional services that are of such high quality that it meets client expectation, professional and ethical standards when working at prevailing low fees rates is one of the biggest challenges facing consulting professionals today.

## 1.5 Research Question

This research aims to investigate the impact of low professional fees resulting from discounts offer on ECSA professional fees scale on the risk exposure of civil and structural engineering services consultants in South Africa. Attempts will be made to answer the following research questions:

- a) Are civil and structural engineering services consultants exposed to significant risk from doing work at low fees?
- b) If yes, can these risks be identified?
- c) Are there measures that can be recommended to help consulting engineers manage the identified risks?

## 1.6 Research Objectives

The output of this research is expected to contribute to the ongoing discussion between policy makers and professionals in the construction industry on the harm caused by low professional fees resulting from discounts offered on fees. This research has the following objectives:

- i. To obtain information on project and organisational risks particular to the consulting engineering practice

- ii. To obtain information on the extent of discounting practices among consulting engineering firms in South Africa
- iii. To identify the ways low professional fees impact on identified project and organisational risks, and additional risks resulting from low professional fees
- iv. Identify measures that can be recommended to help consulting engineers manage and mitigate risk due to low professional fees
- v. To develop a risk catalogue for consulting engineers wishing to analyse the risk to their practice from working at low fees

## 1.7 Research Limitations

This research will be limited to the civil and structural engineering services consultants in the field of civil engineering, and to civil and structural engineers practicing in the capacity of designers and principal agents. Figure 1 shows the area of focus of this research.

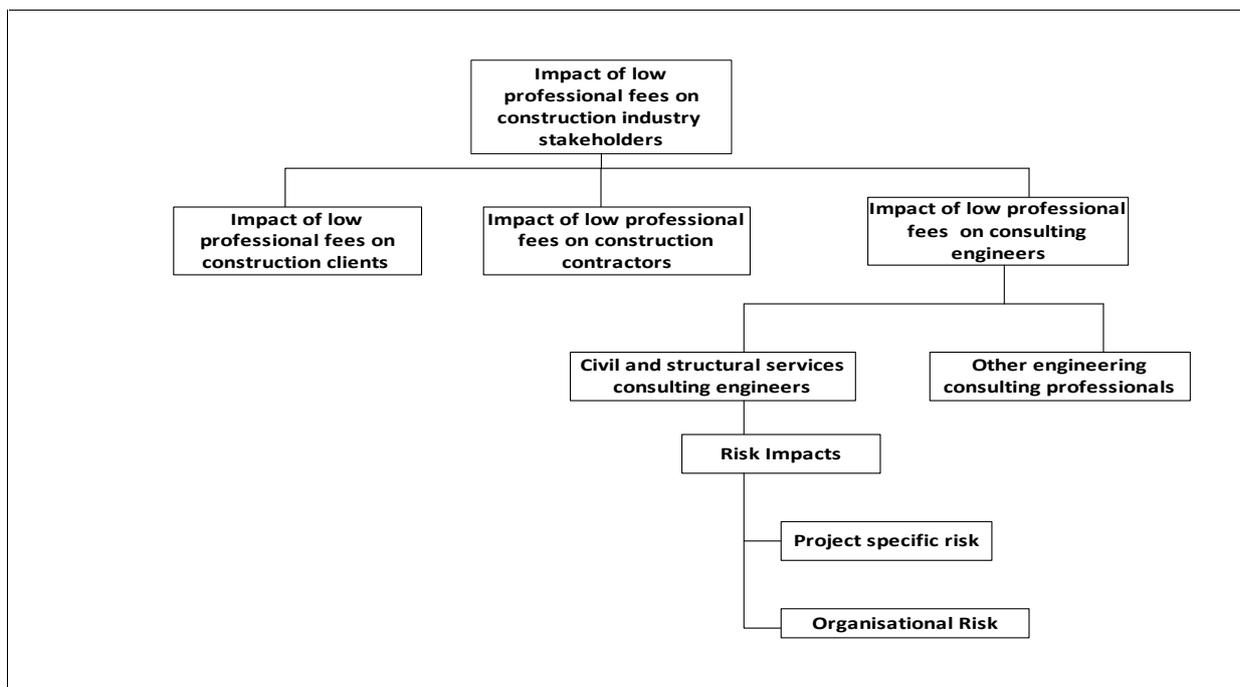


Figure 1: Chart showing Research Area

## 1.8 Research Design

The way a researcher plans to go about research is the theme of a research design. In order to conduct a good research, a researcher must have a clear idea of what he/she intends to find out and the best way to do it. The information for this research was obtained mainly from the review of literature, interviews and the use of questionnaires to collect data. The steps taken in the conduct of this research are discussed below.

### **1.8.1 Preliminary discussions with practicing consulting engineers**

In order to establish that the construction industry will find this research useful, preliminary discussions were carried out with practising consultants in order to obtain their views on the proposed research. All consultants interviewed agreed that the consulting engineer is exposed to risk, but their views on the nature of the risk faced varied with the services they offered. It was observed that the risk identified by design engineers were different from the risk identified by principal agents. The feedbacks from these initial discussions confirmed the relevance of this research and provided a guide for the issues to be investigated.

### **1.8.2 Literature review**

Review of literature was conducted on the subject. The purpose of this was to identify the information available from previous research on the subject and the knowledge gap. Very little literature exists on South African construction industry risks. Most of the literature available provided information on construction risk experienced in other countries, mostly as it applies to clients and contractors. South African construction industry legislations, regulations and guidelines such as those published by the ECSA, CIDB and CESA were reviewed to establish the responsibilities and nature of fees for the consulting engineer. Information obtained on the consulting engineer's responsibilities and construction risk issues were then used to formulate a questionnaire to enlist more information about the issues so far identified from literature review, with emphasis on the construction industry in South Africa.

### **1.8.3 Questionnaire based survey**

A questionnaire was developed based on the issues identified from the literature review already conducted. The questionnaire contained both closed and open ended questions for the purpose of obtaining both quantitative and qualitative data. The questionnaire was reviewed with a small research group and practicing professional to check for adequacy and clarity. Feedback from this review highlighted areas of deficiency and provided information on issues not adequately captured and on those omitted. The modified questionnaire retained the same open ended structure of the initial questionnaire. The modified questionnaire was then distributed to a wider sample of respondents by email.

### **1.8.4 Analysis and synthesis of questionnaire data**

The data obtained from the survey questionnaire was analysed both qualitatively and quantitatively. Content analysis was employed to analyse the responses received for the open ended questions qualitatively. Responses were classified into risk categories according to key words used by the respondents. Frequency analysis and ranking was used to quantitatively analyse the closed (structured) questions.

Finally, answers were provided to the research questions, and recommendations to the industry and for further research were formulated.

## **1.9 Overview of thesis Chapters**

This dissertation document contains seven chapters. This chapter provides a background to the research and introduces the research problem statement, research objectives and steps taken in the conduct of the research.

Chapter two provides a brief overview of the workings of the construction industry. The various market segments of the construction industry, nature of construction business, procurement methods, tendering strategies and contracting strategies are discussed. The state of the construction industry at the time of this research is also highlighted.

Chapter three discusses the consulting engineer's practice. Specific consideration is given to the organisational structure of consulting engineering firms, their responsibilities on projects as determined by various legislations, professional guidelines and professional services agreement, and the consulting engineer's competency requirements. The selection processes employed in the procurement of consulting engineers as well as professional fee scales and discounting practice in South Africa is also discussed.

Chapter four discusses the risk exposure of the consulting engineer and the impact low professional fees have on their risk exposure. The consulting engineer's risk exposure is discussed from the perspective of project specific risks and organisational business risks. Organisational business risks are discussed from the perspective of competitiveness and adaptation to changes in the construction environment. Construction risk management practices and procedures are also discussed.

Chapter five describes the methodology employed in sourcing data for the research, including the theory of the methodology adopted, the respondents, description of the questionnaire, and method of questionnaire distribution

Chapter six presents the analysis and synthesis of the survey data and discusses the findings.

Chapter seven presents a summary of the results and draws up conclusions as well as recommendations on further research on the subject.

## CHAPTER 2 OVERVIEW OF THE CONSTRUCTION INDUSTRY

### 2.1 Chapter Introduction

The construction industry is unlike other industries because of its unique project delivery process. This chapter aims to provide an overview of the nature of the industry, market segments, business and procurement processes. The state of the South African economy at the time of this research and its impact on the construction industry will also be discussed.

### 2.2 Description of the Construction Industry

The construction environment involves many speciality disciplines and service providers, which include various engineering professionals, architects, quantity surveyors, manufacturers and suppliers. These stakeholders engage in various activities that include planning, designing, regulating, constructing, decommissioning and other ancillary services.

The construction industry is made up of different market segments which can be divided into:

- Building
- Civil engineering
- Repair and maintenance

These markets can be further sub divided, e.g. the building market can be divided into residential, commercial and industrial. The civil engineering market can be divided into highway and bridges, and heavy construction.

Construction activities contribute significantly to national economies by providing direct employment and creating business opportunities in sectors of the economy that provide ancillary services such as solicitors, estate agents, manufacturers and suppliers of construction materials.

The construction industry is a mobile services industry whose activity is influenced by the location of its clients, it is characterised by activities carried within a confined location (clients' premises) for a limited period of time. These activities may be repetitive in sequence and operation, but the construction sites are almost always different. These attributes have resulted in problems for the industry such as "low profitability, low productivity and discontinuous demand" (BurtonShAw-Gunn, 2009).

Because of the number of companies conducting construction related business, the ease of entry and the difficulty in regulating their practice, the construction industry is often considered a fragmented industry. These companies provide a host of construction related

services from the most simple to very complex specialist services such as tunnelling and underground works. Also the financial turnover of the companies vary; while some companies are owned and managed by a single individual with a few employees, others are big public enterprises quoted on the stock exchange and conducting international business and employing an array of professionals and skilled personnel.

The government is often the biggest customer to the construction industry in any country, with investments in the infrastructure, housing and non-residential sectors being major drivers of economic growth and development. Most government infrastructure projects involve huge financial costs, 80% of infrastructure construction contracts in South Africa are valued at ZAR13 million and larger, the nature of construction projects is such that these projects cannot be further broken down into small value projects (CIDB, 2012). This places a restriction on the size of firms that can participate in the execution of these projects. The big consulting engineering and construction firms with the capacity in terms of manpower resources, equipment and plants, necessary insurance and financial balance sheet are often the ones able to bid for high value jobs in these sectors. Smaller companies also benefit but often times as sub-contractors contracted to execute sub-task on such big projects.

The construction industry is fraught with many challenges ranging from its propensity to claims and disputes, lack of technological innovation and its poor attitude towards risk. When compared to other industries the construction industry has lagged behind on these issues. To address these challenges it has been advocated that the industry must invest in innovation by increasing spending on research and development, engendering collaboration and 'partnering' and allocating construction risk contractually in a fair and balanced way among project participants (Rust & Koen, 2011).

### **2.3 Construction Market and Business**

The construction industry is characterised by variability of demand and the ease of entry for firms wishing to participate in it. These two combine to shape the nature of the construction industry which has been described by many commentators as a fragmented industry. A fragmented industry is one in which no company can claim dominance in market share and significantly influence the outcomes within the industry (Langford & Male, 2008). Porter (1980) described a fragmented industry as one populated by many competitors, who have weak bargaining leverage in comparison with both the buyer and supplier in the industry and in which profitability is marginal. These definitions are true for the construction industry. The construction industry is populated by a large number of small and medium size firms and a small number of large firms. Entry of new firms into the small firms' category is almost unrestricted, while some level of entry restriction is imposed into the league of medium and large firms because of the financial and technical competence required. Hence, the small

number of medium size firms and even fewer large firms in comparison to the number of small firms. Fragmentation decreases as the number of firms able to participate in a certain market decreases.

Small firms are generally unable to compete with large firms irrespective of market segment. Larger firms have a great bargaining leverage with which to negotiate with clients and greater capacity to bear the risks associated with large construction projects. The fear of competition from new entrants influence the pricing policies within the small firms segment such that clients are at an advantage in terms of determining price and risk allocations on projects.

Langford & Male, (2008) used the concepts of 'industry' and 'market' in explaining the construction business environment and competition among firms in the industry. The industry is a supply concept that is defined by service products (design and management contracting) and end product (usually the completed physical structure handed over to the client). Professionals such as consulting engineers provide service products to the industry while contractors deliver the physical structure end product.

The market is a demand concept; demand in the construction industry is generated by clients. There are two distinct market structures in construction; the contracting construction market and the speculative construction market. A contracting construction market is characterised by a pre-demand by a client and the responsibilities of the project parties contractually defined and the price of the structure negotiated before construction. In the speculative market, demand is anticipated or created in reaction to industry gaps. Services and products are then developed to bridge the identified gap.

## **2.4 Construction Procurement, Tendering and Contracting**

Products of the construction industry are unique because they cannot be bought off the shelf. The project delivery process in construction involves the pre-order of a bespoke designed facility by a client from a designer and the erection of the physical facility on-site within the client's premises by a contractor. This process involves sequenced activities and multi-party collaboration; they take considerable time and require huge financial commitments to execute. Clients need some form of managerial and administrative framework which gives them control over the process. The procurement, tendering and contracting strategies are 3 important decisions taken by clients that influence the organisation, selection of project team and risk allocation among project teams on a project.

### 2.4.1 Procurement Strategy

Procurement strategies are options available to clients for balancing project risks against the project objectives of time, cost and quality. The choice of a procurement strategy may depend on which of the project objectives is most crucial to the client's business objectives as well as funding mechanisms and asset ownership of the project (Office of Government Commerce, London, 2003). Every procurement strategy sets up a unique organisational, managerial, administrative, and risk relationship between the client, the consultants and the contractor (Langford & Male, 2008). Common procurement strategies available to clients include:

- Traditional procurement (design-bid-build)
- Design and construct (design-build)
- Management contracting
- Construction management
- Develop and construct
- Turnkey procurement
- Build, operate transfer
- Private finance initiative
- Prime contracting

Procurement strategy falls outside the scope of this study and will not be discussed in further details.

### 2.4.2 Tendering strategy

Tendering strategy is the selection process available to the client for the selection of members of the project team. Tendering can either be by negotiation or through competitive bidding process. Under the negotiation option, the client approaches a firm of choice and negotiates directly the cost for the works. Competitive bidding, however, involves a number of firms submitting bids for the execution of the works and the firm with the lowest bid price or that best meets a set of pre-determined criteria is selected.

Tendering practices for the procurement of consulting engineering services by public and private clients is discussed in detail in chapter 3 of this document.

### 2.4.3 Contracting

The primary aim of construction contracts is to allocate project risks among the contracting parties. Construction contracts are written and signed agreements between parties involved in the contracts and they aim to clearly state rights and responsibilities of parties to the contract. Construction contracts set the legal framework guiding the relationships between

clients, consultants and contractors on a project. Common standard contracts used on construction projects in South Africa include:

- General Conditions of Contract (published by SAICE)
- Joint Building Contract Committee (JBCC) contract Principal Building Agreement
- New Engineering Contracts (NEC) suite of contracts
- FIDIC suite of contracts (published by the International Federation of Consulting Engineers)
- Professional Services agreement Contract including those published by –
  - FIDIC
  - NEC
  - PROCSA (Professional Consultants Services Agreement Committee)
  - CESA
  - CIDB

The South African experience shows that choice of contract is dependent on the type of project and client's preference. The JBCC contract is the preferred choice on building projects, the GCC is preferred choice on civil works contracts (road projects and civil infrastructure projects), while the FIDIC and NEC contracts are mostly used on large multi-disciplinary engineering projects. This point is supported by empirical data from the CIDB 2013 Construction Industry Indicators report which showed that the JBCC contract form was used on 81% of residential and 78% of non-residential building projects, the GCC was used on 78% of civil works projects, the FIDIC and NEC contracts are the least used contract forms on civil engineering projects in South Africa (Marx, 2013:16).

Information on the level of penetration of the various consulting engineering professional services agreement contracts in South Africa could not be obtained. However, consulting engineers are known to use any of the above standard service agreement on large projects and projects involving public clients. Bespoke contracts based on the standard service agreements are drawn up for small value projects. One consulting engineer interviewed stated that he only uses standard service agreement contracts on projects with contract value exceeding a hundred thousand Rands (ZAR100,000.00); otherwise, he draws up his own contract.

Professional services agreement for consulting engineering services is discussed in detail in chapter 3 of this document.

## **2.5 State of the South African construction industry at the time of this research**

According to data from Statistics South Africa, the construction industry contributes about 3% to South Africa's Gross Domestic Product (GDP), contributing ZAR31 billion in the first quarter of 2013. Statistics from the Construction Industry Development Board (CIDB) show that the construction industry employed 1,020,000 people as at the first quarter of 2012, and the public sector was a major financier of infrastructure projects in South Africa, with an annual investment of about R150 billion on civil engineering projects and R25 billion on residential and non-residential buildings (CIDB, 2012).

Various industry indicators suggest that the South African construction industry was hard hit by the global economic recession that followed the local construction boom heralded by the hosting of the 2010 FIFA World cup. Preparations for hosting of the World Cup saw massive investments in the construction of soccer stadia, upgrade of railways and other public infrastructures. The construction industry has post 2009 headed into a protracted period of inactivity. Fewer construction projects were executed in the country by both the public and private sector between 2009 and 2013 (Pricewaterhousecoopers, 2013).

First quarter 2013 Bi-annual Economic and Capacity Survey report published by CESA suggests the consulting engineering industry in South Africa maybe showing signs of recovery supported mainly by increased earnings by large consulting firms (employing more than 100 people), followed by medium size firms. Small and micro size firms recorded negative growth. The report also suggests that availability of work increased in the same period resulting in an ease in competition, with professional fees expected to increase marginally. Figure 2 presents the fee earnings for the consulting engineering industry in South Africa between year 2007 and 2013.

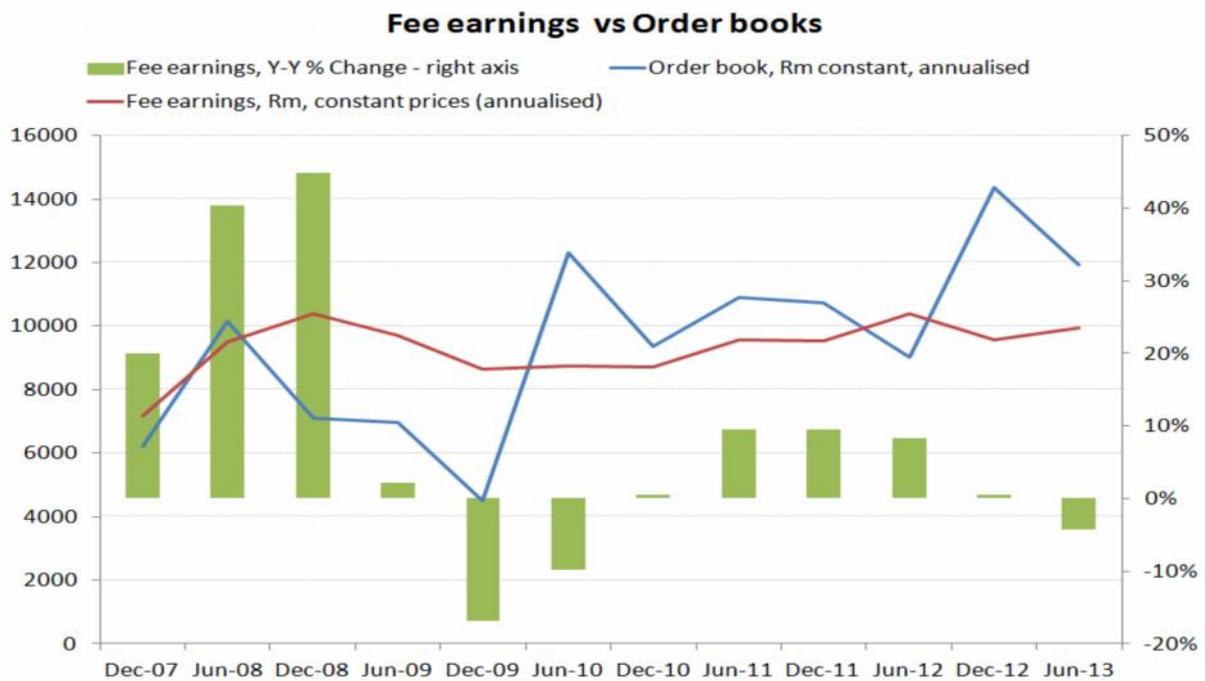


Figure 2: Fee earnings vs Order books of the Consulting Engineering Industry

Source: CESA (2013)

## 2.6 Chapter Summary

An overview of the construction industry in general has been provided in this chapter without specific focus on the consulting engineering sub-market. A review of literature revealed that the construction industry is made up of different market segments characterised by their end products and nature of services provided. The ease with which firms enter the construction industry and the slack regulation of their practice makes the industry highly fragmented (Langford & Male, 2008). The industry is populated largely by small firms disadvantaged in their ability to bargain and tender for large projects when compared to larger firms that are fewer in number. This distribution of firms in the industry has shaped the constructing industry's supply chain which is characterised by subcontracting, with many of these small firms acting as subcontractors to larger firms on construction projects. The industry is fraught with many challenges such as a high propensity for disputes and litigation, poor risk management culture and dearth of technological innovation in its operations when compared to other industries.

The construction industry has a unique project delivery process that makes it different from other manufacturing and services industry. The project delivery process consists of a combination of procurement, tendering and contracting strategies. Common procurement, tendering and contracting strategies have been highlighted, while detailed discussion of these strategies as they concern the procurement of consulting engineering services will be carried out in chapter 3.



The industry in South Africa contributes significantly to the national economy, with the public sector being the source of a significant proportion of annual revenue for the industry. The construction industry has been in a sustained period of inactivity post 2009 after the construction boom heralded by the hosting of the 2010 World cup. The industry however appears to be on the part of recovery judging by improved earnings mainly by large firms in the industry in the year 2012.

## CHAPTER 3: THE CONSULTING ENGINEER'S FUNCTIONS, METHODS OF SELECTION AND REMUNERATION

### 3.1 Chapter Introduction

The perception of consulting engineering services as a commodity is manifest in the way in which these services are procured by clients. Competitive bidding with more emphasis on price and less regard for quality have resulted in price based competition amongst consulting firms in South Africa. This chapter examines the role and responsibilities of consulting engineers on engineering projects as required by professional statutes and legislation, as well as procurement procedures and fee scales for consulting engineering services as it applies to South Africa.

### 3.2 Civil and Structural Engineering Services Consultants

Consulting engineers are professionally qualified engineers who apply their experience and knowledge of engineering to the benefit of those who have engaged their services. The majority of engineering consulting firms operate in the fields of civil engineering partly because traditionally project owners are more likely to outsource design and supervisory functions for civil construction works than they would for projects in other fields of engineering. Corporations that engage in projects of a mechanical or electrical nature tend to develop their in-house engineering capacity (Baark, 2001). Civil and structural engineering consultants offer professional advice to the client with regards to the structural design and specifications, construction supervision, contract management and any other aspect of the project as may be determined by the contract between the engineer and the client.

Consulting engineers may practice as individual proprietorships, partnerships or corporations; individual proprietorships are small firms limited in the scope of work they can handle because of the limited human resource available. Two or more professionals may come together to form a partnership practice. Partnerships are usually medium size firms that are able to serve a wider market segment and have a larger client base when compared to individual proprietors. The professionals in a partnership may take responsibility for specific market segments or project type, one of the partners, usually the managing partner, may assume responsibility for managing the business aspects of the practice. Contractual obligations, risks and liabilities as well as earnings and profits accruing to the practice are shared among the partners according to their shareholding in the firm.

Corporations constitute the bulk of large consulting practices (Ricketts, 2004). In the last decade most consulting practices have reorganised into corporations through mergers and

acquisitions. A corporation business model confers significant business advantage on engineering firms, because it limits the liability of the principals to just the corporate assets of the organisation, even though the individual principals continue to be responsible for their own professional acts (Ricketts, 2004).

The Engineering Council of South Africa (ECSA) was established in terms of the Engineering Professions Act No. 46, 2000 of the South African parliament as a statutory body charged with the responsibility of registering competent engineering practitioners and regulating their professional conduct. Clause 18 of the Act provides for the registration of engineering professionals in two broad categories; Professional Engineer and Candidate Engineer. The Act allows only a registered Professional Engineer to practice in consulting capacity. Professional engineers registered with ECSA are usually the principals in consulting engineering firms and they may employ the services of candidate engineers who with years of practice experience can attain professional registration status.

The responsibilities of consulting engineering professionals on engineering projects in South Africa will be discussed in the next section.

### **3.3 Responsibilities of the Consulting Engineer**

Responsibilities are allocated to the various parties involved on a construction project. The responsibilities are allocated in a manner that reduces to an acceptable level risks associated with the project (FIDIC, 2014). Consulting engineers are responsible for the professional service they provide. According to a policy statement published by the International Federation of Consulting Engineers (FIDIC), the professional services responsibilities of the consulting engineer can be defined in terms of the following:

1. The scope of service for which the consulting engineer is engaged as set out in the contract agreement between the consulting engineer and the client.
2. The standard of the service provided by the consulting engineer should be such that he exercises reasonable skill, care and diligence in the discharge of his duties
3. The conduct of the consulting engineer while discharging his duties should be governed by ethics and the codes of professional practice of the consulting engineer's profession.

(FIDIC, 2014)

The provisions of the FIDIC policy statement are consistent with the provisions of the Rules of Conduct for Registered Persons in terms of the Engineering Profession Act 2013 which stipulates that a registered person (Professional Engineer):

- Must exercise due care, skill and diligence in the discharge of their duties to clients

- May only assume responsibility for work which their education, training and experience confers on them competence to perform
- To only assume responsibility for work that falls within their registration category
- Must adhere to the norms of the profession when carrying out work

(ECSA, 2013)

The above provision imposes moral and regulatory obligations on the professional engineer, most importantly to work within his area of competence.

Table 1 shows the responsibilities of the consulting engineer by way of their inputs at various phases of a project delivery lifecycle as identified by Ramalisa & Mayne (2012). They categorised the engineer’s responsibilities under three groups of services;

- 1) Support services: Advisory in nature and during the planning phases of the project
- 2) Design Services: Technical in nature and during the development phases of the project
- 3) Contract related services: Administrative and managerial in nature and during the construction and post construction phases of the project

Table 1: Consulting engineer’s input throughout project delivery cycle

Infrastructure Delivery Cycle		Deliverable	Consulting Engineer’s Input
Support services	Infrastructure planning	Infrastructure plan for MTEF (Medium Term Expenditure Framework) period	Specialist inputs and cost advice
	Procurement planning	Procurement strategy	Specialist advice
	Work Package preparation	Strategic brief	Specialist inputs and cost advice
Design services	Work Package definition	Concept report	Develop solution and report
	Design development	Design development report	Design development report
	Design documentation	Production information and (drawings specifications)	Produce production information

Infrastructure Delivery Cycle		Deliverable	Consulting Engineer’s Input
Contract related services	Works	Works in accordance with contract	Administer contract and confirm design intent is met
	Hand over	Record information	Produce record information
	Asset data	Updated asset register	Provide data
	Package completion	Completed contract	Close out contract

Source: (Ramalisa & Mayne, 2012)

The competence of a consulting engineer in an area of specialisation is defined by certain knowledge, skill and ethics requirements which are regulated by various engineering regulatory bodies. The ECSA Guide to the Competency Standards for Registration as a Professional Engineer defines competence as the *“possession of the knowledge, skills and attitude necessary to perform the activities within the professional category to the standard expected in independent employment or practice”*

The Civil Engineering BOK (Body of Knowledge) for the 21<sup>st</sup> Century published by the American Society of Civil Engineers identified 24 outcomes necessary to enter the civil engineering profession. These outcomes were grouped into three broad areas as follows:

1. Foundational
  - a. Mathematics
  - b. Natural Sciences
  - c. Humanities
  - d. Social Sciences
2. Technical
  - a. Material science
  - b. Mechanics
  - c. Experiments
  - d. Problem recognition and solving
  - e. Design
  - f. Sustainability
  - g. Contemporary issues and historical perspective
  - h. Risk and uncertainty
  - i. Project management
  - j. Breadth in civil engineering areas

- k. Technical specialisation
3. Professional
- a. Communication
  - b. Public policy
  - c. Business and public administration
  - d. Globalisation
  - e. Leadership
  - f. Team work
  - g. Attitudes
  - h. Lifelong learning
  - i. Professional and ethical responsibility

(ASCE Body of Knowledge Committee, 2008)

Fifteen of the 24 BOK outcomes cannot be fulfilled by formal educational training alone, experience in addition to formal education is required to obtain professional status in order to practice as a consulting engineer (Watermeyer & Smith, 2014).

The responsibilities of the consulting engineer will be discussed below in more detail from the perspective of ECSA guideline and legislation in the South African context.

### **3.3.1 ECSA Guideline for Services for Persons Registered In Terms of the Engineering Profession Act No. 46 of 2000 (2014)**

The ECSA Guideline for Services for Persons Registered in Terms of the Engineering Profession Act addresses the more technical aspects of the engineer's responsibilities. Professional engineering services under this guideline are categorised under 'normal services' and 'additional services'. Normal services are the basic services expected of a consulting engineer, while additional services are outside of the normal services and the engineer is entitled to additional remunerations if he is to provide such services. Normal services cover the following project phases:

- a) Inception
- b) Preliminary design
- c) Detailed design
- d) Documentation and procurement
- e) Contract administration and inspection
- f) Project close out

The guideline covers a wide spectrum of engineering consulting disciplines. However an interrogation of the guideline from the perspective of civil and structural engineering services reveals the following salient points:

- a) The provisions of the guideline are the minimum level of service to be expected by clients from consulting engineers at the prescribed fee scale. However, additions and subtractions can be made to the list of services upon negotiation by both parties
- b) The consulting engineer may also function as a principal agent to the client and carry out project management functions as an additional service
- c) On civil projects with the exception of building and multi-disciplinary projects, the consulting engineer assumes responsibilities for calculating quantities and estimating associated costs on project when a quantity surveyor is not involved on the project
- d) There is an increased service demand on the consulting engineer in the areas of contract administration and inspection when compared to previous editions

In comparison, the guideline is fairly consistent with other professional services guidelines published by the ACE (Association for Consultancy and Engineering) in the UK, Association of Professional Engineers and Geoscientist in Canada and the Malaysia Board of Engineers.

However, a major difference between the ECSA guideline and those mentioned above, is that the scope of normal services as anticipated in the ECSA guideline does not give consideration to project characteristics such as size and complexity in determining sufficient supervisory effort required from the consulting engineer. A blanket provision of one day of site visit in two weeks is specified as the 'norm'. Considering the increased scope of the construction monitoring responsibilities, this provision may be inadequate on most engineering projects. Should the client not be willing to contract for more supervision input as an additional service, the consequence for the consulting engineer's practice would probably be inadequate supervision which in turn exposes both the client and the consulting engineer to risk with respect to quality and safety objectives on the project. It should be noted that the ECSA guideline compels the engineer to bring such risk and any other technical risks associated with the project to the notice of the client in writing.

### **3.3.2 Occupational and Health Safety Act, 1993 - Construction Regulation 2014**

The occupational and Health Safety Act, 1993 is the enabling Act under which the Construction Regulation, 2014 was enacted. Under the Act, the consulting engineer is recognised to act in two possible capacities:

1. **Agent:** A competent person who acts as a representative of the client

- 2. Designer:** A competent person who –
- i. Prepares a design
  - ii. Checks and approves a design
  - iii. Design temporary works, including its components (if appointed by the contractor)
  - iv. Contributing or having overall responsibility for a design

(Republic of South Africa, 2014)

The Act defines a competent person as: *“A person who has in respect of the work or task to be performed, the required knowledge, training and experience and where applicable qualifications, specific to that work or task”*.

The Act imposed a health and safety obligation on the consulting engineer to ensure that his designs can be executed without exposing workers to hazardous procedures and materials.

The Act compels the consulting engineer to:

- Design in compliance with health and safety specifications and standards meeting industry recognised best practices set out for the construction project
- Make available to the client by way of a health and safety report all information related to the design required to safely execute the work
- Inform the client in writing of all hazards related to the construction work and information required for safe execution

(Republic of South Africa, 2014)

In the event that the consulting engineer is appointed as the client's agent, the consulting engineer is responsible for managing Health and Safety on the construction project on behalf of the client.

The Act makes provision for a fine or imprisonment for a period not exceeding 12 months should the competent person be convicted of failing in his responsibilities under this Act.

### **3.3.3 National Building Regulations**

The NBRs (National Building Regulations) are enacted under the National Building Regulations and Building Standards Act 1977 (Act No. 103 of 1977). The Act seeks to promote the uniformity of laws relating to the erection of buildings and the prescribing of building standards. The NBRs sets out functions, principles, procedures and documentation required to satisfy standards in the design, planning and supervision processes of building construction. Compliance with the NBRs shall be by adhering to the requirements of all

prescriptive (deemed-to-satisfy rules spelt out in the Act) and functional regulations. Functional regulations are satisfied by either:

- I. Adopting building solutions that comply with the requirements of the relevant part of SANS 10400; or
- II. Appointing an approved competent person to prepare a rational design or rational assessment of an alternative building solution design which can be demonstrated or predicted with certainty to have an equivalent or superior performance to a solution that complies with the relevant part of SANS 10400.

(Republic of South Africa, 1977)

SANS 10400 (The Application of National Building Regulations) is a supporting document to the NBR Act which describes design and construction methods, building materials and solutions which satisfy functional requirements and standards of the NBRs.

A competent person under the NBRs is defined as a person who is registered in the appropriate category of registration in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000), in other words a person qualified to function as a consulting engineer.

Clause A19 of the Act compels the owner to appoint and retain the services of a competent person who will serve as a single point of responsibility for ensuring compliance to building standards stipulated by the Act. The competent person shall carry out inspection and certification functions to ensure compliance with requirements of the regulation for all components of the building including those designed by other competent persons.

The function of the consulting engineer under this Act to assume responsibility for the entire building system and to certify components designed by someone else has risk implications for the consulting engineer (Watermeyer, 2014).

Clause A19 (13) of the Act states that, "*where any person provides any information or certificate required in terms of this regulation for which he or she knows to be incomplete or false, such a person shall be guilty of an offence*". Watermeyer (2014) observed that this clause puts the consulting engineer at risk; "*signing of form 4 on completion without being capable of demonstrating compliance with function regulations is an offence under the terms of the NBR Act.*" Possible implications of this according to Watermeyer include:

1. Disciplinary action by ECSA leading to a fine or withdrawal of professional registration status
2. Professional indemnity insurance claims being refused by the insurer on the grounds of dishonesty

### 3. A potential offence in terms of the Prevention and Combating of Corruption Activities Act 2003

It is advised that in the event that a consulting engineer does not issue bespoke specifications for his/her designs, a clause should be included in their contracts that will compel the contractor to incorporate in their works materials, components and assemblies that satisfy the requirements of SANS 10400.

#### **3.3.4 Service Agreements**

Consulting engineers often find themselves in a difficult position when they have to distinguish between what their clients and peers in the industry imagine to be their responsibility and what their actual responsibilities are (Kagan, Leary & Pratter, 1986). Kagan et al were of the opinion that the actual responsibility of the engineer on a project is a contractual matter. In South Africa, the provisions of the ECSA guideline discussed in section 3.3.1 are usually the basis for contractual negotiation between clients and engineers on the services to be provided under the service agreements; especially on projects involving inexperienced clients.

Professional service agreements define the role, responsibilities, contractual and financial framework under which a consulting service is to be provided. The common practice in South Africa is that consulting engineers use standard form client/consultant services agreements such as those published by FIDIC, NEC, PROCSA (Professional Consultants Services Agreement Committee), CESA and the CIDB on large value contracts or draw up bespoke contracts based on these standard form contract documents for small value contracts.

Information on the level of use of each professional services agreement contract in South Africa could not be obtained. However, FIDIC professional services agreement is very much promoted by CESA, while discussions with practicing engineers suggest that the PROCSA service agreement is also used. The NEC professional services contract will naturally be used along with the NEC engineering and construction contract. The NEC contract is the least used form of contract on building and civil construction projects in South Africa compared to the JBCC and SAICE GCC contracts (Marx, 2013:16). This suggests that the NEC professional services agreement is not frequently used by civil and structural engineering services consultants in South Africa.

Most client/contractor standard form such as the SAICE GCC and FIDIC suite of contracts used on traditional project procurement provide for the position of an engineer who will be responsible for administering such contracts. The role of the engineer on construction

projects under such contracts is therefore divided between that of the employer's agent (administrative duties) and that of providing professional judgement (technical duties). The engineer has a responsibility to protect the client's interest in terms of managing cost, schedule and quality targets of the project and at the same time to be equitable to the contractor.

It is important that a practicing consulting engineer must be aware of all the legal and regulatory obligations surrounding their practice and ensure that agreements entered into with clients are not on terms that impede their ability to provide good professional service that satisfy standards and ethics requirements expected of them.

The selection methods for consulting engineering professionals will be discussed in the next section.

### 3.4 Consultant Selection Process

According to the Federation of Canadian Municipalities (FCM), best practices principles for the selection of consulting engineers should include the following:

- Qualifications
- Quality
- Innovation
- Relationships
- Fairness
- Respect for intellectual property
- Efficiency and Effectiveness
- Flexibility
- Non predatory pricing
- Sustainability

(Federation of Canadian Municipalities, 2006)

In South Africa, public sector clients account for the greater percentage of professional fees earned by consulting engineering firms. In 2013 for example, 54% of all fees earned in the first half of the year were from public sector clients (CESA, 2013a). The procurement of consulting engineering services by organs of government in South Africa is governed mainly by the CIDB's SUCP (Standard for Uniformity in Construction Procurement). The SUCP aims to ensure uniformity in the procurement process for construction services by organs of government. The SUCP takes into consideration the procurement reform requirements laid down by the Treasury Department. The SUCP allows for the soliciting of consulting engineering services using any of the following procurement procedures:

- 1) Negotiation procedure
- 2) Nomination procedure
- 3) Open procedure
- 4) Qualified procedure
- 5) Quotation procedure
- 6) Proposal procedure using the two envelop system
- 7) Proposal procedure using the two stage tendering system

The SUCP document also stipulates the following four methods of tender evaluation when implementing any of the procurement procedures:

- Method 1: Financial offer (lowest cost based selection)
- Method 2: Financial offer with preferences ( Cost based selection)
- Method 3: Financial offer and quality (Quality and cost based selection)
- Method 4: Financial preference, quality and preferences (Quality Cost Based Selection)

The CIDB advocates the use of Quality and Cost Based Selection (method 4) for the evaluation of tenders. Under the Quality Cost Based Selection approach as envisaged by the CIDB, firms are awarded points for price, quality and preference criteria, and the firm that scores the highest points gets awarded the job. According to the CIDB best practices guideline No.A7 for the procurement of professional services a quality to cost ratio of between 85:15 to 50:50 is proposed depending on the complexity of the project. The CIDB recommended procurement procedures have however not been appropriately applied by public sector clients for the following reasons:

- Lack of capacity and capability in the public service
- Poor information dissemination and inconsistency in applying procurement procedures
- Political interference in consultant selection

(CIDB, 2011)

Quality Based Selection (QBS) is the law in certain countries such as the United States for the procurement of engineering services and is advocated by CESA for the selection of consulting engineering firms in South Africa (CIDB, 2011). Under the QBS as envisaged by CESA, consulting engineering firms are first evaluated for quality; qualifications of key staff, experience and performance on similar projects, and the quality management system of the firm are some of the standard criteria against which consulting engineering firms should be assessed. The scope, schedule and professional fee for the project is subsequently negotiated with the firm scoring the greater points on quality, and any reduction in

professional fees below the approved fee scale should be accompanied by a reduction in the scope of services offered (Davies, 2006:20).

The SUCP is not enforceable with private sector clients. Private clients are known to adopt negotiation selection procedure based on an agreed scope of work. While the CIDB expects quality not to be compromised in favour of price in the selection of consulting engineering firms, while implementing its QCBS method, the practice of tendering negates this intention. Government procurement guidelines require some form of competitive tendering for its procurement activities. Once price is introduced as is the case with tendering, the selection process becomes biased towards lowest cost rather than quality; the consulting engineer is forced to submit lower bids to win the job and focus then shifts from protecting the client's interest to protecting their financial positions (Davies, 2006).

### **3.5 Lowest Cost – Based Selection of Engineering Services Consultant**

Lowest cost selection is one of the seven cost based selection methods identified to be used for selecting engineering services consultants in South Africa (Davies, 2006:23). In response to cost based selection methods adopted by clients, consulting engineering firms have adopted a 'market driven' strategy of price based competition and no longer compete on quality of services offered (Love & Edwards, 2004). Under-cutting of competitors and other unethical tendering practices have meant lower professional fees for civil and structural services consultants in South Africa. The rationalisation for lowest cost based selection for consulting engineering services includes:

- Clients wanting to pay fees that conform to existing market practice
- The availability of qualified firms willing to do work at lower fees; and
- The need for economy

(Ling, 2004).

Clients and consulting firms appear to have their justification for the practice of discounted professional fees. However, this practice is not without its implications for both parties. Ramalisa & Mayne (2012) identified pitfalls associated with lowest cost based selection for the procurement of consulting engineering services to include:

- Less optimisation
- Poor performance
- Poor quality outcomes
- High construction cost
- High lifecycle cost
- Lower expertise on the project

(Ramalisa & Mayne, 2012)

All economic activities involve a trade-off between cost and quality, when fees are too low there is a corresponding decline in quality of service (Hoxley, 2000). According to the Economic Theory of the Firm, the objective of a firm is to maximize profit (Coase, 1937:386), firms seek to minimize cost and maximise profit. Professional fees can be reduced to the following constituent parts as depicted by the equation (RICS, 1988):

$$\text{Fees} = \text{Resources (hours)} \times \text{Unit Cost (Rands/hour)} + \text{Margin (Profit)}$$

Ling (2004) observed that when fees are low one or more of the fee constituents will be reduced. The engineering input on the project may be reduced as fewer hours are allocated to the project, or the project is assigned to a less qualified staff member who is paid a lower hourly rate. Low fees could also mean that the profit margins will be insufficient to cover areas of risk associated with the commission.

Davies (2006:19) observed that it is difficult to draw up specifications against which the consulting engineer's performance will be measured compared to drawing up specifications for the physical aspects of the works done by contractors. Therefore, different levels of service quality will be anticipated by consultants should the competition be based on price. The selection process for professional services consultants and the subsequent fees negotiated will influence the quality of services provided. A negative correlation exist between services fees and documentation quality resulting in increased project cost (Abolnour, 1994; DeFraités Jr, 1989).

A reduction in quality of service constitutes risk for the client and the consulting engineer; the client faces the risk of increased lifecycle cost for the project, while the consulting engineer stands the risk of reputational damage and loss of a repeat job and referral among other risk resulting from poor performance.

The professional fee scale obtainable in South Africa will be discussed in the next section.

### **3.6 Professional Fees and Discounting**

The ECSA is required by law to publish professional fee scales by way of a government gazette on an annual basis. Some countries such as the USA and the UK have since abolished mandatory fee scales and professional bodies in these countries no longer publish fee scales. In South Africa however Professional fee scale guidelines are still obtainable even though price based competition is not prohibited. The ECSA fee scales form the basis for negotiation between consulting engineers and clients on small and large routine projects.

The 2014 ECSA professional fee scale guideline envisages four methods of remuneration for engineering services in South Africa and they include:

- i. Time based fees
- ii. Reimbursable expenses
- iii. Value based fees
- iv. Percentage fees based on the cost of the work

Of all the methods of remuneration, percentage fees based on the cost of the work is perceived to be the most commonly used on building and civil engineering projects.

The civil and structural engineering fraternity have long argued that compensation for their services as provided for under the ECSA guideline is inadequate especially on building projects mainly due to:

- a) Increased frequency of redesigns and coordination inputs required on building projects
- b) Increased construction monitoring and supervision responsibilities implied by the nature of their service which has not been adequately reflected under 'normal service'
- c) Undercutting and competition on the basis of price among civil engineering professionals
- d) Discounts on fees being demanded by clients from the project team

A comparison of the ECSA fee scales shows that between 2012 and 2014 professional fees scales for civil and structural engineering services on building projects has taken a cyclic pattern. In 2013, there was a considerable reduction in fees accruing to civil and structural engineering consultants particularly on building projects which was attributable to the re-classification of project types based on their perceived level of complexity. This reduction has however been addressed in 2014. Appendix A shows the fee trend for 2012, 2013 and 2014. Further reduction by way of discounts on the fee scale prescribed by ECSA which has already been argued to be inadequate can be interpreted to mean low fees for the engineer's services.

The perception within the South African consulting engineering industry is that the practice of discounting is widespread even though empirical data was not found to indicate the extent of the practice. However, the Bi-annual Economic and Capacity survey report published by CESA has consistently tracked the average discount on fees offered by their members. The 2007 report suggested that discounts on professional fees ranged from 5% to 50% of the

ECSA fee scale especially on projects involving private clients; the level of discounts depends on the availability of work and level of competition (CESA, 2007). Figure 3 shows a timeline of the discounting rate among CESA member firms.

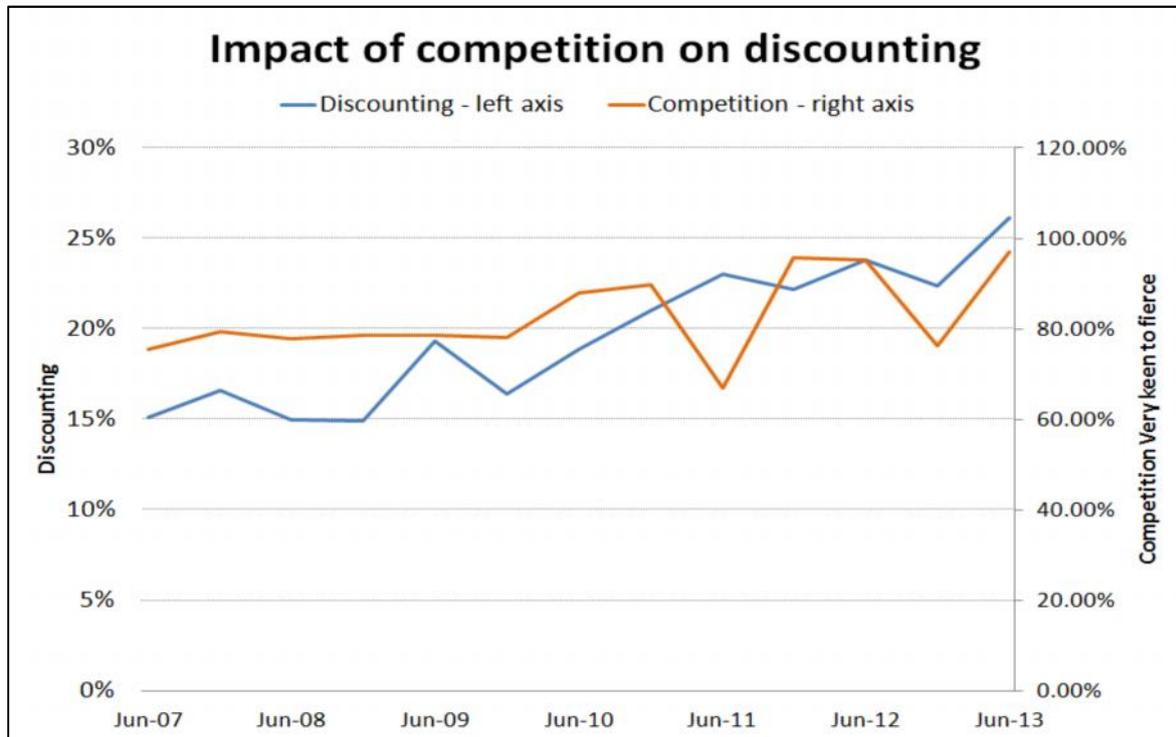


Figure 3: Timeline of discounts on professional fees offered by CESA members

Source: (CESA, 2013)

The competition axis indicates the perceived level of competition in the industry. Competition here is a measure of the number of CESA firms participating in the survey that perceive competition to be either keen or fierce. Ninety seven percent of CESA firms perceived competition to be either keen or fierce in June 2013 compared to about 80% in June 2009.

In the view of CESA, consulting engineers are overly dependent on the ECSA fees scale guideline and the majority of firms have little or no knowledge of their cost or how to calculate their fees without recourse to the published fee scale (CESA, 2013b). Consulting engineers therefore offer reckless fee discounts without appreciating the consequence.

Weidemann (2014) describes the discounting practice within the South African construction environment and its implications thus:

Our discounting goes much further than mere reduction on the recommended fees - we accept limits on reimbursable extras, we render additional services, we do full design at discounted fees, we undercharge when 'working at risk', we develop new or innovative techniques which we do not charge for, and we act as bankers for late fee payment – Thanks to discounting the engineer will work longer hours for the same pay, have less time to liaise with the client and to

investigate design alternatives and optimisation, nor time or money to invest in much needed training, development and mentoring. Cutting the engineer's fees will not only lead to a project of lower quality, but also one that is considerably more expensive than the savings on fees.

(Weidemann, 2014:84)

The apparent disregard for the ECSA published fees scale evident in the level of discounting witnessed in the industry raises questions about its relevance. In May 2005 CESA, SAICE and ECSA jointly issued a press release highlighting the urgent need to educate clients about the construction industry and the negative consequences and effect of discounting.

### **3.7 Chapter Summary**

In this chapter the responsibilities and functions of the consulting engineers as defined by relevant guidelines and legislations have been presented. The procurement of consulting engineering services in South Africa was identified to be mainly by lowest cost tendering and public sector clients accounted for a greater share of fees earned by consulting engineers. The CIDB's Standard for Uniformity in Construction Procurement document which guides the procurement of consulting engineering services mainly by public clients was also discussed with focus on the Quality and Cost Based selection method (QCBS) and the Quality Based selection (QBS) methods recommended by CIDB and CESA respectively. Methods of remuneration, professional fees and discounting practices within the industry were also discussed.

The next chapter shall deal with the subject of risk and risk management.

## CHAPTER 4: THE CONSULTING ENGINEER’S RISK EXPOSURE

### 4.1 Chapter Introduction

The Chapter discusses the issues at the heart of this research; it presents information on the subject of risks encountered by civil and structural engineering services consultants. A review of literature was employed to gather the information contained in this chapter. The insights gained from materials in this chapter form the basis for questions posed to the industry in the questionnaire survey which is presented in subsequent chapters.

Issues covered in this chapter are presented in the following order:

1. Project specific risk
2. Organisational business risk
3. Business sustainability and competitive advantage
4. Risk Management processes

### 4.2 Consulting Engineer’s Risks

Risk to the consulting engineer in the context of this research is defined as:

An event, condition or circumstance before, during or after the execution of a project that puts the consulting engineer in an unfavourable position with regards to meeting client’s expectation, meeting professional and ethical standards and the possibility of incurring financial liability or reputational damage.

The risk exposures of engineering services consultants are two pronged; one aspect of their risk exposure is liability for the professional services they offer to their clients. The other aspect concerns threats to running a financially viable business. For the purpose of this dissertation, risk associated with the consulting engineer’s practice will be discussed under two risk groups namely:

1. Project risks
2. Organisational business risks

Low professional fees have been observed to influence conditions and/or attitudes that create risk for consulting engineers. This is evident in the findings of a questionnaire survey of members of the Association of Consulting Engineers in the UK. The survey revealed the following for projects with low fees:

- 73% of consulting engineers would give less consideration to design alternatives
- 31% of consulting engineers would give less consideration to checking and reviewing drawings
- 40% of consulting engineers consider that the risks of design error occurring are higher
- 74% of consulting engineers produced simpler designs to minimize the commitment of resources to a task
- 84% of consulting engineers judge the number of claims for additional fees to be higher on projects with low fees
- 69% of consulting engineers think that low fees engender mistrust between client and consulting engineer
- 35% of consulting engineers bid low with the intention of doing less than in the enquiry
- 61% of consulting engineers bid low with the intention of making up fees with claims and variation

(Hoxley, 2000)

The implication of these is a decrease in quality of professional services which creates risk for the consulting engineer's practice. Quality issues often result in *"unsafe structures, delays, cost overruns and disputes in construction contracts"* (FIDIC, 2004). Client dissatisfaction resulting from poor project performance is not desirable if a consulting practice is to be successful. However, quality service on the project and a satisfied client will to a great extent ensure a repeat job from the same client and also referrals.

### 4.3 Project Risks

Project risks threaten the attainment of project objectives in terms of cost, time, quality, environmental sustainability and safety. The occurrence of a project risk event could have serious consequences for project stakeholders. These consequences include, clients paying more due to overruns on the project budget; reputational damage, indemnity claims and loss of future jobs for the consulting engineer and loss of revenue to the contractor due to penalties (Visser & Joubert, 2008).

Project risks from the perspective of the consulting engineers' practice and the possible impact of low fees on such risks will be discussed in details under the following groupings:

- a) Client risk
- b) Brief, scope and contractual risk
- c) Design and documentation related risk
- d) Rework of designs and drawings
- e) Quality control risk
- f) Unethical practices
- g) Financial loss on the project
- h) Professional indemnity cover
- i) Legal liabilities (Claims, disputes and litigations)

#### 4.3.1 Client Risk

The consulting engineer markets to prospective clients his time and expertise, they offer their knowledge and expertise for a fee to supplement that available within the client's organisation. Optimal pricing and deployment of their time and intellectual resource is fundamental to running a successful consulting practice (Russell, 2004).

Kometa, Olomolaie & Harris (1996) studied client generated risk for consulting engineers and found that the actions of clients before, during, and after projects can have a negative impact on the commercial viability of consulting firms. They observed that consultants who work for risky clients often suffer financial losses. Jerling (2009) identified characteristics of client organisation such as type, size and project execution philosophy as risk factors that could impact on projects and the performance of project participants. Client risk factors as identified by various authors include:

- a) Size of client organisation relative to consulting firm
- b) Depending on a single client for a substantial portion of the firm's annual fee income
- c) Non-payment or late payment by client
- d) Client insolvency; Inability of client to meet financial obligation
- e) Unrealistic project duration target set by clients
- f) Poor communication and decision making structure within client organisation
- g) Client's legal history; clients having a reputation of being litigious
- h) Past experience and performance; client having a history of unsuccessful projects
- i) Vulnerability of client to prevailing political and economic situation. If client is impacted negatively, this will be transferred to the consulting engineer

(Institution of Engineers Australia, 2005; Kometa, Olomolaiye & Harris, 1996; Tang, Qiang, Duffield, Young & Lu, 2007; Maritz & Robertson, 2012:27)

The consulting engineer has also been accused of creating risk for other project participants. Jerling (2009) in his study of the South African construction industry identified three main risk generated by the client and his agent to include:

- Deficiency in design and project management skills in terms of process, organisational and staff ability
- Inadequate design detail for construction; poor quality of drawings and specifications and absence of constructability considerations in designs
- Inherent safety risk to construction staff due to designs

The poor performance by consulting engineers as identified by Jerling could be as a result of client factors such as late arrival of drawings from architects, poor decision making from client, tight project schedules and low fees.

A client organisation significantly larger than the consulting engineer's organisation constitutes a risk for the consulting firm because of its potential to exert undue influence in order to achieve favourable project outcomes and cause harm from the legal perspective (Institution of Engineers Australia, 2005).

A broad client base where no one client contributes more than 20% of the consulting firm's annual fee income is advised. Dependence on one client for the bulk of the engineer's fee income is a major source of risk to the consulting engineers practice. This is because a loss of this major client will put significant financial strain on the firms, forcing the firms to result to careless measure such as accepting high volumes of low fee jobs to meet cash flow requirements.

The above risk factors are important client acceptance criteria which the engineer should consider before entering into a contract with a prospective client.

#### **4.3.2 Brief, Scope and Contractual Risk**

The 2012 Construction Industry Indicator Report published by the CIDB highlighted the lack of capacity of South African public clients in engineering, architecture and quantity surveying fields of work. This point is further supported by Jerling (2009) who observed that South African clients do not have the capacity to properly scope and define projects, brief consultants and make project decisions timely. This situation has resulted in difficulties for consulting professionals as the duties of various consulting professionals employed by the

client tend to overlap; it is not uncommon to hear consulting engineers complaining of taking on more responsibilities on account of the poor performance of other professionals such as the architect. Risk factors related to project brief, scope and contract are summarized as follows:

- a) Unclear brief that does not properly state the role and responsibility expected of each party
- b) Client's expectation for the project being higher than that communicated and understood by the engineer. Usually as a result of conflicting understanding of project requirements
- c) Scope creep – Aspects of the project changing and broadening scope of services to be provided by the engineer than initially anticipated by the engineer
- d) Unclear procedure for variation and expansion of project scope
- e) Providing professional advice without a written professional services agreement in place
- f) Professional services agreement that does not clearly define terms and conditions of appointment, or is unbalanced in risk allocation and limits of liability

Managing client expectations in line with the consulting engineer's competence and resources is crucial to meeting client expectations. If the expectations of the client are not managed within the limits of what the engineer can deliver, the consulting engineer stands the risk of being accused of non-performance and incompetence.

Interviews with practicing engineers suggest that it is not unusual for clients to change certain aspects of the project brief or the need for changes in design input as the project progresses. These changes along with variation in cost and scope are a major source of dispute between consulting engineers and clients. Many professional bodies have recommended to their members to include clauses that address the method for dealing with variations in their contracts. It is recommended that all variations be agreed in writing and signed-off by the client.

Clarity, balanced allocation of risk and realistic liability limits are crucial to project success. Consulting engineers are advised to avoid projects where they are unable to negotiate mutually beneficial terms of contract. Many professional bodies have developed standard form professional services agreements aimed at protecting the interest of both clients and consulting engineers. Service agreement contracts should clearly address the following contentious areas (Victor, O Schinnerer & Company Inc, 2014a):

- Scope of normal services

- Scope of additional services
- Quantum and timing of compensation
- Schedule for service performance
- Personnel for the project especially site staff
- Channels of communication
- Client obligations and responsibilities

Terms of contract that are ambiguous and unspecific often result in more liabilities than anticipated for contracting parties and subsequently disputes. Clear contract terms and scope of services protects the consulting engineer from claims by clients and third-parties.

### 4.3.3 Design and Documentation Related Risk

Design documentation (drawings and specification) provide the graphical representation and instructions that enable the construction contractor to transform the engineer’s design ideas into a physical facility required by the client. The quality of the design document goes a long way towards determining how effective and efficient the construction process will be.

Poor quality design documents often lead to structural failures, a final facility that is not fit for its intended purpose, delays, variations and cost escalation on construction projects (FIDIC, 2004). Repeated incidences of high profile design errors that have resulted in building and infrastructure failures suggests that engineers find it difficult to learn from design mistakes (See Delatte & Rens (2002); Lopez, Love, Edwards & Davis (2010)).

Design misinterpretation, miscalculation, omissions, poor quality drawings, faulty specifications and incomplete technical information to contractors are forms of deficiencies in design and documentation that will usually create risk for the engineer (Lopez, Love, Edwards & Davis, 2010). A study of 60 construction projects in Saudi Arabia showed a correlation between low fees and deficiencies in design; the study showed that design deficiency is inversely proportional to design fee (Bubshait, Al-Said & Abolnour, 1998). Causes of design and documentation error and deficiencies as it concerns the consulting engineer have been identified to include:

- a) “Time boxing” (allocating set time) of design task usually on account of low fees
- b) Poor management and control of documentation
- c) Inability to perform value engineering and constructability analysis
- d) Designs not being reviewed by experienced colleagues
- e) Inability to consider design alternatives

- f) Time pressure resulting from the fast tracked nature of most construction projects or unrealistic schedule demands by clients
- g) Weakness or absence of quality control systems in the design process
- h) Insufficient knowledge, skill and experience within the design organisation
- i) Over dependence on and ineffective utilisation of Computer Aided Design programs
- j) Poor coordination and communication between members of the project team

(Bubshait, Al-Said & Abolnour, 1998:44; Lopez, Love, Edwards & Davis, 2010:399; Love, Edwards & Irani, 2008:234)

The manifestation of design and documentation deficiencies on construction projects include:

- a) Conflicting contract documents resulting from discrepancies between design drawings and specifications
- b) Inter-disciplinary coordination errors resulting in interface problems of structural, mechanical or electrical nature
- c) Technical compliance discrepancies resulting from non-adherence to the appropriate design guidelines, building codes and technical specifications
- d) Delays in making design document available to other project parties leading to disruptions
- e) Constructability and value engineering issues leading to a design that is difficult to construct on site and expensive.

(Bubshait, Al-Said & Abolnour, 1998)

Design and documentation risk increases on projects that involve complex designs and technical innovation and is further heightened if the project is under staffed. When fees are low, the consulting engineer may be unable to consider design alternatives and may simply consider the simplest and least expensive design option which may not necessary offer the least lifecycle cost. The practice denies the client the benefit of a cost effective design. Design deficiencies often result in crisis situations on projects, causing the engineering firm to work under pressure, rework becomes frequent and whatever profit that should have accrued to the firm from the commission is eroded.

#### **4.3.4 Rework of designs and drawings**

The Construction Industry Development Agency (1995) defined rework as “doing something at least one extra time due to non-conformance to requirements”. Love & Edwards (2004) identified deficient contract documentation, poor quality management and change orders by

clients as leading causes of reworks on construction projects. Factors that influence the occurrence of rework during the design phase of a project as identified by various authors (Burati, Farrington & Ledbetter, 1992; Lopez, Love, Edwards & Davis, 2010; Love, Mandal, Smith, Irani, Treloar & Faniran, 2000; Love, 2002; Love & Edwards, 2004) are summarized below:

- a) Type and method of procurement
- b) Low design fee
- c) Staff strength and work load at the firm, understaffing of a project increases the chances of error
- d) Quality of staff assigned to the project; new design staff with no knowledge of the history of the project and that lack experience are more likely to make design errors
- e) Schedule pressure

The majority of engineering projects are procured by the traditional procurement method (Love, 2002), where engineering design is done upfront before construction work begins. Increased pressure from clients to compress project schedule, have resulted in attempts to reduce the 'procurement gap' between design and construction stages on projects. Inviting contractors to tender even before detailed design is completed under traditional procurement method is fairly common among South African clients. This practice increases the complexity of the project for the consulting engineer due to the challenge of communicating and coordinating design tasks and construction tasks concurrently (Love & Li, 2000). The problem of coordinating multiple tasks concurrently is further exacerbated by time pressure, especially when rework occurs; in order to respond to tight schedules, consulting engineering firms have had to employ additional resources which may not have been allowed for in their fees.

On building projects for example the impact of this practice is more on the structural engineering consultants who are required to provide bending schedules and construction drawings for implementation by the contractor. The Structural engineer's drawings are often based on preliminary sketch drawings provided by the architect which are almost always subject to change. When the architect does provide revised drawings the engineer is also forced to rework his/her drawings, often under tight time pressure considering the importance of structural drawings to the contractor. Changes by electrical and mechanical engineers also results in redesigns by the structural engineer.

When the cause of rework is traced to the engineer's design, it is not uncommon that the engineering firm bears the financial cost of the rework.

#### 4.3.5 Quality Control Risk

Quality on a project is achieved if the stated legal, aesthetic and functional requirements of the completed project conform to the initial project requirements (Arditi & Gunaydin, 1997). From the perspective of the consulting engineer, quality on a project includes quality of design and quality of construction. Design quality can be achieved by implementing Quality Assurance (QA) programs during the design process. A QA program involves established “procedures, standards, training, guidelines and systems necessary to produce quality” (Arditi & Gunaydin, 1997). Quality Assurance programs are usually implemented at the organisational level.

Quality control during construction can be achieved by effective construction monitoring by the consulting engineer. Construction monitoring allows the consulting engineer to verify ground conditions, design assumptions, document procedures and performance of the contractor for the purpose of accessing quality (Kagan, Leary & Pratter, 1986). In addition, questions relating to ambiguities in drawings and specifications can be resolved early thereby avoiding rework and associated costs. Inspection responsibilities imply that the engineer will monitor the contractor’s work and this extends the engineer’s liability to undetected errors and omissions that may subsequently lead to structural failure (FIDIC, 1997).

The ECSA guideline for engineering services places on the engineer the responsibility of inspecting the contractor’s work for quality and to ensure conformity with the contract documentation. Likewise the National Building Regulations Act places on the consulting engineer the responsibility of ensuring compliance with the quality requirements of the Act for the whole building system. The engineer’s capacity to monitor quality on the project is diminished if the client is unwilling to contract for sufficient construction monitoring services.

A few potentially risky practices by consulting engineers that expose them to supervision related risks include:

- a) Professional services agreement that limit their inspection responsibility or totally abrogate such responsibilities to the client
- b) Engaging the services of inexperienced site staff for site inspection services, especially on projects involving speciality construction
- c) Negligence during supervision

In their study of the Hong Kong construction industry, Tang, Lu & Chan (2003) observed that consulting firms were unable to afford good quality site supervision on projects with low fees. Adequate site inspection services will often require the engineer to visit the construction site

frequently or engage the services of a site engineer. When fees are not sufficient the cost associated with carrying out construction supervision may erode profit.

According to the FIDIC policy statement on construction quality, appointing the consulting engineer to render partial inspection services during the construction phase increases risk to the consulting engineer and the client with respect to quality and safety of construction; it also increases the overall cost of the project on account delays resulting from disputes if this risk does occur (FIDIC, 2004). Full involvement in the construction phase avails the engineer of the opportunity to correct any errors or omissions in the construction documents early enough. Proper supervision during construction also gives the engineer the opportunity to identify problems during construction and to bring it to the attention of his client early enough before failure occurs.

Negligence with regards to project supervision is one of the major reasons why consulting engineers get sued; the engineer is in a much better position professionally and financially, by carrying out proper supervision (Kerkes, 2006).

#### 4.3.6 Unethical Practices

Engineering practice is governed by a set of moral principles that guide the actions of practicing engineers. This set of principles is usually articulated and published by professional bodies regulating engineering practices. The code of conduct for persons registered under the Engineering Professionals Act, 2000 requires engineers to amongst other things; discharge their duties with integrity and with the utmost consideration for public safety and environmental sustainability; and in a manner that promotes excellence within the engineering profession.

Martin (2002) identified four aspects of ethics as it concerns the engineering profession to include;

- Professional code of ethics
- Business ethics
- The social impact of technology
- Personal commitments and meaning

The ethical concerns of the consulting engineer relates to professional code of ethics and business ethics. While professional ethics may be clearly defined by professional codes of conduct, business ethics is often a subjective matter. Business ethics “*concerns the social acceptability, both morally and legally of business decisions and actions on the wider society*” (Tow & Loosemore, 2009:122).

The level of unethical practice in the construction industry is such that in 2005, Transparency International has branded it the most corrupt sector of the international economy. Ethical challenges plaguing the construction industry in South Africa includes:

- a) Bid shopping

- b) Bid cutting
- c) Collusion
- d) Bribery
- e) Conflict of interest
- f) Inflated or false claims
- g) Professional negligence
- h) Fraud

(Bowen, Akintoye, Pearl & Edwards, 2007)

Unethical practices peculiar to consulting services professionals in the construction industry as identified by (Vee & Skitmore, 2003) include:

- a) Conflict of interest; consultants using their position for financial gain
- b) Revealing tender information
- c) Concealing construction faults, poor workmanship and material quality during inspection
- d) Altering of construction documents
- e) Overstating capacity and qualifications to secure work
- f) Overstating experience, capability and falsification of qualifications
- g) Main consultant cutting the fees of other consultants
- h) Consultant withholding information from the client which results in variations
- i) Charging clients for work not done, or cost not incurred or overstated
- j) False promises of project advancement
- k) Misleading clients in project management

(Vee & Skitmore, 2003)

Others include:

- a) Omission of required tests, investigation or surveys e.g. geotechnical investigation in order to save cost
- b) Signing off building control form of the local authority on projects they are not actively involved with or fail to ascertain compliance with National Building Regulations quality requirements
- c) Appending their seals to designs and drawings not produced by them

Unethical practices by consulting professionals in the construction industry is encouraged by unfair tender practices by clients (biased tender evaluation system, re-tendering and price shopping when tenders have closed), non-payment of consultants' fees, tendering processes that are predatory in nature and encourage price based competition (Vee & Skitmore, 2003).

Professional firms who bid very low for jobs are often accused of lacking competence to undertake the commission and not realising the full extent of work required hence their low fees. This point is further buttressed by Kerkes (2006) who observed that to many engineers "there appears to be a fine line between aggressively competitive and unethical", as engineering firms often put-in bids at extremely low fees with the intention of not providing the quality of work that is expected.

Ayat (2013) observed the effect of unethical practices to include; structural collapse, upward review of contract duration and cost, abandonment of project and reduced lifespan for facilities. Unethical practices carry many penalties and consequences for a consulting firm:

- a) A reputation for unethical practices harms the firm's chances of securing new clients
- b) Unethical practices increases the risks of civil and criminal charges
- c) Scandals resulting from unethical practices can harm the firm financially by way of depreciation in stock prices or bankruptcy from fines and litigations
- d) Unethical practices amongst employees negatively affects the quality of the firms services
- e) A reputation for unethical practices weakens the ability of the firm to recruit and retain quality employees
- f) Unethical practices constitute a risk to the corporate reputation of the firm; illustrative of this are companies recently fined by the competitions commission in South Africa for unethical tendering practices related to works carried out in the build up to the 2010 world cup

Unethical practices negatively affect the public's perception of the industry and consulting professional in particular

#### 4.3.7 Project Financial Risk

One important consideration for consulting professionals when accepting a brief should be the feasibility of successfully executing the brief within the proposed fee budget. For every commission it is important that the fees cover the cost of the service, plus a margin to cover profit and returns for risk associated with the project. When fees are low, resulting from inaccurate estimate of resources required for the job or a deliberate unethical practice by the engineer in an attempt to secure the contract, the risk of incurring financial loss is always present.

Kometa, Olomolaie & Harris (1996) were of the opinion that certain risks created by clients are applicable to both consultants and contractors. Jerling, 2009 identified financial risk induced by clients that impact contractors; client generated financial risks identified by Jerling that are perceived to be true for consulting engineers include:

- a) Client's treasury and financial control system not suited to project circumstances (applicable to public clients in South Africa)
- b) Clients requesting consulting engineer to provide service 'at risk'. The consulting engineer becomes the banker of the client
- c) Unreasonable levels of contractual penalties and liabilities
- d) Contract payment tied to project milestones that are not clearly defined and dependent on the performance of other project parties e.g. contractor

Some firms choose to contract with new clients at significantly low fees as a Public Relations strategy with the purpose of securing such clients. But it should be noted that it may be

difficult to negotiate higher fees with such a client in the future considering the precedent set with previous assignments.

#### 4.3.8 Professional Indemnity Cover

When failure of a design or engineering nature occurs arising from negligent advice, the consulting engineer involved is legally liable to compensate the client or third party who suffers a loss as a result. Professional indemnity insurance is a cost effective method of managing professional liability risks. The procurement guidelines for consulting services published by CESA recommend adequate professional indemnity cover as a condition precedent to obtaining an appointment to provide professional engineering services (CESA, 2011).

Hoxley (1998) noted that since mandatory fees scales for consulting professionals were abolished in the UK, the level of claims has increased. In response to this insurance companies have raised insurance premiums. Data on professional indemnity insurance claims in South Africa are difficult to obtain due to the confidentiality policies of insurance companies. However, data on the AON professional indemnity insurance scheme for CESA members was obtained. The 2011 year-end report showed that consulting firms spent about 1% of their gross fees earnings on professional indemnity premiums (Padayachee, 2011). In 2013, the consulting engineering industry in South Africa spent approximately R400 million on professional indemnity insurance premiums, which is about 1.8% of gross fees earned; percentage of cost of premiums to fee earning range from 1% for majority of the firms to as much as 11% for a few firms (CESA, 2013). The ability of engineering firms to afford adequate professional indemnity cover in the face of declining professional fees has frequently been questioned.

The challenge for consulting engineers is finding affordable insurance and maintaining a high service quality in the face of declining professional fees to avoid claims. The increased level of claims by clients against consulting professional has been attributed to factors such as declining quality of services, increased pressure on consulting professionals to be competitive with regards to cost and the litigious nature of society. Claims made against South African consulting engineers emanated mostly from “inexperienced consulting engineers, inadequate or lack of supervision, fast tracked nature of construction, failure to define scope of service at contract stage and cost overrun claims” (Padayachee, 2011). A review of the top four claims annually (2006 – 2010) under the CESA insurance scheme reveals that civil and structural engineering practices accounted for 80% of all claims exceeding R500,000.

The risk exposure of a consulting firm working at low fees with regards to professional indemnity cover will include:

- a) Difficulty in affording professional indemnity insurance premiums
- b) Paying higher premium/premium loadings being applied by insurers because insurance firms consider low fee jobs to be high risk
- c) Dishonesty and unethical conducts are conditions for denial of claims. Some cost cutting measures adopted by consulting firms boarder on dishonesty and unethical conduct

- d) Poor service quality by some members of the profession and increased cases of claims will mean that insurance firms will continue to increase premium rates and this affects the whole profession

(Watermeyer & Smith, 2014; Padayachee, 2011; Institution of Engineers Australia, 2005)

Professional indemnity Insurers have introduced incentives to encourage consulting engineering firms to adopt measures that limit their risk exposure; Padayachee (2011) noted that insurers in South Africa offer discounts on deductible payables by as much as 25% to firms that adopt the CESA approved Quality Management System. Even higher discounts (as much as 50%) are offered to firms that limit their liability contractually to a fixed amount or multiple of the fee earned on the project provided it is lower than the professional indemnity limit of that policy.

Most insurers have established Legal Risk Management Services to help consulting engineers vet the terms of services agreements to ensure that they are not injurious from the perspective of their professional indemnity policies. A few advisory notes have also been published by CESA to provide guidance to their members on matters of professional indemnity. Examples of such notes include Advisory Note 82/1 (How to avoid and deal with professional indemnity claims) which recommends negotiating of appropriate professional fees as a way of preventing claims.

#### **4.3.9 Legal Liability (Claims, Disputes and Litigation)**

The legal liability of a consulting engineer for work carried out for a client arises from the common law and the tort of negligence (Hoxley, 1998). When claim issues are not resolved amicably and go to trial the consequences for small firms can be grave. Most consulting engineering firms are small organisations compared to the size of their client organisation and the cost associated with a suit can be quite significant for small organisations.

Kerkes (2006) observed that the most common reason for which engineers get sued is 'basic and avoidable mistakes' and that having their designs reviewed was a good way to avoid being sued. While the impact of other forms of negligence on the part of the engineer on cost and schedule growth can be difficult to prove in court, design errors are not so difficult. South African consultants have been accused of altering standard form contract documents to cover for their negligence and incompetence, this practice has resulted in contract documents becoming a legal minefield (Bowen, Akintoye, Pearl & Edwards, 2007). Construction clients are showing increasing willingness to sue for negligent advice received from consultants (Flanagan & Norman, 1993).

#### 4.3.10 Summary of Project Risks

The project risk exposure of the consulting engineer is greatly influenced by client risk factors. Other factors identified include unethical tender practices, fast tracked construction, low fees and contractual issues. The consulting engineer’s response to constraints imposed by these factors is identified to be the main source of risk; practices such as ‘time boxing’ design activities, assigning low fee jobs to less experienced engineers, under staffing of projects, and non-review of design calculations and drawings by experienced colleagues result in design errors and poor quality documentations. Table 2 presents a summary of the consulting engineer’s project risk discussed in this section.

Table 2: Summary of Consulting Engineer’s Project Risk

Project Specific Risk Groups	Risk Factors
Client Risk	Type of client and structure of client organisation
	Size of client organisation relative to consulting firm
	Depending on a single client for a substantial portion of the firm’s annual fee income
	Non-payment or late payment by client
	Client insolvency; Inability of client to meet financial obligations
	Unrealistic project duration target set by clients
	Poor communication and decision making structure within client organisation
	Client’s legal history; clients having a reputation of being litigious
	Past experience with client
	Client performance on previous projects; client having a history of unsuccessful projects
Brief, Scope and Contractual Risk	Unclear brief that does not properly state the role and responsibility expected of each party
	Client’s expectation higher than that communicated and understood by the engineer
	Scope creep – broadening scope of services
	Unclear procedure for variation and expansion of project scope
	Providing professional advice without a written professional services agreement in place
	Professional services agreement that does not clearly define terms and conditions of appointment
	Unbalanced risk allocation and limits of contractual liabilities

Project Specific Risk Groups	Risk Factors
	Terms of contract that are ambiguous and unspecific in terms of: <ul style="list-style-type: none"> <li>- Scope of normal services</li> <li>- Scope of additional services</li> <li>- Quantum and timing of compensation</li> <li>- Site staff for the project</li> <li>- Channels of communication</li> <li>- Client obligations and responsibilities</li> </ul>
Design and Documentation Related Risk	“Time boxing” (allocating set time) of design task
	Inability to perform value engineering
	Low professional fee
	Designs not being reviewed by experienced colleagues
	Time pressure resulting from unrealistic project schedule
	Weak or absence of quality control systems in the design process
	Insufficient knowledge, skill and experience within the design organisation
	Over dependence and ineffective utilisation of Computer Aided Design programs
Rework of Design and Drawings	Method of project procurement (Fast tracked project procurement methods that compress the schedule between design and construction phases of the project or allow both phases to go on concurrently)
	Understaffing of project/Staff strength and work load of firm
	Quality of staff assigned to the project
	Schedule pressure
	In ability of client to make project decisions timely and correctly
Quality Control on Site Risk	Professional services agreement that limit inspection responsibility or totally abrogate such responsibilities to the client
	Inexperienced site staff engaged for construction inspection services
	Professional negligence with regards to construction inspection
Unethical Practices	
	Conflict of interest; consultants using their position for financial gain
	Revealing tender information
	Concealing construction faults, poor workmanship and material quality during inspection
	Altering of construction documents
	Overstating experience, capability and falsification of qualifications
	Main consultant cutting the fees of other consultants
	Consultant withholding information from the client which results in variations
Charging clients for work not done, cost not incurred or overstated	

Project Specific Risk Groups	Risk Factors
	False promises of project advancement Misleading clients in project management
Financial Risk	Performing work 'at risk' 'Below cost' tendering Client's treasury and financial control system (applicable to public clients in South Africa) not suitable for project's financial requirement Unreasonable levels of contractual penalties and liabilities Contract payment tied to project milestones
Professional Indemnity Risk	Difficulty affording professional indemnity insurance premiums Premium loadings being applied to jobs evaluated by insurers to be high risk e.g. low fee jobs Most cost cutting measures adopted by consulting firms boarder around dishonesty and unethical conduct which are grounds for denial of claims by insurers

The impact of low professional fees on these identified project risk groups was further investigated by means of a questionnaire survey. This will be discussed in subsequent chapters.

#### 4.4 Organisational Risk

The failure of construction projects concurrently managed by a consulting engineering firm at the same time may not only be as a result of failure of the firm to manage risk at the project level, but also at the organisational level (Liu, Zou & Gong, 2013). Organisational risks can be considered as threats to the business and operational activities of the organisation, and impact on the competitiveness of the organisation. These risks if not controlled, result in economic losses for the company.

The construction business environment in South Africa is full of risk; companies operating within the industry have weak risk management cultures, frameworks and practices, but have high risk management awareness at the construction project level (Visser & Joubert, 2008). The emphases of these companies appear to be on project level risks and less concern for the risk at the organisational level.

Visser & Joubert (2008) cited the work of Von Widden and Black which categorised risks to construction business using the Marsh 'Risk Universe'. They categorised organisational level risk into Financial, Strategic, Hazard and Operational risks; they also identified risk drivers and stakeholders within the organisation for each risk category. Table 3 shows the organisational risks elements. Most of the construction related business risks within the

South African business environment falls under the hazard and operational quadrants (Visser & Joubert, 2008).

Table 3: Marsh risk universe

Quadrant	Inner Band (Internally Driven Risk)	Middle Band (Externally Driven Risk)	Outer Band (Stakeholders)
Financial Risks	<ul style="list-style-type: none"> <li>• Pensions</li> <li>• Warranty issue</li> <li>• Asset values</li> <li>• Liquidity/cash flow issues</li> </ul>	<ul style="list-style-type: none"> <li>• Financial market</li> <li>• Patents</li> <li>• Credit default</li> <li>• Foreign exchange fluctuations</li> <li>• Global economic conditions</li> <li>• Tax &amp; accounting changes</li> </ul>	<ul style="list-style-type: none"> <li>• Financial Director</li> </ul>
Strategic Risks	<ul style="list-style-type: none"> <li>• Time of market</li> <li>• Research &amp; Development</li> <li>• Compliance</li> <li>• Intellectual capital</li> </ul>	<ul style="list-style-type: none"> <li>• Brand &amp; Image</li> <li>• Competition</li> <li>• Mergers &amp; acquisitions</li> <li>• Customer/Industry changes</li> <li>• Joint Ventures</li> </ul>	<ul style="list-style-type: none"> <li>• Public Relations</li> <li>• Managing Director</li> <li>• Board</li> </ul>
Hazard Risks	<ul style="list-style-type: none"> <li>• Contractual liability</li> <li>• Business continuation</li> <li>• Public liability</li> <li>• Employee safety</li> </ul>	<ul style="list-style-type: none"> <li>• War &amp; Terrorism</li> <li>• Fire &amp; natural disasters</li> <li>• Property damage</li> <li>• Security</li> </ul>	<ul style="list-style-type: none"> <li>• Risk Manager</li> <li>• Health &amp; Safety</li> </ul>

Quadrant	Inner Band (Internally Driven Risk)	Middle Band (Externally Driven Risk)	Outer Band (Stakeholders)
Operational Risks	<ul style="list-style-type: none"> <li>Information systems</li> <li>Key staff</li> <li>Staff attraction &amp; retention</li> <li>Accounting systems &amp; Control</li> <li>Legislative compliance</li> </ul>	<ul style="list-style-type: none"> <li>Supply chain</li> <li>Utility supply</li> <li>Environmental issues</li> <li>Industry actions</li> </ul>	<ul style="list-style-type: none"> <li>Legal Officer</li> <li>Operational Manager</li> <li>Human Resources</li> </ul>

Source: (Visser & Joubert, 2008)

Based on the Marsh risk universe, Visser & Joubert (2008) proposed a risk framework of construction risks faced by companies in South African. Based on this risk frame work, organisational and business risks and their potential impact as it affects consulting engineering firms in South Africa has been identified and is shown in Table 4.

Table 4: Organisational business risks

No.	Organisational Business Risks	Potential Impact
1	Shortage of key skills (human Capital)	Poor workmanship
2	Tendering and contract exposures	Legal exposures
3	Identification, reporting and actioning of project non-conformance	Project management and Quality control issues
4	Poor business risk management	Guarantee exposure/business sustenance
5	Project management issues	Delays and penalties
6	Poor data management	Operational exposure
7	Financial fluctuations and cost overruns on long term projects	Financial/cost exposure

No.	Organisational Business Risks	Potential Impact
8	Government and legislation issues	Curtailed options/Legal exposure
9	Client relationships	Repeat job/business sustenance
10	Dearth of innovation	Competitiveness/ reputational issues

*Adapted from (Visser & Joubert, 2008)*

#### 4.5 Business Sustainability and Competitive Advantage

Failure to adapt to rapid changes in the construction industry is the biggest threat to the business of AEC (Architecture, Engineering and Construction) firms; firms that are unable to adapt to these changes will become marginalised and fail (Gupta, 2012). The increased complexity and sophistication of construction projects, rapid technological changes, changes in project delivery methods and globalisation have transformed design processes and the way engineers collaborate. Globalisation has removed geographic constraints, and has resulted in ACE firms being able to provide their services across international borders. Technology has transformed the way information is shared and accessed, while the increasing complexity of engineering projects is driving greater specialisation within the various engineering disciplines. The implication of these for AEC firms is increased competition as well as opportunities.

The sustainability of a consulting engineering practice depends on the firm’s ability to develop strategies to improve competitiveness and secure adequate volumes of projects that satisfy cash flow requirement and profitability (Jaafar, Aziz & Wai, 2008). Peteraf (1993) discussed the concept of business sustainability from the perspective of maintaining competitive advantage; she argued that firms of varying capabilities are able to compete in the same market place, and firms with marginal resources can only expect to break even, while firms with superior resources will earn profit as a result of their better efficiency. The following competitive factors have been identified by various researchers:

- a) Human resource
- b) Corporate reputation
- c) Innovative ability
- d) Information Technology

(Boxall & Steeneveld, 1999; Ewing, Caruana & Loy, 1999; Jaafar, Aziz & Wai, 2008; Thum, 2005; Cainelli, Evangelista & Savona, 2006).

Risks at the organisational level hamper the competitiveness of consulting engineering firms. Threats to an organisation’s sustenance from the perspective of these identified competitive factors will be discussed below

#### 4.5.1 Human Resources

Consulting engineering firms, much like other professional services firms, use the phrase ‘our assets are our people’. The competitive asset of these firms is based mainly on the skills accumulated by their professionals both in their individual capacities and in project groups (Baark, 2001). Consulting firms sell the expertise and time of their employees to their clients. Superior human resource confers competitive advantage on professional services firms that possess them, and separates them from competitors. Human resources are “imperfectly imitable and imperfectly substitutable” and are difficult to neutralize by competitors (Boxall & Steeneveld, 1999). Firms with exceptional talents highlight this advantage to clients, for example Forster and Partners is reputed for the iconic architect, Norman Foster, famous for high-tech architecture.

The human resource advantage of a firm is a product of the firm’s ‘human capital advantage’ and ‘human process advantage’. A firm generates human capital advantage by recruiting and retaining outstanding people; while ‘human process advantage’ is a function of historically evolved processes such as learning, cooperation and innovation within the firm (Boxall, 1996).

Human resource risk factors identified to impact consulting engineering firms include:

- Shortage of skilled professional engineers and graduate engineers
- Lack of capacity to train and mentor young engineers
- Competitors poaching key staff and the attendant loss of corporate intelligence
- Weak organisational leadership

(Boxall, 1996; *Visser & Joubert, 2008*; Lawless, 2005)

Skills shortages in the fields of science, engineering (including civil engineering) and other knowledge based industries have been a major source of concern to policy makers in South Africa (Oosthuizen & Nienaber, 2010). The shortage of professionals in the field of engineering in South Africa has been attributed to the high mobility of engineers moving between countries and sectors of the economy, and the low number of qualified engineers produced by the tertiary education system (Steyn & Daniels, 2003). The shortage of experienced and mid-career (35 and 50 year olds) professionals has been identified to have

the biggest impact on South Africa’s civil engineering industry; the ratio of civil engineers per 100,000 of the population has reduced from 20 before 1994 to 2 by 2005 (Lawless, 2005).

Oosthuizen & Nienaber (2010) discussed talent management practices of civil engineering consulting firms in South Africa. Talent management is an integrated strategy and system aimed at improving workplace productivity by attracting, developing, retaining and utilising people with the required skills and aptitude to meet current and future business needs (Oosthuizen & Nienaber, 2010). They identified three areas of improvement critical to successful talent management practices to include building a deeper reservoir of successors at every level, creating a culture that makes employees want to stay with the organisation and assessing a candidate’s skills in the hiring process.

Boxall & Steeneveld (1999) advocated that consulting engineering firms adopt HRM (Human Resource Management) strategies as a survival strategy to enable them to attract, combine and retain top talents for the purpose of building reputation and consolidating their positions in specific market niches. They also identified the need for firms to have the ability to put in place suitable leadership teams when the business context demands it.

#### **4.5.2 Corporate Reputation**

Gray & Balmer (1998) identified corporate reputation as a critical corporate asset that contributes to the competitive success of a firm. Wang (2014) is of the opinion that a good corporate reputation based on perceived quality of service and market prominence is the cornerstone of the competitive strategy of many firms. Fombrun (1996) defined reputation as “a perceptual representation of a company’s past actions and future prospects that describe the firm’s overall appeal to all its key constituents when compared to other leading rivals”. A positive corporate reputation drives successful organisation/client relationships and positively affects business performance; a firm with a good reputation is likely to stand out in the market place, drawing both repeat and trial clients (Ewing, Caruana & Loy, 1999).

Building a positive corporate reputation has been identified as a marketing strategy for consulting engineering firms considering the fact that many engineering regulatory and professional bodies do not approve of marketing activities such as advertising, direct solicitation and referral commissions by its members (Jaafar, Aziz & Wai, 2008).

Dealing with the employees, clients, the public, shareholders and other stakeholders in a transparent and honest way boosts the corporate reputation of an organisation (Ewing, Caruana & Loy, 1999).

Sheikh & Lim (2011) observed the critical role played by employees in promoting the corporate image of consulting engineering firms as they influence clients’ buying behaviours. They were of the opinion that the personal brand of employees contributes to clients’ perception of the organisation and that the significance of these personal brands increase more at senior levels. The departure of employees with a strong personal brand can have a significant impact on the corporate brand of the organisation.

A healthy corporate reputation is a ‘risk suppresser’; clients perceive consulting engineering firms with quality senior employees and a track record of successfully completing high profile projects to be low risk (Ewing, Caruana & Loy, 1999). Also, firms that have been able to build a good reputation locally are most likely to earn premium fees and secure international projects (Thum, 2005).

Firms do themselves a disservice by selling themselves down on price when competing for contracts; firms that offer their services cheap are more likely to be patronised by opportunist clients when they are faced with budget constraints. Poor performance on such projects is likely to dent their corporate reputation.

### **4.5.3 Innovative ability**

Innovation is a means of service diversification and enrichment, which firms achieve by acquiring new knowledge and continuously improving on its existing knowledge base and capability in response to the changing market requirements (Thum, 2005). The ability of an organisation to recognise the value of new external information, learn it and deploy it to commercial ends is a measure of its innovative capacity (Doloreux & Shearmur, 2010).

Thum (2005) argues that innovation for consulting engineering firms is derived from entrepreneurship, creativity and knowledge management with ICT as a tool. Innovation in the field of engineering consultancy may not necessarily be viewed as novelties considering the variability of engineering designs. Engineers will most likely stick to proven techniques and approach of work and will only seek to devise new methods when familiar methods are impractical or when the market demands them. Innovation amongst consulting engineering firms is influenced by certain external factors which include; relevant regulations, client’s briefs and nature of contractual relationships, and the market for technical services (Baark, 2001)

Innovation within the KIBS (Knowledge Intensive Business Services) industry which include engineering consultancy, can be technological or non-technological. Doloreux & Shearmur (2010) were of the opinion that for KIBS, non-technological innovations are more developed than technological innovations. Non-technological innovation was identified to include

“innovations in expertise, interpretative skills, market awareness, management and delivery processes”. Consulting engineering firms in the field of civil engineering can be considered to creatively employ technology. They use external technological innovations to improve their operations especially with regards to ICT and construction materials. Doloreux & Shearmur (2010) identified six types of innovations peculiar to KIBS firms to include:

1. Production innovation: new and improved service products (design, specification etc.)
2. Process innovation: improvements in the way service is produced (Improved work routines)
3. Delivery innovation: change in the way service is delivered by way of improved firm/client relationship
4. Strategic innovation: New business strategies, targeting new markets and creating a niche
5. Managerial innovation: Improvements in managerial techniques, human resource management, knowledge management and quality management
6. Marketing innovation: brand improvement and building corporate reputation

(Doloreux & Shearmur, 2010)

Production and process innovation can be considered to be influenced by technological innovations, while delivery, strategic, managerial and marketing innovations are non-technological.

In addition to recruiting and retaining quality employees the innovative ability of an organisation can be improved by the following:

- a) Investing in Research and Development programs either in house or externally
- b) Investing in ICT and new technologies
- c) Recognising and acquiring new knowledge through market research, client feedback, and observing the activities of competitors
- d) Training and retraining of its employees

(Thum, 2005; Doloreux & Shearmur, 2010)

The level of R&D activities by KIBS firms including consulting engineering firms is much lower when compared to that witnessed in manufacturing firms of comparable size (Camacho & Rodríguez, 2005). This may be as a result of the bespoke nature of their service which is usually based on clients’ need.

Changes in project management and procurement in the construction industry such as design build and partnering which intend to improve economic efficiencies by positively

transforming the relationship between project parties ultimately affect innovation adversely (Baark, 2001), in addition to this other obstacles in the way of innovation for consulting services firms include:

- a) Financial constraints; considering the high financial risk and funding costs associated with R&D
- b) Access to qualified labour
- c) Lack of information on markets
- d) Market dominated by other firms
- e) Unknown demands for new services
- f) Government regulations

(Doloreux & Shearmur, 2010)

In all, innovation for consulting engineering firms appears to centre on ways to widening their revenue streams and speeding up delivery processes for their services. Savings on manpower requirement while increasing productivity is required to compensate for declining professional fees earned by consulting engineers.

#### **4.5.4 Information Technology**

Consulting engineers are required to split their work hours between thinking, reading, communicating and other knowledge based routines. From the productivity perspective, reducing the time spent on routine tasks that do not add much value is critical. This will allow the engineer to spend more time on important tasks that require creativity and cognitive reasoning. Information Technology has found relevance as a tool for improving productivity and the competitiveness in consulting engineering firms (Palvalin, Lönnqvist & Vuolle, 2013).

Information Technologies have advanced over the past decade; IT “affects the state of information, changing its divisibility and storage, its processing, transportation and communication, and consequently its accessibility and tradability” (Antonelli, 1998). At present, IT applications are deployed in the construction industry in the areas of administration and accounting, project management, risk management, CAD (Computer Aided Design), drafting, BIM (Building Information Modelling), communication and networking.

Tan (1996) in his study of the Taiwanese engineering consulting industry observed that deployment of IT in the areas of administration and support, engineering analysis, design and project management was a source of competitive advantage for consulting engineering firms. Other benefits of IT deployment to consulting engineering firms include:

- Routine tasks can be performed faster
- Supports knowledge sharing within the organisation
- Storage of organisational information in a reliable and compact state
- Enriches project communication
- Routine and complex calculations, analysis, simulations can be performed quicker and efficiently
- Virtual presence capability cuts down on travel time and associated cost
- BIM tools improve collaboration on projects as project participants are able to share information seamlessly resulting in more accurate solutions
- Improves project and risk management capabilities

(Tan, 1996; Palvalin, Lönnqvist & Vuolle, 2013; Thum, 2005)

The proliferation of IT has enhanced the ability of consulting engineering firms to trade their services in the international market (Thum, 2005). Entry into foreign markets is a successful business strategy for consulting engineering firms when the industry in their home country had performed badly (Jaafar, Aziz & Wai, 2008). This practice has created challenges for firms in developing countries who may have to compete with more experienced foreign companies entering their local market from developed countries.

The huge cost associated with adopting Information Technology is often a challenge for consulting engineering firms. (Irani & Love, 2002:74) identified the need for investment appraisal to be carried out during the budgeting process to ensure that the organisation does not invest in uneconomic and unproductive technology.

The KMPG global construction report 2013 predicted that the traditional 'design, bid, build' procurement is on its way out because technology is changing very fast resulting in many designs being outmoded during actual construction. Contractors are also beginning to take more design responsibilities by applying BIM tools. The implication of this trend on the consulting engineering profession may yet be clearly understood.

#### **4.6 Summary of Organisational and Business Risks**

Organisational business risks have been identified to impact on the operational activities and competitiveness of consulting engineering firms. Organisational level risks were grouped under Financial, Strategic, Hazard and Operational risks. Majority of construction business risks in South Africa fall under the hazard and operational risk groups.

Failure to adapt to changes in the industry was also identified as a big threat to firms operating in the industry. Consulting engineering firms are therefore required to put in place

measures that will ensure that they remain competitive in order to sustain their practice. Factors of competitiveness for consulting engineering firms were identified to include human resources, corporate reputation, innovation and information technology.

The impact of discounted professional fees on organisational level risk will be further investigated by a questionnaire survey to obtain the industry’s perception based on the following identified risk factors:

- a) Business sustainability
- b) Human resource
- c) Client relationship
- d) Corporate reputation
- e) Innovation

This will be presented in a subsequent chapter.

#### **4.6 Management of the Consulting Engineer’s Risk**

Having identified project and organisational risks to the consulting engineer’s practice, consideration is given to the management of these risks.

Risk management aims to reduce the probability and severity of an unfavourable outcome at the lowest long-term cost to an organisation (Victor O Schinnerer & Company Inc, 2014b).

Standards Australia (2004) defines risk management as:

*“The culture, process and structure that are directed towards realising potential opportunities whilst managing adverse effects”*

Risk management is a vital component of project management which aims to identify and quantify risks associated with a project or threats to an organisation’s business so that appropriate strategies can be devised to minimize the impact on the organisation. Risk management will be discussed in this section from the perspective of managing professional liability.

Risk management practice benefits the construction industry at the project level because it enables planners to arrive at realistic project budget estimates through a well-informed assessment of project contingencies which can then be more accurately priced; giving a

greater degree of certainty that set project budget and schedule targets will be met (Liu, Zou & Gong, 2013; Wood & Ellis, 2003).

The implementation of risk management strategies on construction projects can increase the planning cost at the inception phase of a project, but has the benefit of well-informed project decisions leading to better project performance. The cost of implementing a risk management strategy should, however, be commensurate with the anticipated risk.

As a project progresses more information becomes available, while some risks anticipated during the planning phase of the project may not materialise, new circumstances come into play and so do new risk concerns. Therefore, risk management is a continuous exercise which should be re-evaluated at the various phases of the project for the entire duration of the project.

At the organisational level, a new paradigm has emerged in the management of risk. Focus has shifted to Enterprise Risk Management (ERM); ERM approach to managing risk confronting an organisation is more holistic as against the narrow silo-based perspective of applying risk management to individual projects and to functional departments of the organisation. The advantages of ERM over other organisational risk management systems is that it integrates “strategic, financial, operational and hazard risk into a single framework” that guides an organisation’s strategic objectives (Schiller & Prpich, 2013). ERM cuts across all levels of organisational hierarchy and aims to identify and manage corporate risk under an integrated framework ((Liu, Zou & Gong, 2013).

The implementation of ERM within an organisation will require establishing a risk management department or appointing a Chief Risk Officer (CRO) to bear direct responsibility for developing risk management policy and procedures, monitoring compliance with risk policy and procedures, coordinating risk management of various departments at the enterprise level within the organisation and providing intellectual support to project level risk management (Liu, Zou & Gong, 2013).

Benefits of risk management at the organisational level include:

- Improved risk awareness among employees thereby creating an internal risk culture
- Risk attitudes are aligned with organisational strategies and objectives
- Identification of hazards and opportunities are based on organisational objectives

(Schiller & Prpich, 2013)

For consulting firms, handling multiple projects concurrently and across various market segments often occurs. Planning for project risks at the enterprise level is more effective because it benefits from the organisation’s wealth of experience from previous projects, while resources are more effectively allocated and the participation of top management in decision making is secured. This way the impact of the risk management responses and contingency strategy for a project on other projects within the organisation’s portfolio can be kept under review and balanced out (Liu, Zou & Gong, 2013). For consulting engineering firms, a risk management plan should aim at helping the organisation avoid liabilities, while exceeding client expectation and should align with the wider strategic business plan of the firm.

A systematic approach to risk management has been described to involve risk identification, risk assessment, risk response, and risk monitoring and control. Risk response entails any or a combination of the following four actions: risk retention, risk mitigation, risk avoidance and risk transfer. Figure 4 illustrates the risk management process.

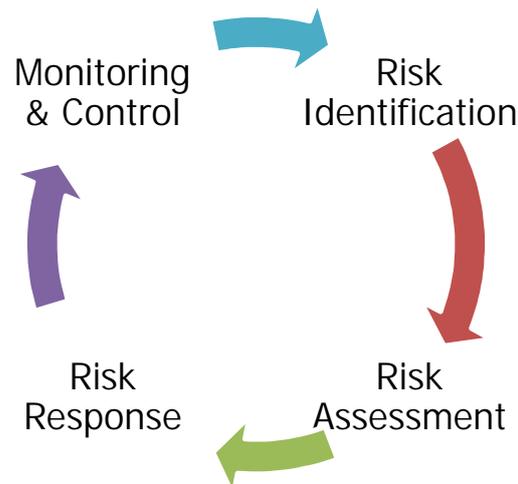


Figure 4: Risk Management Process

#### 4.6.1 Risk Identification

Construction risk will usually vary from project to project. This is because even though the process may be the same the characteristics of project such as the type of client, location (overseas or local), project team, procurement method and type of contract usually differ. The aim of risk identification is to identify the probable sources of risk to a project. The process of risk identification varies from organisation to organisation but common processes include site visits, brainstorming sessions with an assembled risk team, interviews of key project participants and a repository of risk data from previous projects (Tah & Carr, 2001:170). Wagner & Barkley (2010) recommended a Strength, Weakness, Opportunity and

Threat (SWOT) analysis from the perspective of the organisation's strategic business plan in order to identify threats and opportunities. Risk identification is the most important aspect of the risk management process because a risk that has not been identified cannot be planned for. When a risk is identified it is no longer a risk but it becomes a management problem (Flanagan and Norman 1993).

#### 4.6.2 Risk Assessment

Risk assessment aims to carefully evaluate potential risk to a project or the vulnerability of an organisation to identified threats. An assessment of the risk is carried either by qualitative or quantitative analysis but companies rarely split the two in practice (Wagner & T Barkley, 2010). In order to analyse risk qualitatively, the probability (P) of the risk occurring and the likely impact of the risk is required. Subjective judgement and objective analysis are some of the methods of determining risk probability, with objective analysis requiring some historical data before it can be employed. This is sometimes difficult to obtain in the construction industry as historical data are sometimes not available. The arithmetic product of the probability and impact of the risk gives a 'risk value', which is a measure of the magnitude of the risk. A band of 'risk values' constitutes a risk threshold which is usually low, medium or high risk. Qualitative methods also employ pre-determined criteria, checklists and expert judgement in assessment of risk.

The product of a qualitative analysis process is an outline risk register for the identified risks in line with the RBS. Important information that will be provided by the risk register are the probability of occurrence and the impact each risk may have on the project in terms of cost, time, quality etc. Two rankings are normally produced; a ranking of the project risk against each other and a ranking of the overall project risk against risk associated with other projects on the company's portfolio.

Quantitative risk analysis comes into play when a monetary value can be placed on a risk. Quantitative analysis employs statistical tools to determine the sensitivity of risk to various factors that influence the project, also to predict the probability of the project meeting time and cost objectives can be tested. Monte Carlo simulation is the most popular statistical tool employed for quantitative risk analysis.

Jannadi & Almishari (2003) argued that a sophisticated risk assessment process may not always be of importance to an organisation. They were of the opinion that the choice of a risk assessment method should be such that it is sufficiently reliable and accurate to guide management's decision making.

### 4.6.3 Risk Response

Once the risks to a project or an organisation's business have been identified and assessed, an appropriate cost effective risk response must be formulated to address them. What is desired is to reduce the potential negative impact of the risk and increase the level of control over the risk (Zou, Zhang & Wang, 2007). Risk can be responded to by three broad categories; by contract, by insurance and by retention (Zhi, 1995). Risk response strategy could entail any or a combination of the following:

- Risk retention
- Risk mitigation
- Risk transfer
- Risk avoidance

#### **Risk retention and mitigation**

The choice of which risk response measure to adopt is influenced by several factors. Victor O Schinnerer & Company Inc (2014b) suggested that the choice of risk retention or mitigation should be informed by a consideration of the compensation associated with the risk. The compensation offered should be commensurate with the value added plus the risk associated with the project.

The decision to retain and mitigate risk should also be informed by the limits of liability under the contract. Limits of liability beyond that imposed normally by law and accepting responsibilities for the performance of other professionals especially with regards to quality control are discouraged by professional bodies (Watermeyer, 2014). The use of standard form contracts and discussing the terms of contract with the professional indemnity insurance provider is usually a safe practice.

The financial capacity of the firm to bear the financial implications of the risk (legal cost, indemnity deductible and lost fees) if it does materialise, is also an important consideration when deciding to retain risk. Appropriate skill and experience required on the project, along with quality management procedures and procedures for communication and documentation should be in place to adequately mitigate project risks (Victor O Schinnerer & Company Inc, 2014b)

There appears to be a shift in the attitude of organisations in favour of risk mitigation as against the other risk response options (Tang, Qiang, Duffield, Young & Lu, 2007).

#### **Risk Transfer**

In the event that the consulting engineering organisation lacks the capacity to retain and mitigate risk associated with a project, risk transfer becomes an option. Two options generally available for the transfer of risk are either by contract or insurance (Victor O Schinnerer & Company Inc, 2014b).

A professional indemnity (PI) policy cover is usually a condition precedent for appointment of consulting engineers. It is advised by ECSA that consulting engineers hold PI policies to the limits (amount and duration) contained in the conditions of contract. Professional indemnity will usually provide the insured funding to cover the cost of investigation, defending and settling claims arising from the conduct of their duties. A history of claims can result in higher premiums for the professional concerned.

The consulting engineer may transfer risk contractually by sub-contracting and negotiating terms in the service agreement that limits his/her liability on the project.

### **Risk Avoidance**

On projects or in markets where risk far outweighs profit potential and where risk transfer is not feasible, risk avoidance maybe the sensible thing to do. Projects where the limits of liability are unfavourable to the consulting engineer or fees too low in comparison to the value of the service and associated risk should not be accepted. Another way of avoiding risk for consulting engineers will be to adopt only familiar and trusted methods of design; this approach however stifles innovation on the project.

Kometa, Olomolaie & Harris (1996) identified clients as major source of risk for consulting engineers. Avoiding projects that involve clients who have a reputation of being troublesome and litigious may be a sensible course of action; this is against the backdrop that a client organisation significantly larger than the consulting engineer's organisation can cause significant damage from a legal perspective.

#### **4.6.4 Risk Monitoring and Control**

It is important to keep track of identified risk, monitor the effectiveness of risk response strategies and control deviations from planned objectives. Time and cost variances are indicators of risk impacting on a project. Earned value analysis is a useful risk monitoring tool for measuring deviations from planned time and cost objectives on projects.

Communication is essential for successful risk monitoring and controls. Defined lines of communication and reporting mechanisms must be in place between the project and the organisation and also within the organisation, as this guarantees timely decision making at the appropriate levels within the organisation. Right conditions for openness and

transparency ensures that early warning is given when problems arise without the fear of blame sharing. This eliminates surprises and crisis situations on projects.

Regular audit of the risk management process to assess its effectiveness should be incorporated into the monitoring and control process so that lapses in the risk management practice can be identified and modified in order to improve the process.

#### **4.7 Chapter Summary**

In this chapter a review of literature has been conducted to identify risk characteristics of the consulting engineer. The literature review revealed that the consulting engineers' risks are encountered both at the project and organisational levels. Project risks were identified to be attributable to client factors, fast track nature of construction, unethical practices and low professional fees. Organisational risk was identified to revolve around factors that affect competitiveness (Skill shortage, innovation, Information Technology and corporate reputation). Organisational business risks peculiar to the South African business environment were also identified. Risk management practices were also discussed specific to the consulting engineer's practice.

The literature review has shown that project and organisational risks to the consulting engineer's practice are connected as failure to deal with one impact on the other. Failure to manage risk at the organisational level impacts on the engineer's performance on projects.

## 5.0 RESEARCH METHODOLOGY

### 5.1 Chapter Introduction

Information on project and organisational risks experienced by consulting engineers practicing in South Africa is scant. The review of literature carried out on the subject has mainly provided information from other countries on the risk exposure of consulting engineers and the implication of low professional fees on the performance of the consulting engineer and its consequence for the clients.

A questionnaire based survey was employed to obtain information from the perspective of consulting engineers practicing in South Africa on the impact low professional fees have on project and organisational risks identified from the review of literature and strategies they adopt for managing the impacts.

The information in this chapter is presented by first introducing the theory behind the research method adopted from first principles (Section 5.1 to 5.3) by way of a literature review, and then discussing how the chosen method was executed (Section 5.4 to 5.8).

### 5.2 Introduction of Research Method

The field of construction engineering and management witnesses a convergence of natural sciences and social sciences fields of study (Love, Holt & Li, 2002). Social sciences research usually involves human subjects whose perception of the subject being studied forms the basis for research results. Studies in the natural sciences are based on observable facts independent of human rationalisation and opinion.

Jerling (2009) observed that the nature of research in the field of construction management is such that hard scientific data and the perception of the industry participants (experienced professionals and managers) are both important. This viewpoint, with which this author concurs, creates a problem for researchers in the field of construction management; the problem is choosing an appropriate research method that provides scientific data to validate the observed perception of industry participants.

The use of multiple research methods for research in the field of construction management has therefore been advocated (Brannen, 2005; Love, Holt & Li, 2002; Wing, Raftery & Walker, 1998). This understanding informs the research method employed in this research. Qualitative and Quantitative research methods are both used in this research. The choice of

these methods is informed by their different strengths and weaknesses and both methods can be used together. The next sub-section will discuss these research methods.

### 5.3 Theory of Research Methodology

Different research methodologies are characterized by the way they attempt to answer the research question. The research question determines the measurement type, sampling technique, data-collection and data analysis method that the researcher would employ (Babbie, Mouton, Vorster & Prozesky, 2012).

Babbie et al identified 3 principles by which scientific research may be classified to include:

- Type of study - Empirical and non-empirical
- Source of data – Primary and secondary
- Type of data – numerical and textual data

Empirical research attempts to find answers to questions on “real life” problems such as:

- a) Exploratory questions
- b) Descriptive questions
- c) Causal questions
- d) Evaluative questions
- e) Predictive questions
- f) Historical questions

(Babbie, Mouton, Vorster & Prozesky, 2012)

Non-empirical research attempts to explain scientific concepts and theories, and answer the following questions:

- a) Meta-analytical questions
- b) Conceptual questions
- c) Theoretical questions
- d) Philosophical/normative questions.

(Babbie, Mouton, Vorster & Prozesky, 2012)

The distinction between primary and secondary data is that primary data are collected by the researcher using an appropriate data collection method, while secondary data are already existing data which the researcher may have to consult. Research data may be either numerical data (statistics and numbers) or could be textual data such as transcripts of interviews and documented text.

The research questions for this study (see section 1.5) are of an exploratory nature and inform the research method employed. Babbie et al (2012) identified some reasons for conducting exploratory research to include;

- a) Testing the feasibility of carrying out more extensive research
- b) Develop methods to be employed in conducting further research
- c) Determine the areas of priority for future research
- d) Develop new hypothesis about the phenomenon

Exploratory research may be conducted by any of the following methods:

- a) A review of relevant literature
- b) Conducting a survey of people who are knowledgeable and experienced in the field of the problem being studied
- c) By analysing “insight-simulating” examples

(Babbie, Mouton, Vorster & Prozesky, 2012)

### 5.3.1 Survey research

As has been highlighted, the survey research method is appropriate for exploratory studies. Exploratory surveys are used to obtain different perspectives from individuals in a ‘loosely structured manner’ to serve as the basis for developing a framework (concept and methods) for more detailed research on a subject (Pinsonneault & Kraemer, 1993). Survey research method is most suitable when:

- a) The research question seeks to find out ‘what is happening’, and “how and why is it happening”
- b) It is impossible or not desirable to control the variables of the research
- c) The object of study must be studied in its natural setting
- d) The phenomena occur in concurrent time or the recent past (cross-sectional and exploratory studies)

(Pinsonneault & Kraemer, 1993)

Common pitfalls in the application of survey research methods have been identified to include:

- a) The use of a single method design where a multiple methods are required
- b) Poorly articulated and inadequate sampling method
- c) Low response rate
- d) The linkages between respondents and units of analysis being weak

- e) The use of cross-sectional surveys where longitudinal surveys are required

(Pinsonneault & Kraemer, 1993)

When a survey is aimed at exploration and descriptive purposes hypotheses are not required and the use of simple descriptive statistics such as mean and median is sufficient (Pinsonneault & Kraemer, 1993).

A representative sample of the survey population is usually the focus of the survey. The survey on the sample can be carried out by the use of interviews or questionnaires. A questionnaire based survey is adopted for the research because it has been found to be appropriate for an exploratory study of this nature. Also the methodology for the application of questionnaire based surveys is generally understood as it is widely applied by researchers in the field of construction engineering and management.

### **5.3.2 Qualitative research method**

Qualitative research methods are exploratory in nature and aim to collect information and data in order to gain an understanding of a subject so that theories can be formed (Fellows & Liu, 2009:8). Qualitative research methods involve the collection and analysis of textual data and aim to answer research questions which cannot be answered using quantitative methods (Borrego, Douglas & Amelink, 2009:53). Qualitative research methods have been advocated as a research method that can bridge the gap between academic researchers, practitioners and policymakers because of its ability to provide a contextual description of data which makes it easily understood and relevant to practitioners (Sallee & Flood, 2012:137). Qualitative research usually heralds quantitative research.

### **5.3.3 Quantitative research method**

Borrego, Douglas & Amelink (2009) were of the opinion that the purpose of quantitative studies in engineering research is for findings to be projected in an objective process over a large population. This is achieved by collecting data from a survey administered to a sample of the entire population in order to be able to generalize and draw up inferences. Quantitative methods are employed to analyse the data from the qualitative research in order to be able to present quantifiable results for the research.

### **5.3.4 Triangulation**

There is an on-going dialogue within the engineering educational community on qualitative and quantitative research methods. The consensus, however has been that both methods are appropriate for engineering research, with each having its 'advantages and correctness

depending on the research question' (Borrego, Douglas & Amelink, 2009; Brannen, 2005; Love, Holt & Li, 2002).

Research has shown that practitioners and policymakers do not find products of academic research useful with regards to solving immediate problems because they tend to be too theoretical and are better suited for the university environment (Sallee & Flood, 2012:137). Brannen (2005) observed that policy makers and practitioners who make use of the products of academic research now demand that researchers disseminate the results of their research in lay language. Brannen (2005) cited (Bernstein, 2000) who observed that researchers today are required to communicate in 'dual speak'; the technical language of professionals in their field of study and in a generic general language that communicates with the users of their research. Brannen (2005) is of the opinion that this objective can be realised if there is a convergence between qualitative and quantitative research methods.

The use of multiple research methods (usually qualitative and quantitative research methods) simultaneously with the objective of offsetting the weakness of one method with the strength of the other is referred to as triangulation. Triangulation is achieved by collecting both qualitative and quantitative data concurrently in an attempt to answer the research problem by comparing data from both research methods (Borrego, Douglas & Amelink, 2009).

### **5.3.5 Research reliability, validity and bias**

The reliability of research refers to the likelihood that a particular technique used for the research will yield the same result when applied repeatedly to the same subject (Babbie, Mouton, Vorster & Prozesky, 2012). Reliability of a research technique is critical to ensure that the same results would be obtained if the research is repeated by a different researcher. The reliability of a research technique however does not guarantee accuracy and precision of the data collected. It is therefore the responsibility of the researcher to ensure that the technique employed yields accurate and precise data. Carefully choosing respondents who are relevant and knowledgeable about the research subject, and asking survey questions clearly are ways of ensuring reliability when conducting social research (Babbie, Mouton, Vorster & Prozesky, 2012).

The validity of a research method refers to the extent to which it is consistent in measuring the concept of the research which it sets out to measure. It is often defined as the extent to which an instrument measures that which it intends to measure (Anastasi, 1982). Babbie, Mouton, Vorster & Prozesky (2012) observed that to ensure validity of a research method,

the empirical measure of the data collection instrument employed must adequately reflect the range of meanings of the concept being studied.

Bias in research connotes prejudice which results in a deviation from the truth and in turn undermines the validity of a research (Grimes & Schulz, 2002). The relativists however are of the view that there are many truths but no truth is universal as versions of reality are based on ‘conceptual schemes’ employed by different cultures to define what exists in their world (Fellows & Liu, 2009). Bias in many cases cannot be removed but caution can be taken by the researcher. Bias is introduced knowingly into a research when the researcher examines a subject from a “particular viewpoint”, or unknowingly perhaps by asking leading questions (Fellows & Liu, 2009:71). Careful consideration is required when selecting the method of data collection to be employed in any research to remove as much bias as possible.

### 5.3.6 Research ethics

Research ethics refers to a set of moral principles that guides the conduct of a research (Fellows & Liu, 2009), the aim of which is to protect all parties involved in the research (researchers, participants and institutions) as well as the integrity of the research.

The Research Ethics Framework published by the Economic and Social Research Council in the UK (ESRC), stipulates six principles of ethics which should be addressed in every research. These principles include (ESRC, 2012):

- a) “Research should be designed, reviewed and undertaken to ensure integrity, quality and transparency
- b) Research staff and participants must normally be informed fully about the purpose, method and intended possible use of the research, what their participation in the research entails and what risks, if any, are involved
- c) The confidentiality of information supplied by research participants and the anonymity of respondents must be respected
- d) Research participants must take part voluntarily, free from any coercion
- e) Harm to research participants and researchers must be avoided in all instances
- f) The independence of research must be clear and all conflicts of interests or partiality must be explicit”

(ESRC, 2012)

Babbie, Mouton, Vorster & Prozesky (2012) observed that ethical issues especially in social research are “both important and ambiguous”, thus the need for ethical code of conducts to

be published by many professional bodies. Research within the University environment is subject to ethical clearance by ethics committees set up within the faculty in which the research is being conducted. Ethical clearance was obtained from the departmental ethical committee for this research.

### 5.3.7 Research instruments and data collection

The data collection instrument employed in a research is dependent on the research method. Qualitative and quantitative research methods often require different research instruments. Table 5 shows the different methods of data collection used in qualitative and quantitative research methods.

Table 5: Qualitative and quantitative data collection tools

Qualitative Data Collection	Quantitative Data Collection
Interviews (Structured, Semi-structured and Unstructured)	Questionnaires
Questionnaires surveys	Artefact/ Document collection
Opinion surveys	Measurable results from experiments
Participants observation	Quantitative data
Artefact/Document collection	

Switzer, Wisniewski, Belle, Dew & Schultz (1999) identified the following as important considerations that influence the choice of research instrument:

- a) Research goal
- b) Participants characteristics
- c) Historical context
- d) Generic measure vs specific measure
- e) Importance of comparing results with results from other research in the area of study
- f) Fees associated with using copyrighted established measure
- g) Feasibility of covering sample population
- h) Burden on potential respondents
- i) Reluctance of respondents to fill lengthy survey or interviews
- j) Cost of instrument administration modalities

(Switzer, Wisniewski, Belle, Dew & Schultz, 1999:399)

Mailed questionnaires have been found to be appropriate for use in collecting data in survey based research; particularly when factual data is required and individuals are the units of data collection (Pinsonneault & Kraemer, 1993). But mailed questionnaires have the disadvantage of not being effective when sensitive and complex data are required.

#### **5.4 Description of Methodology Applied in this Research**

Research in the field of Construction engineering and management occurs in a continuum between pure research and applied research; pure research are suitable for academic purposes, while applied research yields more towards industrial application of the outcomes of research (Kuo, 2012:16). There is therefore a need to strike a balance between academic correctness and communicating of research outcomes to industry practitioners in way that is relevant to them. This principle consideration informs the methodology adopted in this research.

A mixed research method that employs the triangulation of both qualitative and quantitative data is adopted in this research because of its suitability in addressing the questions this research seeks to answer. This research has previously been described as exploratory and mixed research method has been identified to be suitable for exploratory studies (Borrego, Douglas & Amelink, 2009).

Broadly speaking the following investigative techniques have been employed in obtaining data in this research:

- a) Literature Review
- b) Personal Interviews
- c) Questionnaires

The context in which each of these techniques was applied in this research will be discussed below as shown in Figure 5.



### 5.5.1 Objectives of questions

The questions were structured to obtain respondent's personal information and information about respondent's organisation for the purposes of classification and, identifying trends during analysis. Secondly, the questionnaire aimed to address the research objectives (see section 1.6) by investigating the following:

- a) The extent of the practice of discounting among consulting engineers
- b) The perceived risk faced by consulting engineers as a result of discounted fees
- c) The impact of discounted fees on project and organisational risk factors identified from literature

The nature of the questions was such that open and close ended questions were used to allow the researcher analyse the responses both qualitatively and quantitatively.

### 5.5.2 Technology employed for the design and distribution of questionnaire

A web based tool was used for the design and distribution of the survey questionnaire. Web based survey tools have become common in academic research because of their capability to serve as a single platform for design, electronic distribution of the questionnaire forms, and storage of response data in formats compactible with many computer data analysis programmes. The 'Google Form' web based tool available from Google was used. Google form was chosen because it allows the completion of the questionnaire 'in the cloud'; as respondents are not required to download the forms onto their personal computers or pre-install software programmes in order to access the questionnaire form. Invitation to participate in the survey was sent to respondents by email, the email contained a link which directed respondents to a webpage where the questionnaire form could be completed.

## 5.6 Questionnaire

A sample of the questionnaire and accompanying cover letter used to obtain data for this research is attached as Appendix B.

The target respondents for this research are top cadre employees of consulting engineering firms, for this reason the length of the questionnaire and ease of completion was given careful consideration so as not to lose their interest in the course of completing the questionnaire. The questionnaire was designed to enable respondents to complete all questions in 15 minutes. The questionnaire contained a total of 31 questions, of this number only three questions required descriptive answers, while the other questions were either multiple choice questions or required answers to be provided on a Likert type scale.

In compliance with ethical requirements, the covering letter introducing the questionnaire to respondents stated the nature and purpose of the research. The letter informed respondents that participation was voluntary and that personal and company information provided will be kept confidential as no individual or company will be identified in the dissertation document. This is in line with the ethical principle of informed consent. Details of the research were reviewed by the departmental research ethics committee to ensure that the research did not contain any risks that would expose respondents to harm.

The survey questionnaire was reviewed with a research group comprising of six people (four research students and two research supervisors) to check for logical sequence, brevity, clarity, ambiguity and duplication of the questions. The research group also checked for bias in the way the questions were phrased. The reviewed questionnaire was further sent to a small group of 3 industry respondents to check that the questionnaire could be completed within the 15 minutes anticipated.

The questionnaire is divided into 3 parts; personal information (part1), organisation's discounting practice (part 2) and risk factors (part 3). An overview of these parts will be discussed below.

### **5.6.1 Part 1 – Personal information**

In this section, questions were asked about the number of staff at the firm, annual turnover, location and main business area of respondent's organisation as well as respondent's position in the organisation and years of experience. Identification questions such as name of respondent and name of organisation were made optional.

The objectives of these questions include categorisation of firms, identification of trends associated with organisations with similar characteristics, identifying respondents from the same organisation; and determining the level of experience and participation of respondents in the organisation's decision making.

### **5.6.2 Part 2 – Organisation's discounting practice**

This section aims to obtain information about the discounting practices of consulting engineering firms. Respondents were asked questions about their core clients, common method of remuneration for jobs executed; whether they offered discounts, amount of discount offered as a percentage of ECSA fee scale and reason for offering discount. At this point organisations that do not offer discount on fees were withdrawn from further participation in the survey.

The objective of this section was to understand the practice of discounting among consulting engineering firms and factors that influence the practice.

### **5.6.3 Part 3- Risk factors**

This section contained questions about project and organisation risk peculiar to consulting engineering firms. Respondents were asked to rate the significance of discounted fees on identified project and organisational risk in terms of frequency of occurrence and impact. A Likert type scale was used. Respondents were asked to rate the frequency at which the identified project risks occurred on projects with low fees and the magnitude of the impact. Also respondents were asked to rate the impact of low fees on identified organisational risks.

Questions were asked to identify areas of professional services that are likely to be compromised on when professional fees are low and risk management practices employed to mitigate the impact of low fees.

## **5.7 Survey Sample and Selection of Respondents**

A purposive sampling technique was used in the selection of the survey sample for this research. Purposive sampling is a non-probabilistic sampling technique in which the choice of respondent depends on the qualities possessed by informant (Tongco, 2007). The quality of data obtained from the chosen sample is therefore dependent on the reliability, competence and level of experience of the informants on the subject matter. The purposive sampling technique has been identified to be suitable for quantitative and qualitative research methods and it is most effective when one needs to study a cultural group with knowledgeable experts within (Tongco, 2007). Emuze & Smallwood (2013:21) employed a purposive sampling technique in their study of project performance of South African public clients; they were of the opinion that the purposive sampling technique can be used whenever the characteristics of the population cannot be precisely determined and in such instances the research sample can be made up of informants who the researcher believes to be a representative of the population under investigation.

The target population of respondents for this research were ECSA registered civil and structural professional engineers practicing in South Africa. The focus was on practicing engineers with considerable experience to provide insight on the issues being investigated and not a large statistical sample. Attempts were made to distribute the questionnaire through CESA and SAICE internal communication channels but this was unsuccessful as the researcher did not get the required cooperation. Respondents for the survey were however, selected from two sources.

The first was a working group of structural engineers who in 2013 drafted a document to push for a review of the published fee scale for structural engineering services on building projects under the ECSA Guideline for defining the Scope of Service and determining Professional fees scales. The document highlighted the consistent decrease in fees for structural engineering services when compared to other engineering disciplines and the impact on the profession. Eight members of that working group were identified as respondents for this research.

The second source was a database of civil and structural engineers who had participated in Continuous Professional Development (CPD) courses at the civil engineering department of the Stellenbosch University. Participants at these courses are middle level and senior level employees at both construction and consulting engineering firms. This database was consulted to identify suitably experienced practicing consulting engineers. A total of 61 consulting engineers were considered suitable for selection as respondents based on their years of experience, area of competence and position within the organisation.

## **5.8 Questionnaire Distribution**

An invitation to participate in the survey was sent to respondents by email. The email contained a cover letter and the link to the questionnaire webpage. The cover letter stated the nature and objectives of the research and also addressed ethical requirements such as stating that information provided will be kept confidential and participation was voluntary.

The questionnaire was distributed over a two month period (June and July), partly due to the fact that most senior employees at some firms were away for the winter holiday in July.

The google form web tool deployed for carrying out the survey had the capability to store all response data. The data was subsequently downloaded in a Microsoft excel spread sheet format for analysis.

## **5.9 Chapter Summary**

This chapter has discussed theory of methodology relevant to research in the field of Construction Engineering and Management. The method of research applied to this study was discussed. The choice of research method is informed by the research question. The nature of this study is exploratory and a questionnaire based survey has been found appropriate to obtain data. The research instrument used, method of distribution of the instrument, selection of respondents were also described.

The next chapters will present an analysis of the responses received and synthesis of the findings.

# CHAPTER 6 ANALYSIS AND SYNTHESIS OF SURVEY FINDINGS

## 6.1 Chapter Introduction

Having discussed the methodology for the research including the questionnaire based survey conducted this chapter presents the research findings through an analysis and synthesis of research data obtained from the survey.

The findings will be presented in the following order:

1. Respondent's personal and organisational information
2. Organisational discounting practices
3. Impact of low fees on identified project and organisation risk
4. Risk mitigation strategy

A discussion of the survey findings will be carried out after the findings have been presented.

## 6.2 Method of Data Analysis Employed

Analysis of data received from the questionnaire survey will be carried out using frequency analysis and ranking. Data will be presented using graphical tools such as tables and charts.

Most questions required answers to be provided by means of a Likert type scale; three variants of the scale were used. The first was aimed at determining the frequency of occurrence, the second was to measure the extent to which respondents agreed with certain observations and the third aimed at measuring impact. The method of combination and conversion of these scales for the purpose of qualitative and quantitative analysis is presented in Table 6, Table 7 and Table 8.

Table 6: Scale conversion - Method 1

Frequency Scale	Conversion/Interpretation
Never	Not Common
Seldom	Not Common
Often	Common
Frequently	Common

Table 7: Scale conversion - Method 2

Agreement Scale	Conversion/Interpretation
Strongly disagree	No
Disagree	No
Neither agree nor disagree	Undecided
Agree	Yes
Strongly agree	Yes

Table 6 and Table 7 show the method of combination and interpretation of the scales for the purposes of qualitative analysis. Table 8 shows the weight assigned to the various response options for the purpose of quantitative (numerical) analysis in order to be able to carry out ranking of risk factors being investigated.

Table 8: Scale conversion - Method 3

Frequency & Impact Scale		Weighting	
		Non-linear scale	Linear scale
Frequency	Frequently	1.0	1.0
	Often	0.8	0.66
	Seldom	0.3	0.33
	Never	0	0
Severity	Severe	1.0	1.0
	Significant	0.8	0.66
	Minimal	0.3	0.33
	No impact	0	0

### 6.3 Survey Responses Received

The methodology for sampling and selecting respondents for this research was extensively discussed in chapter 5 (see section 5.7). Respondents were selected from among ECSA registered civil and structural engineers practicing in South Africa. The focus was on practicing engineers with relevant experience to provide insight on the issues being investigated and not on a large statistical sample.

A total of 61 respondents identified to be suitable were invited to participate in the questionnaire survey. Of this number, 23 responses were received representing a 38% response rate.

Three respondents formally declined to participate in the survey by way of a return mail; two respondents stated that they did not offer discounts and as such could not participate in the survey.

The information provided by the 23 respondents will be further analysed in subsequent sections of this chapter.

### 6.4 Analysis and Synthesis of Personal Information

The majority of the responses received came from consulting engineers whose business offices are located in Gauteng and Western Cape provinces. Responses were also received from consulting engineers whose business offices were located in Kwazulu-Natal, Mpumalanga and North-West provinces. One respondent works for an international

consulting firm operating in South Africa. Table 9 shows the breakdown of the business location of respondents.

The business location of respondents was not known to the researcher and was not a criterion in the selection of respondents. The distribution of business offices of respondents suggests that certain provinces have a greater concentration of consulting engineering businesses.

Table 9: Breakdown of respondent's business location

Respondent's Location	Business	Number of Respondents	Percentage of Respondents
Gauteng		9	39.1%
International		1	4.4%
Kwazulu-Natal		2	8.7%
Mpumalanga		1	4.4%
North-West		1	4.4%
Western Cape		9	39.1%

The market segments in which the respondents are active include buildings and structures, civil works and project management. Respondents were most active in the buildings and structures market as 65% of respondents considered it their main business area. This is followed by the civil works market where 17% of respondents were active; fourteen percent of respondents operated in both the structures and civil works markets. One respondent was involved mainly in the project management market. Table 10 and Figure 6 show the distribution of respondents in the various markets.

Table 10: Breakdown of respondent's main business areas

Respondent's Business Area	Number of respondents	Percentage of respondents
Structures and Buildings	15	65.2%
Civil Works	4	17.4%
Project Management	1	4.4%
Multiple (Structures and Civil)	3	13.0%

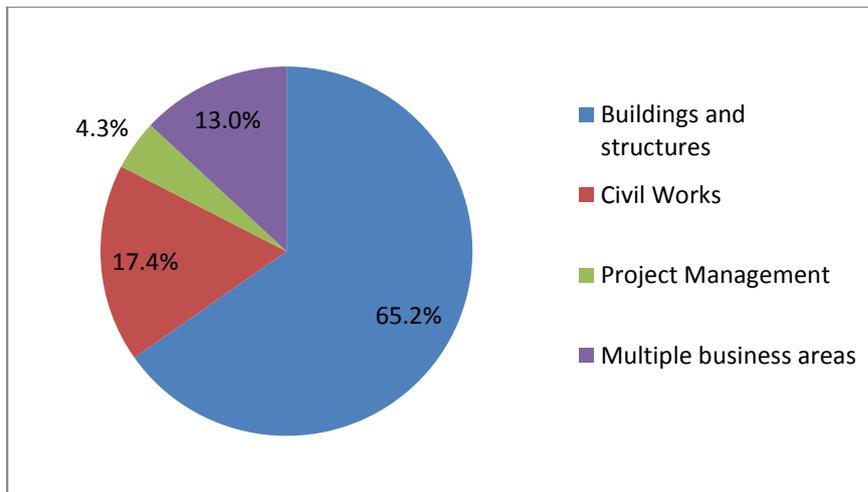


Figure 6: Distribution of respondents by main business area

The size of respondents' organisations was assessed based on the number of employees and financial turnover. About 55% of respondents represented firms that had less than 100 employees, while 45% of respondents were employed by firms with over a hundred employees. Table 11 and Figure 7 present the distribution of respondents' organisation by number of employees.

Table 11: Organisational size by number of employees

Number of employees	Number of respondents	Percentage of respondents
less 10	2	8.7%
10 to 49	7	30.4%
50 to 99	4	17.4%
100 to 499	4	17.4%
above 500	6	26.0%

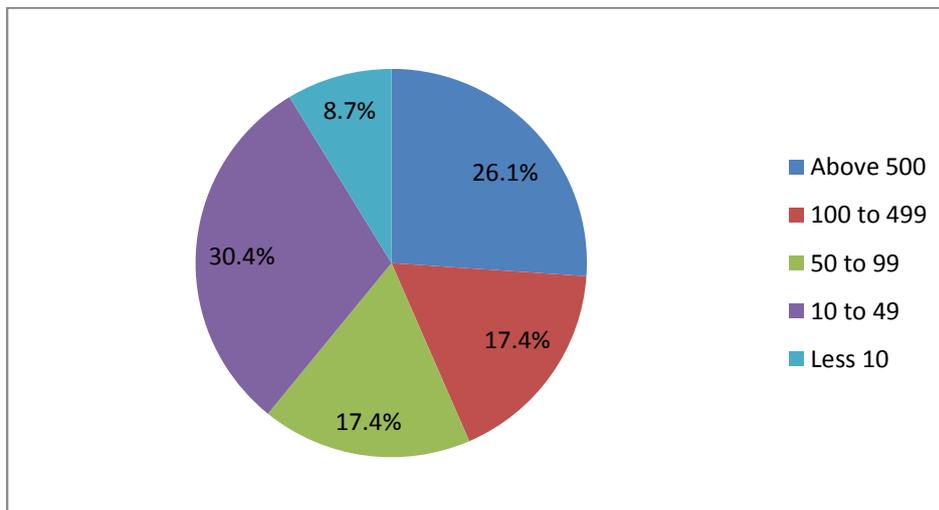


Figure 7: Distribution of respondents' organisations by number of employees

The majority of the firms have an average annual turnover of between ZAR10 million and ZAR100million and included firms active in the building and structures markets, civil works and project management markets. The majority of firms that recorded turnovers above ZAR250 million were active across the civil works and, building and structures markets. The distribution of respondent organisations by annual financial turnover is presented in Table 12 and Figure 8.

Table 12: Annual financial turnover of respondents' organisations

Annual Turnover	Number of firms	Percentage of firms
Below ZAR10 million	2	8.7%
ZAR10million to ZAR100 million	12	52.2%
ZAR100million to ZAR250 million	3	13.0%
Above ZAR250 million	6	26.1%

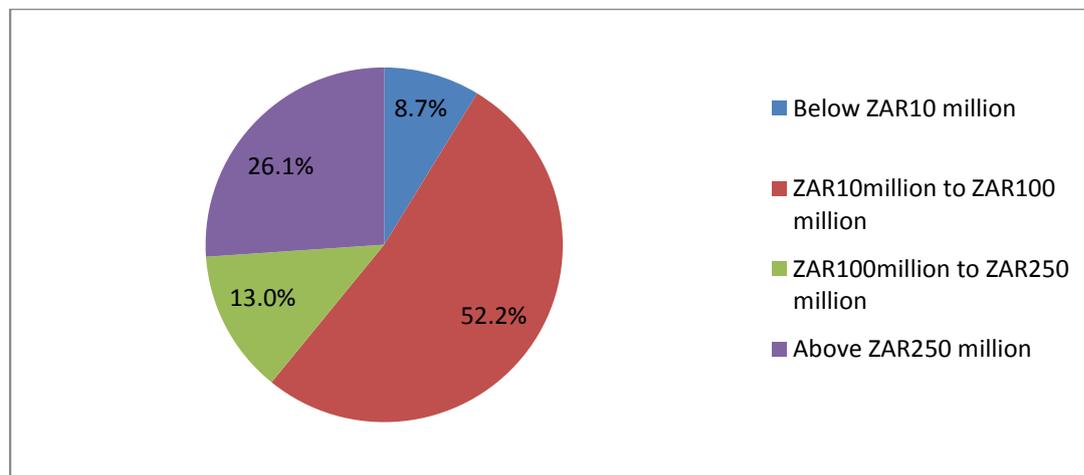


Figure 8: Distribution of respondents' organisations by annual turnover

The analysis of the data received on the size of firms represented by respondents in this survey shows that small, medium and large size firms were all represented. The information obtained from this survey can therefore be assumed to reflect the opinion of the industry irrespective of organisational size.

An analysis of the positions occupied by respondents in their organisations shows that respondents were predominantly top management staff at their organisations. Thirty five percent of respondents were either principal consultants or associates, an equal proportion of respondents were directors or managers (39%) and 26% of respondents were design engineers. Table 13 and Figure 9 show the current position occupied by respondents in their organisations.

Table 13: Breakdown of respondents by position in company

Respondent's current position in company	Number of respondents	Percentage of respondents
Principal/Associate	8	34.8%
Director/Manager	9	39.1%
Design Engineer	6	26.1%

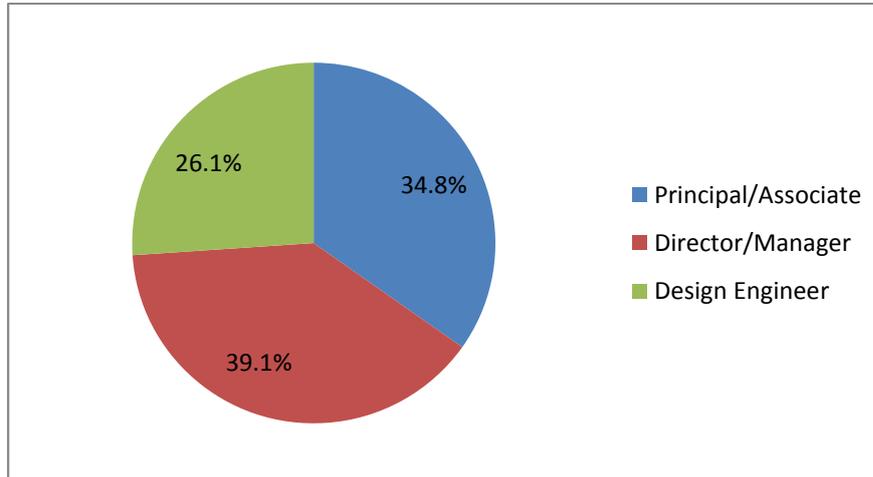


Figure 9: Distribution of respondents by position in company

The level of experience of respondents was assessed both by their years of experience in the industry and the number of years they had spent with their current employer. Sixty one percent of respondents had over 15 years of experience in the industry, 30% of respondents had 5 to 15 years of experience in the industry, while 9% of respondents had less than 5 years of experience in the industry. Figure 10 illustrates the distribution of respondents according to their years of experience in the industry.

The majority of the respondents (44%) had spent over 15 years with their current firm, 35% had spent between 5 and 15 years, while 17% of respondents had spent less than 5 years with the current employer. Table 14 shows a breakdown of the experience of respondents by years of experience in the industry and the number of years spent with current employer.

It is observed that the years of experience in the industry closely compares with the number of years most respondents had been with their current employer. This is indicative of the level of staff mobility within respondents' organisations sampled.

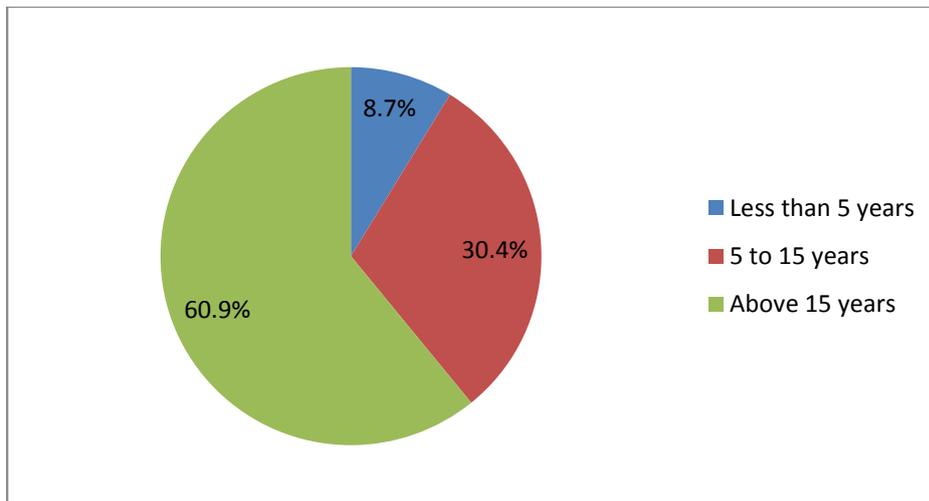


Figure 10: Distribution of respondents by years of experience in the industry

Table 14: Experience of respondents

Years of Experience	Total years of experience		Years with current employer	
	Count	Percentage	Count	Percentage
Less than 5 years	2	8.7%	4	17.4%
5 to 15 years	7	30.4%	8	34.8%
Above 15 years	14	60.9%	11	43.5%

In summary, an analysis of the personal information shows that the majority of respondents were active in the structures and building market, followed by the civil works market and represented small, medium and large size consulting engineering firms. The personal information also defines majority of respondents to be involved in decision making and management roles within their organisations and as such their response can be taken to be indicative of their organisations position on the subject being investigated. The majority of respondents have practiced for over 15 years and have spent an almost equal number of years with their current employer. This is indicative of the level of their industry experience and they can be considered knowledgeable about the industry and the subject being investigated.

## 6.5 Discounting Practices in Respondents' Organisations

This section presents the information obtained from questions asked about the discounting practices of respondents' organisations. Information on the type of client, methods of remuneration, level of discounts offered and reasons for offering discounts are presented.

### 6.5.1 Type of clients

Respondents were asked the type of clients that accounted for the bulk of the fee earning. Table 15 and Figure 11 present information on the client profile of respondents. The majority

of the respondents (52%) have a client base where neither public nor private clients accounted for up to 90% of their annual fee earnings. Private clients accounted for up to 90% of fees earned by 39% of respondents. While only 9% of respondents had public clients accounting for up to 90% of their fee earnings.

Table 15: Type of clients accounting for respondents' fee earnings

Type of client	Number of respondents	Percentage of respondents
Public client (accounting for 90% of work)	2	8.7%
Private client (accounting for 90% of work)	9	39.1%
Both Public and private clients	12	52.2%

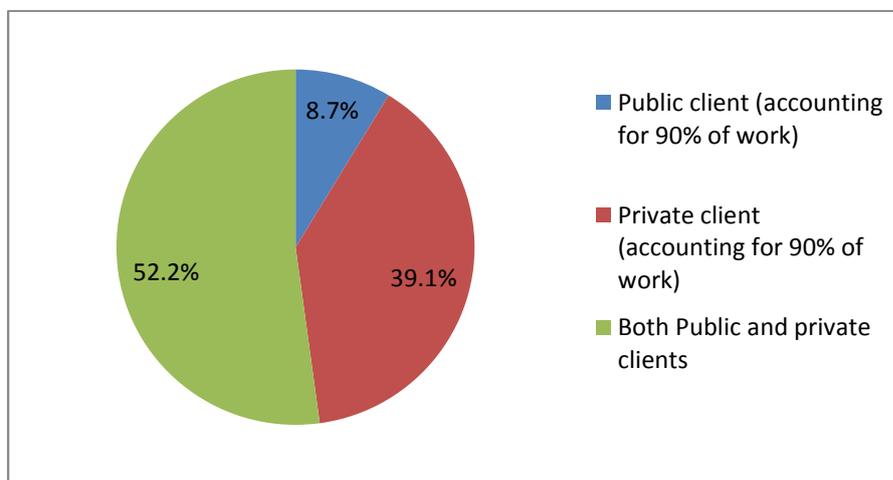


Figure 11: Distribution of respondents' by client type

It is observed that firms with less than 10 employees all had private clients accounting for up to 90% of their fee earnings. The two firms that had public clients accounting for up to 90% of their fee earning had similar profiles in terms of number of employees (50 to 99) and annual turnover (Between ZAR10 million and ZAR100 million). Figure 12 shows the distribution of respondent organisation by staff strength and the type of client that account for over 90% of their fee income. Figure 13 shows the distribution of respondent organisation by annual turnover and the type of client that account for over 90% of their fee earned. The majority of the firms with annual turnover above ZAR 250 serviced both public and private clients.

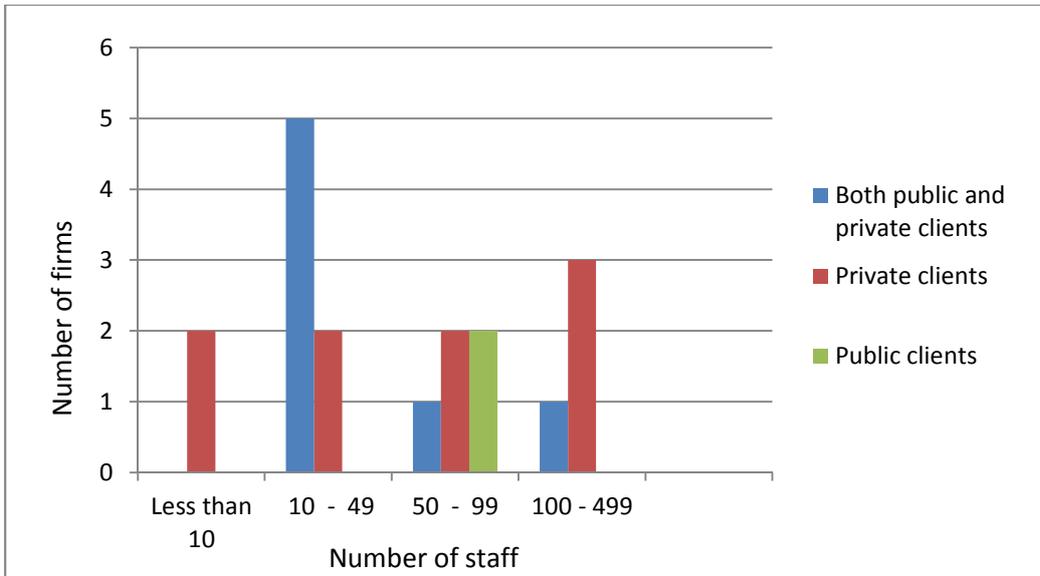


Figure 12: Staff strength and type of client served

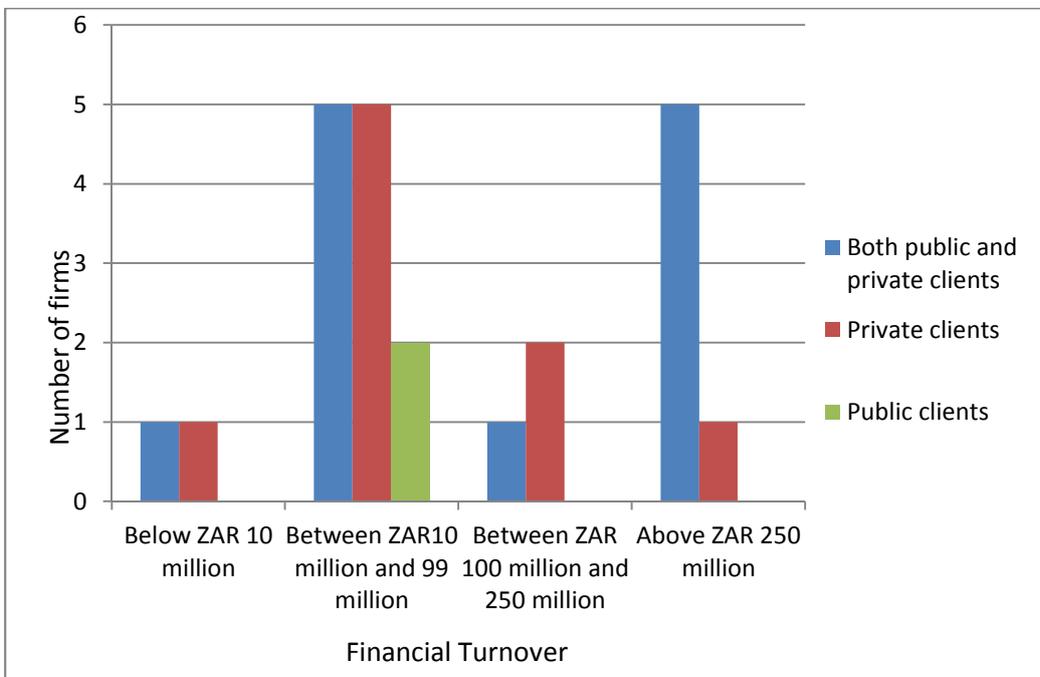


Figure 13: Annual Turnover and type of client served

### 6.5.2 Method of remuneration

The methods of remuneration common to respondent's organisation were tested using Likert type scale of 'never', 'seldom', 'often' and 'frequently' to obtain information on how common each of the remuneration methods are used in the industry. The responses received were analysed using 'method 1' (see section 6.2, table 1). Never and seldom responses were combined and interpreted to mean that the particular remuneration method was uncommon with the respondent's organisation, while 'often' and 'frequently' responses were combined and interpreted to mean that the remuneration method was commonly used. Table 16 presents the data received from respondents.

Table 16: Methods of remuneration

Method of Remuneration	Commonly Used		Not Commonly Used	
	Count	Percentage	Count	Percentage
Percentage fees based on the cost of the works	17	77.3%	5	22.7%
Time based fees	15	68.2%	7	31.8%
Reimbursable expenses	12	54.6%	10	45.5%
Fixed sum	10	45.5%	12	54.6%
Value based fees	5	22.7%	17	77.3%

Percentage fees based on the cost of the works is found to be the most common method of remuneration among respondents' organisations. This is followed by time based fees, reimbursable expenses and fixed sum. Value based fees is the least commonly used methods of remuneration.

### 6.5.3 Prevalence of discounting

The prevalence of discounted fees benchmarked against ECSA recommended fees scale was tested. Respondents were asked if their organisations offered discounts on ECSA recommended fees scale during tender or negotiation with clients; Figure 14 presents the responses of the 23 respondents considered. The responses suggest that the practice of discounting is quite prevalent as 83% of respondents either frequently or often offer discounts on fees during tender or during negotiations with clients.

Analysis of an open ended question revealed a response that is relevant to the issue of prevalence of discounting practices. It appears that some engineers even though they do not explicitly offer discounts, they however reduced their fees. One respondent had this opinion.

*"I run a cost efficient small practice. I don't offer discounts, I just charge less than I should because the profession has historically been abused by the client body. In my opinion this situation evolved because we the professionals allowed it."*

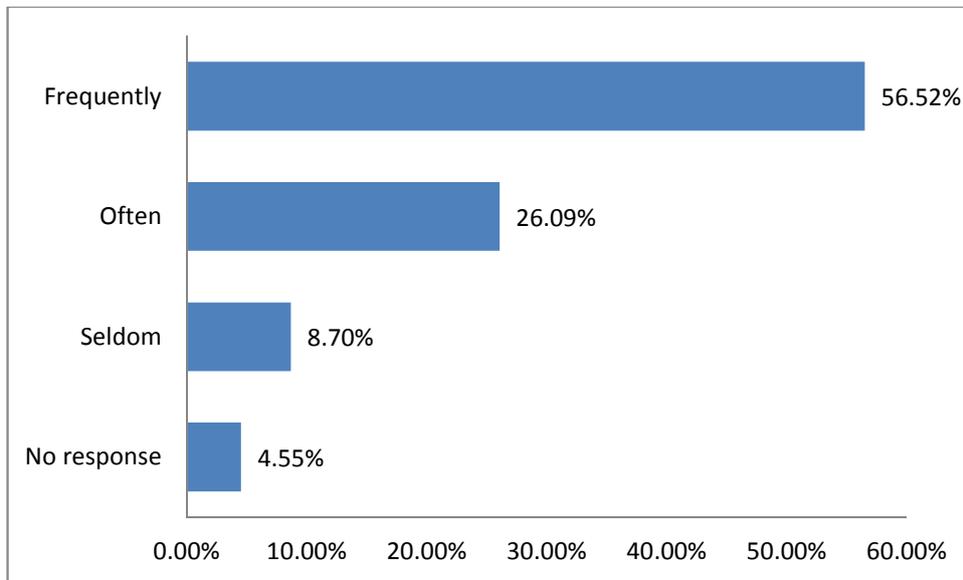


Figure 14: Prevalence of discounting

#### 6.5.4 Reasons for offering discounts on fees

The primary reason why discounts are offered in the industry was tested by way of a structured question. Respondents provided their answers on a Likert type scale; the responses were analysed using method 2 (see section 6.2, table 2). Answers under the options of strongly disagree and disagree were interpreted as a ‘No’. Neither agree nor disagree was interpreted to mean ‘Undecided’, while answers under agree and strongly agree were interpreted to mean a ‘Yes’. Table 17 presents the responses of respondent.

Table 17: Reason for offering discounts

Primary Reasons	YES		NO		UNDECIDED	
	Count	Percentage	Count	Percentage	Count	Percentage
Secure new clients (client relations)	18	81.8%	0	0%	4	18.2%
Test a new market	7	31.8%	1	4.6%	14	63.6%
To keep staff busy and cover running cost	12	54.6%	3	13.6%	7	31.8%
Forced by prevailing market conditions	21	90.9%	1	4.6%	1	4.6%

Analysis of the responses suggests that prevailing market conditions and clients’ demands for discounts were the main reasons why consulting engineers offer discounts on fees.

This trend is further supported by responses to an open ended question which allowed respondents to provide additional information on the reason they offer discounts. A total of nine respondents completed the open ended questions. Fifty six percent of the comments

were connected to pressure from client to offer discounts; three respondents identified non-regulation of the different civil engineering discipline as worsening the impact of competitive tendering on the pricing of consulting engineering services. Appendix C presents a summary of these responses, which were analysed using key words to classify them.

Some responses are however instructive and are quoted below. Responses that point to client factors include:

*“I don’t like the concept of offering discounts, but Clients often insist on discounted fees.”*

*“For Private Clients, discounts are expected. Many private clients even expect free work (work done at risk) during the feasibility stage with a promise to appoint the consultant to the project should it go ahead.”*

*“In some markets the fees are simply stated by the client / project manager / QS, and if you want the job you must accept a certain percentage fee. This is common on commercial projects such as shopping centres.”*

Some other respondents argue that the market is unregulated and as such the discounting practices is influenced by prevailing market conditions. One respondent explained it thus:

*Especially in the private sector the industry is largely unregulated in terms of who can practice as a structural engineer (with specific reference to building structures). There are a vast number of people practicing as structural engineers without the necessary credentials (being a PrEng means nothing as anyone with this title can practice in any discipline without any questions being asked - though in theory this is not allowed through so-called self-regulation). The only time an individual’s credentials are queried is when things go wrong. A properly qualified and certified structural engineer will not work at large discounts - because he understands the risks involved and the effort required to mitigate the risk. The ignorant few offering practicing as structural engineers without the right credentials are blissfully unaware of the risks that need to be addressed and the time and effort required to do so. The problem with discounting I believe is by far the worst in building structures and ultimately it boils down to insufficient regulation.*

### **6.5.5 Amount of discounts offered**

The amount of discount offered by respondents’ organisations was investigated. Respondents were asked the average and maximum amounts of discounts they offered as a percentage of their fees. Their responses are presented as Figure 15 and Figure 16.

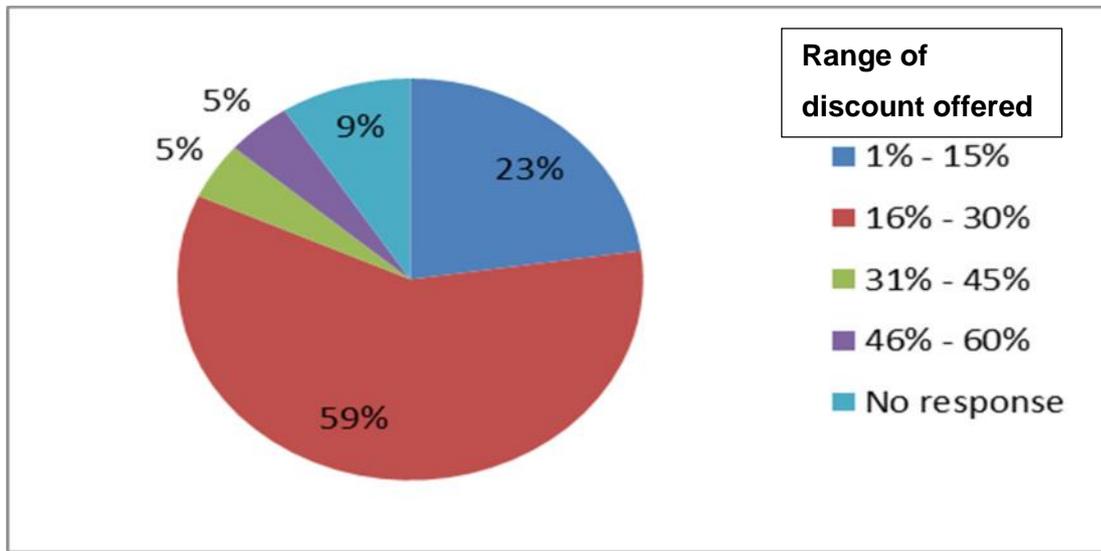


Figure 15: Average percentage of discount offered on fees

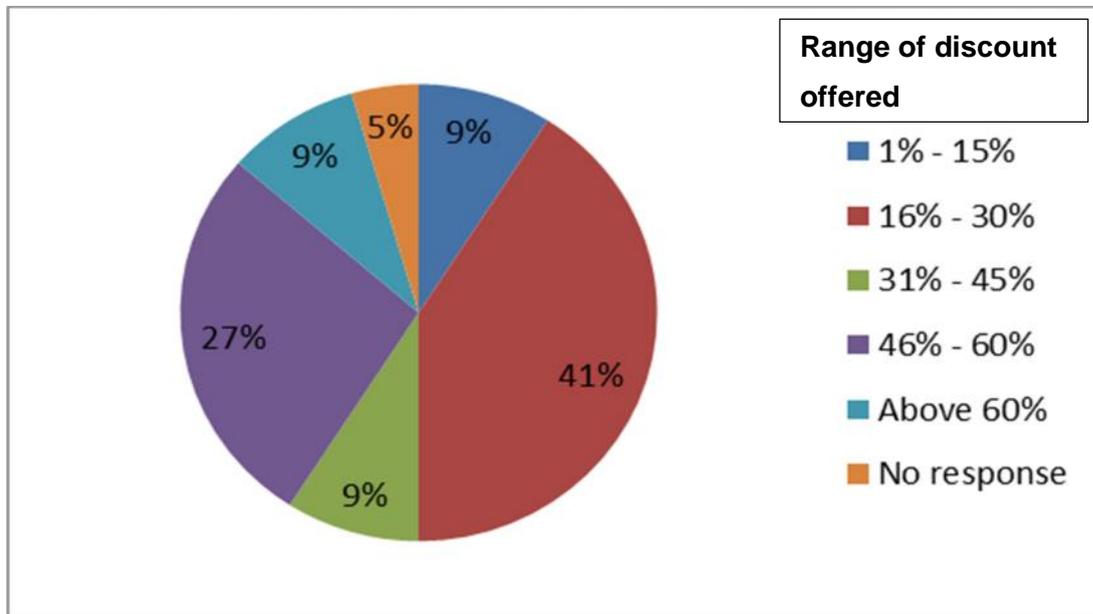


Figure 16: Maximum percentage of discount offered on fees

Analysis of the data shows that the majority of the respondents offered an average discount of between 16% and 30% of the approved ECSA fees scale. A substantial proportion of respondents reported that they have offered discounts of between 46% and 60% of the ECSA approved fees scale. No trend was observed in the amount of discount offered by small, medium and large firms as no range of discount was particular to any category of firm irrespective of size, the market segment they operated or the type of client they serviced.

### 6.5.6 Price based competition

Respondents were asked if they considered that their organisation engaged in price based competition. Sixty eight percent of respondents agreed that their organisation engaged in

price based competition, 14% disagreed and 18% of respondents were undecided. These responses are depicted in Figure 17.

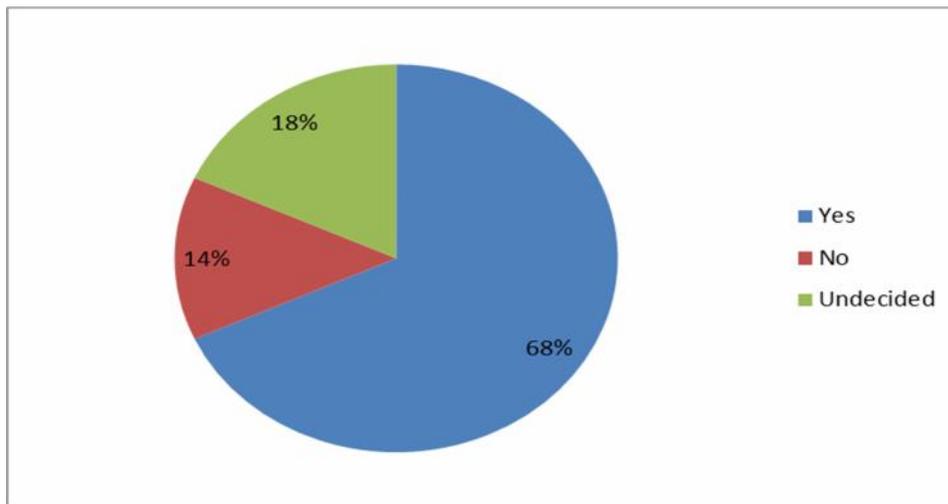


Figure 17: Response to question on price based competition

## 6.6 Analysis of Impact of Discounted Fees on Risks to the Consulting Engineer's Practice

In chapter 4, project specific and organisational business risk factors that are particular to the consulting engineer's practice were identified. These risk factors were further grouped together into risk groups. These risks factors and groups were tested to obtain information on the perspective of South African consulting engineers on how discounts they offer on professional fees influence these risks. The findings of this section of the questionnaire are presented in following sections.

### 6.6.1 Analysis of impact of discounted fees on project specific risk

In section 4.3, project specific risks particular to consulting engineers was discussed and project risks influenced by low professional fees were identified. The influence of low professional fees on these project risks was tested by in this questionnaire survey. The data gathered was analysed with a view to obtain information on which risk groups had the most impact on the consulting engineer's organisation and also to rank these risk groups in the order in which they are perceived to be influenced by low professional fees.

Respondents were asked which of the project risks had the greatest, second and third greatest impact on their organisations. Table 18 presents the data obtained. Analysis of the data shows that financial loss on the project was identified by 43% of respondents to have the greatest impact on the organisation. Inadequate supervision and quality control issues were identified by 39% of respondents to have the second greatest impact. Inability to

perform value engineering was identified to have the third greatest impact by 30% of respondents.

Table 18: Project risk groups and order of perceived impact on organisation

Project Risk Group	Greatest Impact	Second Greatest Impact	Third Greatest Impact
Poor Quality of design and documentation	21.7%	13.0%	13.0%
Inadequate supervision and quality control	8.7%	39.1%	13.0%
Inability to perform value engineering	8.7%	17.4%	30.4%
Rework of design and drawings	4.4%	13.0%	21.7%
Legal liabilities (claims, disputes and litigation)	13.0%	4.4%	8.7%
Unethical practices	0.0%	4.4%	0.0%
Professional indemnity cover	0.0%	4.4%	0.0%
Financial loss on the project	43.5%	4.4%	13.0%

The influence of low professional fees on these project risks was assessed quantitatively. The objective was to rank the various project risks in an order of perceived importance by obtaining risk values for each project risk considered. In order to achieve this, the various response options were weighted. As the weighting could affect the result, two weighting alternatives were used in the ranking exercise. A non-linear weighting scale was introduced to accentuate the significance of frequently occurring risk with high impact; this approach is consistent with the methodology employed by Jerling (2009) in ranking the risk generated by employers for contractors.

The risk value was arrived at by considering the value of a particular risk to be:

$$\text{Risk Value} = \text{Risk Frequency} \times \text{Risk Severity}$$

To compare the items, risk values were obtained by multiplying the number of responses received for the various frequency and severity types by their weighted score making the formula for the risk item relative value as follows

$$\text{Risk Value} = \left[ \left( N_{\text{responses for frequency}} \times \text{Frequency Weight} \right) \times \left( N_{\text{responses for severity}} \times \text{Severity weight} \right) \right]$$

Table 19 shows the Frequency and Severity weighted values attached to the various response options. While Table D1 (See Appendix D) and Table E1 (see Appendix E) shows the counts for frequency and severity responses.

Table 19: Weighting for response options

Frequency & Impact Scale		Weighting	
		Non-Linear	Linear
Frequency	Frequently	1.0	1.0
	Often	0.8	0.66
	Seldom	0.3	0.33
	Never	0	0
Severity	Severe	1.0	1.0
	Significant	0.8	0.66
	Minimal	0.3	0.33
	No impact	0	0

Project risks with the highest risk values are considered to be most influenced by low professional fees and are ranked above project risks with lower risk values. The ranking of the project risks based on the risk values obtained from both weighting scales is presented in Table 20. Financial loss on the project, inability to perform value engineering, inadequate supervision and quality control issues, rework of design and drawings and poor quality of design and documentation are identified as the top 5 project risk groups impacted by low professional fees.

Table 20: Ranking of project risk groups

Risk Description (Linear Scale)	Rank		Risk Description (Non-linear Scale)
Financial loss on the project	1	1	Financial loss on the project
Inability to perform value engineering	2	2	Inability to perform value engineering
Inadequate site supervision and quality control	3	3	Inadequate supervision and quality control
Rework of design and drawings	4	4	Rework of design and drawings
Poor Quality of design and documentation	5	5	Poor Quality of design and documentation
Legal liabilities (claims, disputes and litigation)	6	6	Legal liabilities (claims, disputes and litigation)
Professional indemnity cover	7	7	Professional indemnity cover
Unethical practices	8	8	Unethical practices

The results presented in Table 20 shows that there is a correlation between the two weighting methods used. Even though both methods presented different risk values, the ranking of the risks groups are similar. Appendix D presents a detailed calculation of the risk values.

### 6.6.2 Impact of discounted fees on organisational business risks

Organisational business risks particular to the consulting engineer's practice were discussed in section 4.4 and 4.5. Seven organisational risks were identified to be influenced by low professional fees. These seven organisational business risks identified were tested in the questionnaire survey.

Organisational business risk was defined as threats to the business and operational activities of an organisation; it can be assumed that they are always present in the organisation's day to day running. The managers of the business therefore need to constantly steer the organisation away from these threats. In this light, testing for frequency of occurrence was not feasible; respondents were therefore only asked to assess the impact of discounted professional fees on the identified organisational risk factors.

The impact of low fees on these identified risk factors was tested quantitatively so that they could be ranked in an order indicative of the extent to which they are impacted by low fees. The linear and non-linear weighting scales previously employed section in 6.6.1 and shown in The risk value was arrived at by considering the value of a particular risk to be:

Risk Value = Risk Frequency x Risk Severity

To compare the items, risk values were obtained by multiplying the number of responses received for the various frequency and severity types by their weighted score making the formula for the risk item relative value as follows

Risk Value = [ (N<sub>responses for frequency</sub> X Frequency Weight) X (N<sub>responses for severity</sub> X Severity weight)]

**Table 19 shows the Frequency and Severity** weighted values attached to the various response options. While Table D1 (See Appendix D) and Table E1 (see Appendix E) shows the counts for frequency and severity responses.

Table 19 was also applied. A risk value was obtained for each risk factor using the expression:

Risk Value = N<sub>responses for severity</sub> X Severity Weight

Table 21 presents the result of the ranking process; Human resource issues (training/mentoring of young engineers and attracting experienced engineers) appear to be impacted most by discounted fees, this is followed by business sustainability and technical innovation within the organisation. Staff morale, relationship with clients and the organisation’s corporate reputation were ranked the least impacted organisational risks.

Table 21: Ranking of Organisational Business Risks

Risk Description (Linear Scale)	Rank		Risk Description (Non-linear scale)
Ability to train and mentor aspirant/graduate engineers	1	1	Ability to train and mentor aspirant/graduate engineers
Ability of organisation to attract and retain quality/experienced staff	2	2	Ability of organisation to attract and retain quality/experienced staff
Business sustainability	3	3	Business sustainability
Ability of organisation to be innovative in design	4	4	Ability of organisation to be innovative in design
Motivation of staff	5	5	Motivation of staff
Relationship with clients	6	6	Relationship with clients
Reputation of your organisation	7	7	Reputation of your organisation

Appendix E presents the detailed calculation of the ranking process.

### 6.6.3 Analysis of qualitative responses on project and organisational risks

Two open ended questions were included in the questionnaire for the purpose of obtaining additional information on project and organisational risks resulting from discounted professional fees. Respondents were asked to provide their perspective on the impact of discounted fees on the project risk and organisational risk exposure of consulting engineer’s. A total of 22 respondents provided answers to these questions.

The responses provided were however not at variance with the project risks and organisational risks captured in the preceding structured questions. Analysis of response provided to the open ended questions was carried out qualitatively by interpreting respondents’ opinion and categorizing into common risk groups identified.

The majority of the opinions highlighted the limited resources and time deployed to projects with low fees resulting in risks related to quality of design documents; Eighty one percent (81%) of respondents mentioned quality related risk. Sixty seven percent (67%) of respondents mentioned profitability and financial losses as possible risks.

Other risks that received considerable mention include business sustenance, ability to train young engineers and to retain the services of experienced engineers, all factors critical to the sustenance of the profession. Devaluation of the profession, relationship between

engineer and client, increased workload for consulting engineers and demotivation of engineering staff were also mentioned. Analysis and collation of the responses received is presented in Table 22.

Table 22: Risks identified by respondents

Risk Associated with Discounted Fees Identified by Respondents	Number of times recorded
Marginal profit or financial loss on projects	11
Decreased quality of service/inability to perform value engineering	9
Ability to hire and retain highly qualified staff	8
Staff demotivation and fatigue resulting from increased workload on engineers	8
Design errors	6
Business sustenance (sustainability of the practice)	6
Poor quality design and documentation	5
Inability to afford staff training	5
Legal problems	4
Inability to afford competitive salaries	4
Client relationship suffers	4
Devaluation/Deterioration of the profession	3
Professional indemnity claims	2
Absence of innovation in design	1
Inability to carry out proper quality control on site	1
Huge financial implication of redesigns can erode profit	1

All the responses to the opened question received are presented in Appendix F. However, a few responses were instructive and quoted below:

*“Discounting forces the consulting engineer to spend less time on a particular job. This in itself isn’t an increased risk, but it does allow for unforeseen errors to creep in which then raises the project’s overall risk.”*

*“Severely discounted fees can only be sustained by “working cleverer” or by doing less. All too often it is the second option which applies, with consequential quality problems.”*

*“Risk has to increase commensurate with fee discounts, due to commercial and resource constraints as a result of fee discounting. A fee discount of say 20-25 % effectively negates the profit that could normally be made on a project. So in broad term, high risk exposure with very low return or no return.”*

*“It (discounted fees) opens up a door for exploitation of consultants by their clients.”*

*“The future of the industry is at stake as the required training cannot be afforded. The insurance companies should also be wary as the cost of the insured assets can rise far above the insured cover.”*

### 6.6.5 Impact of discounts on components of professional fee

In section 3.5 it was discussed that the consulting engineer’s professional fee can be reduced to three components of resource allocation. These components are cost associated with the number of hours spent on the project, hourly rates associated with the quality of professional deployed to the project and realisable profit to the firm.

Respondents were asked in which order the various components will be reduced or compromised when fees were low. Analysis of the responses is presented in Table 23, it shows that profit realisable from the project is the first component to be reduced; this is the position held by 52% of respondents. Forty three percent of respondents considered the number of hours dedicated to the project as the second component to be reduced. Forty three percent of respondents equally identified quality of professional assigned to the project as the third component to be compromised.

Table 23: Components of Fees

Component of Fees	1st		2nd		3rd	
	Count	Percentage	Count	Percentage	Count	Percentage
Number of hours	5	21.7%	10	43.5%	8	34.8%
Quality of professional	6	26.1%	7	30.4%	10	43.5%
Profit	12	52.2%	6	26.1%	5	21.7%

### 6.6.5 Strategies employed for the management of risks associated with discounted fees

An open ended question was employed to obtain information on how consulting engineers manage risk associated with working on projects with low professional fees. The question asked what risk mitigation strategies are employed when their organisations execute projects at discounted fees.

Twenty two respondents provided responses to this question. A qualitative analysis of the responses shows that 90% of respondents’ organisations accepted risks associated with working at low fees and employed various measures to mitigate the risks; this was followed by contractually limiting their risk. An analysis of the responses by classifying them into risk retention and mitigation, contractual limitation of liability and risk avoidance is presented

Appendix G. The following risk management measures were however deduced from the responses received.

- a) Limit time spent on jobs by avoiding innovative ideas or alternative solutions
- b) Accept financial losses on the project but guard against technical risks by dedicating adequate time and engineering input to the project
- c) Tight scope management and claim for variation orders where possible
- d) Execute project plans diligently
- e) Contractually limit professional indemnity liability
- f) Negotiate a clearly defined reduced scope of service
- g) Assign job to a less experienced personnel but a final design review is done by senior professionals
- h) Not exceeding specific rates or assuming a loss in view of recovering the costs in future projects with the specific client
- i) Time based fees are used on low fee jobs even at lower rates but time spent on the project is at the discretion of the professional
- j) Detailed qualification of contracts and listing exclusions.
- k) Charging inflated prices for variations and refuse to do work not include in the scope
- l) Use efficient and experienced staff members who will do the job in minimal time
- m) Time management and well planned project design stages to minimize risk of possible re-design
- n) Doing only jobs which are more repetitive at low fees so that information can be used from previous projects
- o) Improving organisational efficiency by the use of technology
- p) Adopting Quality Assurance Scheme irrespective of the fees

Respondents were finally asked if discounts they offered on professional fees impacted on their ability to provide good professional services to their clients and if discounted professional fees constituted additional risk to them. Eighty six percent (86%) of respondents agreed that discounted fees impact on their ability to provide good professional service and constituted additional risk for their practice. Nine percent (9%) of respondents did not agree that discounted fees had an impact on their performance on projects, 5% and 9% of respondents were undecided on the impact of discounted fees on their performance on projects and their risk exposure respectively. Table 24 shows the breakdown of the responses received.

Table 24: Impact on discounted fees on project performance and risk

	Yes		No		Undecided	
	Count	Percentage	Count	Percentage	Count	Percentage
Discounted professional fees impact on the consulting engineer's ability to provide good professional service to the client	19	86.4%	2	9.1%	1	4.6%
In your professional opinion, discounted professional fees constitute additional risk for the consulting engineer	19	86.4%	0	0.0%	2	9.1%

## 6.7 Discussion of Research Findings

### 6.7.1 Overview of survey data

The survey recorded a response rate of 38% which is considered satisfactory considering that industry participants in South Africa have a history of reluctance to participate in questionnaire surveys distributed by mail or other electronic means (Ugwu & Haupt, 2007:665). Akintoye & MacLeod (1997:31) were of the opinion that a postal questionnaire survey can only be considered biased if it receives a response rate lower than 30-40%.

The majority of respondents were active in the building structures and the civil works markets, and involved in decision making and management roles within their organisations. The level of experience of the majority respondents and the senior positions they occupy within their organisation confirms that the desired group of consulting engineers were reached and participated in the survey.

### 6.7.2 Findings

Five research objectives were put forward at the onset of this research. The first research objective which was to obtain information on project and organisational risks particular to consulting engineering practice has been dealt with in chapter 4 through an extensive review of literature. The second, third and fourth research objective are addressed by the questionnaire survey conducted.

The second objective was to obtain information on the extent of discounting practices among consulting engineering firms in South Africa. Questions in part 2 of the questionnaire (organisational discounting practices) address this objective.

Findings from the survey show that discounting practices are widespread among structural and civil engineering services consulting firms that were represented in this survey. At least seven in every ten respondents reported that they either frequently or often offered discounts. Discounts offered in the industry are benchmarked against ECSA recommended fees scale; discounts of between 16 and 30% of the recommended fee scale are observed to be the industry's standard. However, a significant proportion of respondents reported that they have offered discounts above 60%; discounts ranging from 45 to 60% of the recommended fees scale were also reported.

Respondents were asked the type of clients that accounted for the bulk of their annual fee earnings; this was intended to obtain information on whether the offer of discounts was limited to one type of clients. While the majority of respondents worked for both public and private clients, some respondents mainly serviced either public or private clients. Small size firms employing less than 10 staff were observed to work mostly for private clients while

medium size firms employing between 50 and 99 staff worked mostly for public clients. Data obtained suggests that respondents offered discounts to both public and private clients.

No clear dichotomy was observed between the discounting practices of small, medium and large firms represented in the survey. The majority of the respondents represented firms that can be described as medium size firms judging by their staff strength and annual turnover. Fewer respondents represented firms that can be described as large firms (employing over 100 staff and turnover above ZAR250 million) and even fewer represented small firms (employing less than 10 staff and annual turnover below ZAR10 million).

Findings show that percentage fees based on the cost of the works is by far the most common method of remuneration, this is followed by time based fees. The monetary value of remuneration under both of these methods is informed by rates recommended in the fee scale guidelines published by ECSA. This further suggests that the ECSA fee scale is widely used in the industry.

Competition based on price appears to be a well-entrenched business strategy as about two-third of respondents agreed that their firm competed based on price. This finding is in agreement with the assertion by Love & Edwards (2004), that consulting firms are increasingly adopting a 'market driven' strategy of price based competition and no longer compete based on quality of service.

It is found that prevailing market conditions characterised by competitive tendering and demands from clients for discounts are the leading reasons why respondents offered discounts. Responses to an open ended question reveal that because the ECSA fees scale is not enforceable and the practice of professional engineers within the various engineering discipline is unregulated, clients have a greater bargaining leverage when it comes to negotiating fees with the consulting engineer.

Competition based on price rather than quality of service is obvious from the responses received, perhaps this has forced respondents to offer discounted fees in order to keep staff busy and cover running cost. This reason was the third most common reason given by respondents for offering discounted fees. These findings are in agreement with the position held by CESA that the practice of competitive tendering in South Africa is partly responsible for the decline in professional fees for its members (CESA, 2007).

The level of discounts offered in the industry evident in the findings of this research, calls to question the relevance of the ECSA fee scales. Some respondents argued in the open ended questions that the fees scales are no longer relevant and that rather than use fee scales, engineers should arrive at their own fees through a careful consideration of the scope of the service they are to provide. This argument is based on the fact that much of the

fees determined in the industry are based on percentage fees based on the cost of the work, but current realities especially on building projects show that ECSA recommended percentage scales may not be an accurate reflection of the engineering input required from the consulting engineer.

The third objective of this research was to identify the ways low professional fees impact on identified project and organisational risks, and additional risks resulting from low professional fees.

Eight project risks were found to be impacted by low fees from the literature review conducted. Of these, financial loss on the project, inadequate site supervision and quality control, and inability to perform value engineering were identified to have with the most impact on the consulting engineer's organisation. Respondents were of the opinion that low fees limit the resources and time deployed to a project. They rated the impact of low fees on identified project risks in the following order of importance:

- a) Financial loss on the project
- b) Inability to perform value engineering
- c) Inadequate site supervision and quality control on the project
- d) Rework of design and drawings
- e) Poor quality of design and documentation
- f) Legal liabilities (claims, disputes and litigation)
- g) Professional indemnity cover
- h) Unethical practices

Organisational risks impacted by discounted professional fees were also identified. It was found that human resource issues such as training/mentoring young engineers and attracting and retaining experienced engineers are organisational risk factors most influenced by discounting practices in the industry. They ranked identified organisational risk in the following order of importance:

- a) Ability to train and mentor aspirant/graduate engineers
- b) Ability of organisation to attract and retain quality/experienced staff
- c) Business sustenance
- d) Ability of organisation to be innovative in design
- e) Motivation of staff
- f) Relationship with clients
- g) Organisation's reputation

From responses to the open ended questions, devaluation and deterioration of the profession, as well as the sustenance of the profession by making it unattractive to young engineers were identified as long term implications of discounting practices on the industry.

It is found from the responses that the quality of the professional service offered is impacted by discounted fees, especially as consulting firms do not spend enough time considering design options and carrying out value engineering on low fee jobs. The implication of this is that the lifecycle cost of projects increases on account of poor engineering inputs (Sterner, 2000:387). When this becomes apparent to clients, they may no longer value the services of the engineering professional, leading to more design responsibilities being awarded to contractors in the form of design build contracts, a trend which is already emerging.

The construction industry is reputed to be plagued by adversarial relationships between project participants leading to conflicts (Black, Akintoye, Fitzgerald, 2000). Findings here have shown that discounted fees negatively impact on the relationship between the consulting engineer and the client. This is a disincentive for consulting engineers to embrace partnering philosophies and collaboration on projects as they will naturally spend less time and deploy fewer resources on projects with low fees.

The fourth objective of this research is to identify measures that can be recommended to help consulting engineers manage and mitigate risk due to low professional fees. Information on the experience of consulting engineers in South Africa with regards to mitigating risk resulting from discounted fees was obtained from an open ended question. It is found that consulting engineers would normally accept the risks associated with discounted fees and would employ various measures to mitigate the risk, or would contractually limit their liabilities on projects with low fees. Some mitigation strategies identified include:

- a) Limit time spent on jobs by avoiding innovative ideas or alternative solutions
- b) Accept financial losses on the project but guard against technical risks by dedicating adequate time and engineering input to the project
- c) Tight scope management and claim for variation order where possible
- d) Negotiate a clearly defined reduced scope of service
- e) Assign the work to less experienced personnel but a final design review is done by senior professionals
- f) Recovering the costs in future projects with the specific client
- g) Charging inflated prices for variations and refuse to do work not included in the scope
- h) Doing only work which is more repetitive at low fees so that information can be used from previous projects
- i) Improving organisational efficiency by the use of technology
- j) Adopting a Quality Assurance Scheme irrespective of the fees

A risk catalogue has been prepared capturing all risk identified from this study and can be found in appendix H.

## 6.8 Chapter Summary

The survey conducted has generated information on the discounting practices of civil and structural engineering services consultants in South Africa. Respondents have provided their perspective on risk to their practice as a result of discounted professional fees offered. The answers provided indicated the following:

- a) The offer of discounts on professional fees and reduction in fees charged by consulting engineers is widespread in the industry
- b) Market conditions characterised by competitive tendering and demands from clients for discount are the leading reasons why consulting engineers are forced to offer fee discounts
- c) Percentage fees based on the cost of the works and time based fees based on the ECSA guideline fees scale are the most common methods of remuneration for consulting engineering service
- d) Typical discount rates in the industry has effectively resulted in a decline in the fees of consulting engineers on structural and civil projects by as much as 16 to 30% on the average, and could be as high as 60%
- e) No difference was observed in the discounting practices of small, medium and large consulting firms, as they all appear to offer the same level of discounts
- f) Discounted fees limit the resources and time the engineer can deploy on the project, resulting in mainly quality and financial risks which threaten the sustenance of the consulting engineering profession
- g) Project and organisational risks impacted by discounted fees were identified and ranked in order of their perceived importance
- h) Risk management measures were identified and proposed for risk associated discounted fees

## CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

### 7.1 Overview of Research Conducted

It is often argued that consulting engineers carry little risk because the nature of their service is mainly advisory. Research on construction industry risks have focused much on client and contractor risks.

The research conducted investigated risks to the consulting engineer's practice with focus on the impact of discounted professional fees on the consultant's risk exposure. The information contained in this dissertation was obtained mainly from an extensive review of literature, discussions with practicing professional engineers and a questionnaire based survey.

The literature review conducted yielded much information on project and organisational level risks to the consulting engineer's practice mainly from an international perspective; discussions conducted with professional engineers yielded information on the local experience of consulting engineers and this information was used to design the survey questionnaire. The impact of discounted fees on identified project and organisational risk was tested by the questionnaire survey conducted.

The research set out to answer three questions; firstly, are civil and structural engineering services consultants exposed to significant risk from doing work at discounted fees. Secondly, if they are, can these risks be identified? Lastly, are there measures that can be recommended to help consulting engineers manage these risks.

### 7.2 Conclusions

The following conclusions can be reached from the research conducted:

From the literature study conducted the following conclusions can be reached:

- a) Information on risks to the consulting engineer's practice in South Africa is scant in the literature. Professional bodies such as CESA do publish risk management guidelines for their members. These documents are mainly in the form of advisory notes and 'housekeeping' rules
- b) The information on project and organisational level risk were obtained mainly from international literature, no proof was found of a study that addressed risks to the consulting engineer's practice in South Africa

- c) The literature review conducted indicates that the responsibilities and functions of the consulting engineer on projects are well defined by relevant guidelines and legislation in South Africa
- d) South African clients lack the capacity to properly scope projects and prepare project briefs. The implications of this is that consulting engineers take on additional responsibilities as they are often unable to accurately determine the level of engineering effort required for the project
- e) The procurement of consulting engineering services in South Africa is mainly by lowest cost tendering, with the Quality Cost Based Selection method recommended by CIDB being widely adopted
- f) Clients do consider cost above qualification, experience and competence in the procurement of consulting services. Clients are often unable to judge quality of service and are not aware of the implications of accepting low quality service
- g) The categorisation of civil and structural engineering services especially on building projects under the ECSA fee guidelines is believed to not accurately capture the nature of these services. Consulting engineers argue that the increased complexity of building projects and increased construction monitoring and supervision responsibilities implied are not properly reflected under normal services. The 2014 ECSA guideline attempted to address these concerns by a re-classification of building projects
- h) The literature study conducted led to the identification of project and organisational risk encountered by consulting engineers
- i) The literature review indicated that low professional fees negatively impacted on the quality of service provided by the consulting engineer and this contributes to some project and organisational risks identified

The following conclusions can be reached from the research conducted:

- a) Discounting practices among organisations represented by respondents can be described as widespread. This is in agreement with findings from the literature review conducted. Discounts offered resulted in a 16 to 30% decline in professional fees on the average and could be as much as 60%
- b) Percentage fee based on the cost of the works is the most common method of remuneration among respondents followed by time based fee. The monetary value of compensation under these methods is guided by the provisions of the ECSA fees

scale guideline. Fix sum and value based fees are the least common methods of remuneration and the monetary value of compensation under these methods can be determined without recourse to the ECSA fee scale. The dominance of both the percentage fee based on the cost of the works and time based fee methods of remuneration suggest that the ECSA fee scale is widely used

- c) Prevailing market conditions characterised chiefly by competitive tendering approach for the procurement of consulting engineering services and client demand for discounts have forced respondents to compete based on price rather than quality of service. The majority of respondents agreed that their organisations competed based on price
- d) Respondents agreed that discounts offered on professional fees impacted negatively on their ability to provide good professional service and constitutes additional risks for their practice
- e) The impact of discounted fees on the consulting engineers risk exposure was shown by identifying project and organisational level risk influenced by discounted fees
- f) Project risks influenced by discounts offered on fees were identified and ranked by respondents in the following order of importance:
  - I. Financial loss on the project
  - II. Inability to perform value engineering
  - III. Inadequate supervision and quality control
  - IV. Rework of design and drawings
  - V. Poor quality of design and documentation
  - VI. Legal liabilities
  - VII. Professional indemnity cover
  - VIII. Unethical practices
- g) Organisational risks influenced by discounts offered on fees were identified and ranked by respondents in the following order of importance:
  - I. Ability to train and mentor aspirant/graduate engineers
  - II. Ability of organisation to attract and retain quality and experienced staff

- III. Business sustenance
  - IV. Ability of organisation to be innovative in design
  - V. Motivation of staff
  - VI. Relationship with clients
  - VII. Organisation's reputation
- h) In dealing with risk associated with discounted fees, respondents either contractually limited their risk exposure or mostly accepted the risks and employed various mitigation strategies including:
- I. Avoiding innovative idea in order to cut down on time spent on the project
  - II. Accept financial loss on the project but guard against technical risks by dedicating adequate time and engineering input to the project
  - III. Negotiate reduced scope of service to accompany discounted fee
  - IV. Recover cost on future projects with the specific client
  - V. Charge inflated prices for variations and refuse to do work not included in the scope
  - VI. Doing only jobs which are repetitive at low fees so that information can be used from previous projects
  - VII. Improve organisational efficiency by the use of technology
  - VIII. Adopting a Quality Assurance System

The research questions put out for this research have been addressed by the research. It has been found that the consulting engineer is exposed to significant risk from doing work at discounted fees. Risk generated and impacted by discounted fees have been identified and discussed. Risk management strategies for the mitigation of risks associated discounted fees have been identified and proposed.

Government procurement legislation including those of the competition commission that encourage competitive procurement based on cost may be well intentioned but have obviously engendered price based competition in the consulting engineering industry. This has the following undesirable impact on the industry and the country as a whole:

- a) The cost of professional engineering services on projects constitutes a very small portion of the lifecycle cost of engineering projects. When consulting engineers are required to compete based on cost rather than quality to secure contracts, the amount of engineering input (by way of considering design alternatives and carrying value engineering) on the project is reduced to enable the engineer to bid low and still make a profit. This increases the lifecycle cost of the project
- b) Increased cost of infrastructure and decline in quality of engineering input is a drain on the national economy
- c) When profit is low, the consulting engineer's remuneration will be affected. Engineers will have to take on more responsibilities not commensurate with remuneration. This ultimately makes the profession unattractive to young engineers
- d) The less attractive the profession, the fewer engineers are available to design and implement engineering projects required for national development. This will ultimately result in foreign firms taking over engineering work in the country
- e) While it is acknowledged that discounts are offered by civil and structural engineering services consultants across market segments, the ECSA fees scale does not provide for the same remuneration for the various project types. Certain types of projects in certain markets are known to be more profitable than others when the ECSA fees scale tariff is applied. Building projects are less profitable in terms of remuneration going by the fee tariff. If consulting engineers operating in that market are not protected, a shortage of professionals on such projects may be recorded.

### **7.3 Strengths and Limitations of the Study**

The research conducted has produced a risk catalogue of project and organisational risk particular to the consulting engineer's practice. Project and organisational risks influenced and impacted by discounted fees have also been identified. The identified risks were ranked in an order indicative of their relative importance to the industry.

Literature on risk experienced by consulting engineers in South Africa was scarce; most of the literature reviewed provided information on the risk encountered by consulting engineers in other countries. However, discussions with local practicing engineers provided insight on the experience of engineers in South Africa.

The respondents who participated in the research occupy executive, managerial and technical positions in the industry and the insight they provided is considered reflective of the wider industry. The number of respondents involved in the research may not be statistically

sufficient to allow for detailed understanding of the discounting practices of small, medium and large consulting firms but the representation of the firms was sufficient to provide a general perspective.

While public and private clients were identified to both demand discounts, this research was not able to compare the level of discounts common to each client type and the level of risk associated with working for both types of client at discounted fees.

The risk exposure and the level of discounts offer by other professional consultants in South Africa were not considered. Therefore, this research does not provide a comparison between the experience of civil and structural engineering services consultants and other engineering consultants such as electrical and electronics, industrial and mechanical engineering consultants as well as other professional consultants such as architects, lawyers and medical consultants.

#### **7.4 Recommendations**

- a) The ECSA fees scale tariff has become a tool in the hands of clients to exploit consulting engineers. The relevance of the ECSA fees scale which is not enforceable or mandatory in the face of the current procurement legislation under which it is implemented needs to be questioned. Discontinuation of the publishing of the ECSA fee scale is recommended as it will provide a level playing field for free competition for both clients and consulting engineers
- b) In the interim project supervision and quality control responsibilities of the consulting engineer under normal services as contained under the current ECSA fees scale guideline will need to be redefined to reflect varying project dynamics such as complexity and size of structure. The engineer's fee should be adequate to guarantee sufficient site visits under normal services as it is observed that clients are often reluctant to contract the engineer for additional site visits. The ECSA fee scale guideline should give clear description to vague concepts such as value engineering services and consideration of alternative project concept options under normal services to help clients understand the importance of this aspects of the engineering design process
- c) Many developed countries have identified the danger involved in allowing the engineering profession to be subjected to competition based on cost. Countries such as the United States and the United Kingdom have since abolished the publishing of fee scales by professional bodies. In countries such as the US and Japan which are recognised as technologically advanced, Quality Based Selection is the law for the

procurement of consulting engineering services. It is recommended that procurement legislation for professional engineering services be amended to allow for the selection of consulting engineers based solely on qualification, experience and competence. Upon selection of a consulting engineering firm based on quality criteria, fees can subsequently be determined based on the cost of providing the service required under a well-defined scope of work

- d) Considering the revelation that South African clients lack the capacity to judge quality of service and do not realise the implication of low quality engineering services, a robust discussion between consulting engineers and clients in South Africa is recommended in order to enlighten client bodies about the negative consequences of discounted fees. Professional bodies such as CESA and SAICE can play important roles in this regard
- e) The Rules of Conduct for Registered Persons in Terms of the Engineering Profession Act 2013 requires registered persons to only assume responsibility for work which their education, training and experience provide them with the required skills to execute. This is often referred to as the 'self-regulate' rule. Registered professional who do not possess the right experience and training have often been accused of offering reckless amounts of discounts because they are sometimes unaware of the amount of engineering input required and the level of risk involved. Civil engineering is a broad field of engineering that encompasses many sub disciplines. The structural engineering discipline is one such sub discipline that requires considerable expertise. Regulating the practice requirements within the various sub disciplines in the field of civil engineering such as structural engineering is recommended. Such that only civil engineers with sufficient structural engineering training and experience are allowed to do structural design works. It is believed that properly qualified professionals will be unwilling to offer ridiculously low discounts
- f) Researchers should be encouraged to conduct research on the fees earned by other consulting professionals and the level of risk involved with their practice with a view to drawing a comparison between their risk exposure and remuneration and that of civil and structural engineering services consultants
- g) Although some implications have quantitatively been identified, research should also be conducted on the implication of lower quality service by the consulting engineer engendered by discounted fees on the risk encountered by other project participants such as clients and the contractors in South Africa

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## **Appendices**

**Appendix A - ECSA fee scale for civil and structural services on building projects (2012 - 2014)**

**Appendix B – Survey Questionnaire**

**Appendix C – Analysis of Opened Ended Question on Reason for Offering Discounts**

**Appendix D – Ranking Exercise for Project Risks**

**Appendix E – Ranking Exercise for Organisational Risks**

**Appendix F – Analysis of Combined Responses to Opened Ended Question on Project and Organisational Risks**

**Appendix G – Analysis to Open Ended Question on Risk Mitigation Strategy**

**Appendix H – Risk Catalogue**

**Appendix A: ECSA fee scale for civil and structural services on building projects (2012 - 2014)****Table A1**

Value of Engineering Works	2012	2013			2014			
	Civil/Structural (Building)	Category A Civil/Structural (Building) 6% - 8%	Category B Civil/Structural (Building) 7% -9%	Category C Civil/Structural (Building) 8% - 10%	Category D Civil/Structural (Building) 9% - 11%	Category E Civil/Structural (Building) 10% - 13%	Category F Civil/Structural (Building) 11% - 14%	Category G Civil/Structural (Building) 12% - 15%
<b>15,000,000.00</b>	1,423,500.00	990,000.00	1,170,000.00	1,275,000.00	1,350,000.00	1,575,000.00	1,650,000.00	2,175,000.00
<b>25,000,000.00</b>	2,223,500.00	1,475,000.00	1,825,000.00	2,000,000.00	2,175,000.00	2,525,000.00	2,675,000.00	3,550,000.00
<b>50,000,000.00</b>	4,043,500.00	2,600,000.00	3,450,000.00	3,750,000.00	4,200,000.00	4,850,000.00	5,200,000.00	6,950,000.00
<b>75,000,000.00</b>	5,793,500.00	3,375,000.00	4,875,000.00	5,400,000.00	6,075,000.00	6,975,000.00	7,725,000.00	10,200,000.00
<b>100,000,000.00</b>	7,543,500.00	4,000,000.00	6,100,000.00	7,000,000.00	7,800,000.00	8,900,000.00	10,000,000.00	13,300,000.00
<b>150,000,000.00</b>	11,043,500.00	6,000,000.00	8,550,000.00	9,750,000.00	11,250,000.00	12,750,000.00	14,550,000.00	19,500,000.00
<b>200,000,000.00</b>	14,543,500.00	8,000,000.00	10,600,000.00	12,400,000.00	14,400,000.00	16,200,000.00	18,800,000.00	25,400,000.00
<b>250,000,000.00</b>	18,043,500.00	10,000,000.00	13,000,000.00	15,000,000.00	17,500,000.00	20,000,000.00	22,500,000.00	31,250,000.00

Project categories are defined in Table A2 below

**Project Categories****Table A2**

<b>ECSA Categories for Building Projects</b>	<b>2013</b>	<b>2014</b>
Category A	Warehouses, Single storey buildings	N/A
Category B	Multi-storey buildings	N/A
Category C	Large public buildings	N/A
Category D	N/A	Warehouses
Category E	N/A	Residential, educational, offices and industrial
Category F	N/A	Hospitals, hotels, airport buildings, stadia, exhibition halls, retail shopping centres
Category G	N/A	Iconic and unique buildings, structural alterations

## **APPENDIX B**

### **Survey Questionnaire**

## **APPENDIX C**

### **Analysis of Open Ended Question on Reason for Offering Discounts**

Should you have other reasons for offering discounts, please state below	Forced by Clients	Forced by Market conditions/competitive tendering	Non regulation of the industry
Especially in the private sector the industry is largely unregulated in terms of who can practice as a structural engineer (with specific reference to building structures). There are a vast number of people practicing as structural engineers without the necessary credentials (being a PrEng means nothing as anyone with this title can practice in any discipline without any questions being asked - though in theory this is not allowed through so-called self-regulation). The only time an individual's credentials are queried is when things go wrong. A properly qualified and certified structural engineer will not work at large discounts - because he understands the risks involved and the effort required to mitigate the risk. The ignorant few offering practicing as structural engineers without the right credentials are blissfully unaware of the risks that need to be addressed and the time and effort required to do so. The problem with discounting I believe is by far the worst in building structures and ultimately it boils down to insufficient regulation.			x
I don't like the concept of offering discounts, but Clients often insist on discounted fees.	x		
We price the work from basic principles. What will it cost to deliver the work. Most instances we have a good idea of scope of work and can use our past experience to price the work based on our estimate on how many man hours we require to do the work			
Mostly demanded by clients: so you either take what is on offer or walk away and cut your losses, often having worked on risk for many years.	x		
I run a cost efficient small practice. I don't offer discounts, I just charge less than I should because the profession has historically been abused by the client body. In my opinion this situation evolved because we the professionals allowed it.	x		x
For Private Clients, discounts are expected. many private clients even expect free work (work done at risk) during the feasibility stage with a promise to appoint the consultant to the project should it go ahead.	x		
In some markets the fees are simply stated by the client / project manager / QS, and if you want the job you must accept a certain percentage fee. This is common on commercial projects such as shopping centres.	x	x	
The fee scales are not representative of inputs to projects, I. E. Consultant costs. When the scope of work is well understood, costs are accurately know and a very competitive price can be given, irrespective of the fee scales.			x
Competitive Tendering		x	

## **APPENDIX D**

### **Ranking Exercise for Project Risks**

**Table D 1: Response Counts**

Project Risk Factors	Frequently	Often	Seldom	Never	Severe	Significant	Minimal	No Impact
Poor Quality of design and documentation	3	10	8	1	5	8	8	1
Inadequate supervision and quality control	7	13	1	1	8	10	3	1
Inability to perform value engineering	10	10	2	0	10	10	1	1
Rework of design and drawings	6	12	4	0	7	9	6	0
Legal liabilities (claims, disputes and litigation)	3	8	10	1	4	8	8	2
Unethical practices	4	3	9	6	4	4	7	7
Professional indemnity cover	3	7	9	3	5	5	8	4
Financial loss on the project	10	10	2	0	10	11	1	0

**Table D2: Risk Value Calculation and Ranking**

Project Risk Factors	Frequently	Often	Seldom	Never	Severe	Significant	Minimal	No Impact	Risk Value
Financial loss on the project	10	8	0.6	0	10	8.8	0.3	0	355.26
Inability to perform value engineering	10	8	0.6	0	10	8	0.3	0	340.38
Inadequate supervision and quality control	7	10.4	0.3	0	8	8	0.9	0	299.13
Rework of design and drawings	6	9.6	1.2	0	7	7.2	1.8	0	268.8
Poor Quality of design and documentation	3	8	2.4	0	5	6.4	2.4	0	184.92
Legal liabilities (claims, disputes and litigation)	3	6.4	3	0	4	6.4	2.4	0	158.72
Professional indemnity cover	3	5.6	2.7	0	5	4	2.4	0	128.82
Unethical practices	4	2.4	2.7	0	4	3.2	2.1	0	84.63

## **APPENDIX E**

### **Ranking Exercise for Organisational Risks**

**Table E1: Response Count**

Organisational Business Risk Factors	Frequently	Often	Seldom	Never	Severe	Significant	Minimal	No Impact
Business sustenance	-	-	-	-	5	15	2	0
Motivation of staff	-	-	-	-	2	15	5	0
Relationship with clients	-	-	-	-	2	14	4	2
Ability of organisation to attract and retain quality/experienced staff	-	-	-	-	8	12	1	1
Ability to train and mentor graduate engineers	-	-	-	-	12	6	4	0
Reputation of your organisation	-	-	-	-	1	10	9	2
Ability of firm to be innovative in design	-	-	-	-	7	9	6	0

**Table E2: Risk Value Calculation and Ranking**

Organisation Business Risk Factors	Frequently	Often	Seldom	Never	Severe	Significant	Minimal	No Impact	Risk Value
Ability to train and mentor graduate engineers	-	-	-	-	12	4.8	1.2	0	18
Ability of organisation to attract and retain quality/experienced staff	-	-	-	-	8	9.6	0.3	0	17.9
Business sustenance	-	-	-	-	5	12	0.6	0	17.6
Ability of firm to be innovative in design	-	-	-	-	7	7.2	1.8	0	16
Motivation of staff	-	-	-	-	2	12	1.5	0	15.5
Relationship with clients	-	-	-	-	2	11.2	1.2	0	14.4
Reputation of your organisation	-	-	-	-	1	8	2.7	0	11.7

## **APPENDIX F**

**Analysis of Combined Responses to Opened Ended Question on Project and Organisational Risks**

Please provide your perspective on the impact of discounted professional fees on the risk exposure of the consulting engineer?	Business Sustainance	Motivation of staff	Relationship with clients	Ability of organisation to attract and retain quality/experienced staff	Reputation of your organisation	Ability of firm to be innovative in design	Train and mentor aspirant/graduate engineers	Quality of design and documentation	Adequate supervision and quality control	Ability to perform value engineering	Rework of design and drawings	Legal liabilities (Claims, disputes and litigations)	Unethical practices	Professional indemnity cover	Financial loss on the project	Less time spent on projects	Lost Opportunity to provide better service	Devaluation of the profession	Increased workload
The organisation's risk is increased as the probability of a indemnity or insurance claim is increased, usually due to unforeseen design errors. Operating at near cost prices is also not financially sustainable in the medium to long term.	x							x						x	x				
It is becoming increasingly difficult to realise a profit. Without a healthy business it is not possible to appoint and retain highly qualified staff. The end result is less and less people spending more and more time on projects.	x	x		x											x				
Less work (time) on a project mostly leads to poorer design and documentation and more quality and legal problems on projects leading to significant organisational risk to our company, particularly on large projects.								x	x			x				x			
Engineers tend to complete projects to the best of their ability regardless of how much they get paid for it. One of their "drawbacks" in life is that they enjoy the work they do so much; they do it sometime regardless of the pay they get.																x			



Please provide your perspective on the impact of discounted professional fees on the risk exposure of the consulting engineer?	Business Sustainance	Motivation of staff	Relationship with clients	Ability of organisation to attract and retain quality/experienced staff	Reputation of your organisation	Ability of firm to be innovative in design	Train and mentor aspirant/graduate engineers	Quality of design and documentation	Adequate supervision and quality control	Ability to perform value engineering	Rework of design and drawings	Legal liabilities (Claims, disputes and litigations)	Unethical practices	Professional indemnity cover	Financial loss on the project	Less time spent on projects	Lost Opportunity to provide better service	Devaluation of the profession	Increased workload
Significantly discounted fees place a lot of pressure on the engineering staff. There is an expectation from management that projects are profitable which in many cases becomes impossible. More and more focus is placed on financial management, claims and arguments with clients instead of project delivery, quality and engineering in general. These stressors demotivate staff. The knock on effect is that despite work load, management does not want to employ new engineers due to financial pressures, making things even worse. Therefore the client is getting even worse service because to fee resources are available to his project.		x	x	x				x	x			x			x	x			
Devalues the entire profession as consultants are charging less than what they actually worth. Also affects sustainability of the firm as profit margins are reduced.	x				x										x			x	
With low profits there are little or no fees available for external training of staff. Also with no annual bonus or increase		x					x								x				





Please provide your perspective on the impact of discounted professional fees on the risk exposure of the consulting engineer?	Business Sustainance	Motivation of staff	Relationship with clients	Ability of organisation to attract and retain quality/experienced staff	Reputation of your organisation	Ability of firm to be innovative in design	Train and mentor aspirant/graduate engineers	Quality of design and documentation	Adequate supervision and quality control	Ability to perform value engineering	Rework of design and drawings	Legal liabilities (Claims, disputes and litigations)	Unethical practices	Professional indemnity cover	Financial loss on the project	Less time spent on projects	Lost Opportunity to provide better service	Devaluation of the profession	Increased workload
Without there being VERY stringent regulations as to who practice as a structural engineer there will always be a guy - in his absolute ignorance or greed - willing to work at half price. As well as a client willing to pay the "cheaper" fee without even realising that the end result is a considerable over spent on total construction cost.																			
Discounting of fees inexorably leads to increased risk as care and checking tend to get lost in the rush of a higher workload.								x	x										x
Severely discounted fees can only be sustained by "working cleverer" or by doing less. All too often it is the second option which applies, with consequential quality problems.								x	x							x			
Risk of problems on site is obviously increased, if one has to rush through a project so as to limit losses. Biggest impact is on the sustainability of the practice, having time to train people properly, etc.	x						x	x	x						x				

Please provide your perspective on the impact of discounted professional fees on the risk exposure of the consulting engineer?	Business Sustainance	Motivation of staff	Relationship with clients	Ability of organisation to attract and retain quality/experienced staff	Reputation of your organisation	Ability of firm to be innovative in design	Train and mentor aspirant/graduate engineers	Quality of design and documentation	Adequate supervision and quality control	Ability to perform value engineering	Rework of design and drawings	Legal liabilities (Claims, disputes and litigations)	Unethical practices	Professional indemnity cover	Financial loss on the project	Less time spent on projects	Lost Opportunity to provide better service	Devaluation of the profession	Increased workload
Client loses as he client will not get value for money. Saving on professional fee is counterproductive, as the project overall will cost more.								X		X									
The future of the industry is at stake as the required training cannot be afforded. The insurance companies should also be wary as the cost of the insured assets can rise far above the insured cover.	X						X							X					
Risk has to increase, commensurate with fee discounts, due to commercial and resource constraints as a result of fee discounting. A fee discount of say 20-25 % effectively negates the profit that could normally be made on a project. So , in broad terms , high risk exposure with very low return , or no return.																			X
With inadequate fees one cannot resource a project with adequate people with top experience. This exposes one to the potential of substandard design and errors in detailing. Real risk. The only way to avoid the risk is to accept low or zero profit.				X				X			X				X				



Please provide your perspective on the impact of discounted professional fees on the risk exposure of the consulting engineer?	Business Sustainance	Motivation of staff	Relationship with clients	Ability of organisation to attract and retain quality/experienced staff	Reputation of your organisation	Ability of firm to be innovative in design	Train and mentor aspirant/graduate engineers	Quality of design and documentation	Adequate supervision and quality control	Ability to perform value engineering	Rework of design and drawings	Legal liabilities (Claims, disputes and litigations)	Unethical practices	Professional indemnity cover	Financial loss on the project	Less time spent on projects	Lost Opportunity to provide better service	Devaluation of the profession	Increased workload
<p>limited. The unreasonable expectation of the client leads to very poor relationships with the professionals during the project. There are little benefits to the projects, as the traditional partnering relationship between professionals and the client is eroded.</p>																			
<p>it opens up a door for exploitation of consultants by their clients.</p>					x													x	





Please provide your perspective on the impact of discounted professional fees on the risk exposure of the consulting engineer?	Business Sustainance	Motivation of staff	Relationship with clients	Ability of organisation to attract and retain quality/experienced staff	Reputation of your organisation	Ability of firm to be innovative in design	Train and mentor aspirant/graduate engineers	Quality of design and documentation	Adequate supervision and quality control	Ability to perform value engineering	Rework of design and drawings	Legal liabilities (Claims, disputes and litigations)	Unethical practices	Professional indemnity cover	Financial loss on the project	Less time spent on projects	Lost Opportunity to provide better service	Devaluation of the profession	Increased workload
discounts, they normally only use junior and inexperienced staff on their projects to limit costs. It is then the engineer that must make the project work, as our risk is the greatest, should something go wrong.																			
Senior staff in firm work additional hours to check work of staff. Senior staff are therefore overworked and underpaid, resulting in an environment where mistakes can easily slip thru, resulting in claims against the firm.		x						x				x							
<b>Count</b>	<b>9</b>	<b>5</b>	<b>3</b>	<b>7</b>	<b>3</b>	<b>2</b>	<b>6</b>	<b>5</b>	<b>9</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>0</b>	<b>3</b>	<b>14</b>	<b>9</b>	<b>1</b>	<b>4</b>	<b>1</b>

## **APPENDIX G**

**Analysis to Open Ended Question on Risk Mitigation Strategy**

<p><b>What risk mitigation strategy does your organisation employ when executing projects at discounted fees?</b></p>	<p><b>Risk retention and mitigation</b></p>	<p><b>Contractual limitation of liability</b></p>	<p><b>Risk Avoidance</b></p>
<p>Designers and support staff are reminded that excess time should not be spent on a low-paying job. Staff are to complete the necessary as quickly as possible and should not spend time on innovative ideas or alternative solutions.</p>	<p>x</p>		<p>x</p>
<p>We try to manage the financial risk as best we can but as for the technical risk (physical risk on site) there is no other way but to spend the time required to do things right.</p>	<p>x</p>		
<p>Design reviews</p>	<p>x</p>		
<p>As an organisation, we strive to deliver work of high standard regardless of how much we are paid.</p>	<p>x</p>		
<p>We find that it does not pay to cut corners, because of low fees - in the end it takes longer to sort out problems. So we still do the work to the best of our ability. Another problem is that the other professionals, e.g. the Architects, are probably also on reduced fees, leading to a reduction in the quality of information we receive from them. This also increases risk of problems on site, and often to higher construction costs.</p>	<p>x</p>		
<p>Tight scope management. Claim for variation orders where possible.</p>	<p>x</p>		
<p>We have to execute our project plans diligently.</p>	<p>x</p>		
<p>1. Limit PI liability 2.reduce and clearly define reduced scope of services</p>		<p>x</p>	
<p>Senior professional has to be on the constant alert as to anything that might have been overlooked. MY rule used to be: no drawing leaves the office without my signature whereby I have a last minute opportunity to look for anything that seems suspect.</p>	<p>x</p>		
<p>Not exceeding specific rates or assuming a loss in view of recovering the costs in future projects with the specific client.</p>	<p>x</p>		
<p>Work is delegated to less experienced personnel.</p>	<p>x</p>		

<p><b>What risk mitigation strategy does your organisation employ when executing projects at discounted fees?</b></p>	<p><b>Risk retention and mitigation</b></p>	<p><b>Contractual limitation of liability</b></p>	<p><b>Risk Avoidance</b></p>
<p>Work on a time basis even if the rates are less than recommended. The Client has no say in how much time is spent. Time spent is at the discretion of the professional. The reduced time rates however have an implication on the infrastructure available to the professional.</p>	<p>x</p>	<p>x</p>	
<p>Qualifications are very detailed in projects. Exclusions are listed. Any exclusion is subject to Variations orders instructed by client later. Refuse to do any work that is not included in the scope and charge inflated prices for variations. Provide the minimum of information and don't do any value engineering.</p>		<p>x</p>	
<p>Use efficient and experienced staff members who will do the job in minimal time.</p>	<p>x</p>		
<p>Time management and well planned project design stages to minimize risk of possible re-design.</p>	<p>x</p>		
<p>Doing jobs which are more repetitive so information can be used from previous projects.</p>	<p>x</p>		
<p>More efficiency</p>	<p>x</p>		
<p>Keep hours as low as possible and keep expensive staff's hours very low.</p>	<p>x</p>		
<p>Know the client and the work required, subsidise projects.</p>	<p>x</p>		
<p>The Quality Assurance Scheme will apply irrespective of the fees.</p>	<p>x</p>		
<p>Senior staff checks designs and drawings after hours.</p>	<p>x</p>		
<p>Work smarter and use technology.</p>	<p>x</p>		
<p><b>Count</b></p>	<p><b>19</b></p>	<p><b>3</b></p>	<p><b>1</b></p>

## **APPENDIX H**

### **RISK CATALOGUE**

Risk Type	Risk Grouping		Risk Factors	Impacted by Discounted Fee? Yes/No
1.0 Project Risk	1.1 Client Risk	1.1.1	Type of client and structure of client organisation	NO
		1.1.2	Size of client organisation relative to consulting firm	
		1.1.3	Depending on a single client for a substantial portion of the firm's annual fee income	
		1.1.4	Non-payment or Late payment by client	
		1.1.5	Client insolvency; Inability of client to meet financial obligation	
		1.1.6	Unrealistic project duration target set by clients	
		1.1.7	Poor communication and decision making structure within client organisation	
		1.1.8	Client's legal history; clients having a reputation of being litigious	
		1.1.9	Past experience with client	
		1.1.10	Client performance on previous projects; client having a history of unsuccessful projects	
		1.1.11	Vulnerability of client to prevailing political and economic situation.	
	1.2 Brief, Scope and Contractual Risk	1.2.1	Unclear brief that does not properly state the role and responsibility expected of each party	NO
		1.2.2	Client's expectation higher than that communicated and understood by the engineer	
		1.2.3	Scope creep – broadening scope of services	
		1.2.4	Unclear procedure for variation and expansion of project scope	
		1.2.5	Providing professional advice without a written professional services agreement in place	
		1.2.6	Professional services agreement that does not clearly define terms and conditions of appointment	
1.2.7		Unbalanced risk allocation and limits of contractual liabilities		

Risk Type	Risk Grouping	Risk Factors	Impacted by Discounted Fee? Yes/No
		1.2.8 Terms of contract that are ambiguous and unspecific in terms of: <ul style="list-style-type: none"> <li>- Scope of normal services</li> <li>- Scope of additional services</li> <li>- Quantum and timing of compensation</li> <li>- Site staff for the project</li> <li>- Channels of communication</li> <li>- Client obligations and responsibilities</li> </ul>	
	1.3 Design and Documentation Related Risk	1.3.1 "Time boxing" (allocating set time) of design task	YES
		1.3.2 Designs not being reviewed by experienced colleagues	
		1.3.3 Time pressure resulting from unrealistic project schedule	
		1.3.4 Weak or absence of quality control systems in the design process	
		1.3.5 Insufficient knowledge, skill and experience within the design organisation	
		1.3.6 Over dependence and ineffective utilisation of Computer Aided Design programs	
		1.3.7 Poor coordination and communication between members of the project team	
	1.4 Rework of Design and Drawings	1.4.1 Method of project procurement Method of project procurement (Fast tracked project procurement methods that compress the schedule between design and construction phases of the project or allow both phases to go on concurrently)	YES
		1.4.2 Understaffing of project/Staff strength and work load of firm	
		1.4.3 Quality of staff assigned to the project	
		1.4.4 Schedule pressure	
		1.4.5 In ability of client to make project decisions timely and correctly	
		1.4.6 Quality and timeliness of information from other project consultants (Architect, electrical and mechanical engineers)	
	1.5 Quality Control on Site	1.5.1 Professional services agreement that limit inspection responsibility or totally abrogate such responsibilities to the client	YES

Risk Type	Risk Grouping	Risk Factors	Impacted by Discounted Fee? Yes/No
		1.5.2 Inexperienced site staff engaged for construction inspection services	
		1.5.3 Professional negligence with regards to construction inspection	
	1.6 Financial Risk	1.6.1 Performing work 'at risk'	YES
		1.6.2 'Below cost' tendering	
		1.6.3 Client's treasury and financial control system (applicable to public clients in South Africa) not suitable for project financial requirements and circumstances	
		1.6.4 Unreasonable levels of contractual penalties and liabilities	
		1.6.5 Contract payment tied to project milestones	
	1.7 Professional Indemnity Risk	1.7.1 Difficulty affording professional indemnity insurance premiums	YES
		1.7.2 Premium loadings being applied to jobs evaluated by insurers to be high risk. Low fees jobs are considered high risk	
		1.7.3 Most cost cutting measures adopted by consulting firms border around dishonesty and unethical conduct which are grounds for denial of claims by insurers	
	1.8 Unethical Practices	1.8.1 Conflict of interest; consultants using their position for financial gain	YES
		1.8.2 Revealing tender information	
		1.8.3 Concealing construction faults, poor workmanship and material quality during inspection	
		1.8.4 Altering of construction documents	
		1.8.5 Overstating experience, capability and falsification of qualifications	
		1.8.6 Main consultant cutting the fees of other consultants	
		1.8.7 Consultant withholding information from the client which results in variations	
		1.8.8 Charging clients for work not done, cost not incurred or overstated	
1.8.9 False promises of project advancement			
1.8.10 Misleading clients in project management			

Risk Type	Risk Grouping	Risk Factors	Impacted by Discounted Fee? Yes/No
<b>2.0 Organisational Risk</b>	<b>2.1 Financial Risk</b>	2.1.1 Liquidity and cash flow constraints	<b>YES</b>
		2.1.2 Depreciating asset values	
		2.1.3 Prevailing local and international economic conditions	
		2.1.4 Tax and accounting changes	
		2.1.5 Financial fluctuation and cost overrun on long term projects	
	<b>2.2 Strategic Risk</b>	2.2.1 Lack of investments in research and development	<b>YES</b>
		2.2.2 Inability to recognise and acquire new knowledge	
		2.2.3 Innovation and intellectual capital -Shortage of skilled professional engineers and graduate engineers - Lack of capacity to train and mentor young engineers	
		2.2.4 Staff training and development	
		2.2.5 Competitiveness and maintaining competitive advantage	
		2.2.6 Adapting to changes in the industry and client behaviours	
		2.2.7 Maintaining client relationships to ensure repeat jobs and business sustenance	
		2.2.8 Compliance with codes of conduct and ethics for the profession	
	<b>2.3 Hazards</b>	2.3.1 Contractual liabilities (tendering and contract exposure)	<b>YES</b>
		2.3.2 Staff motivation and morale	
		2.3.3 Disputed communications and contractual disputes	
		2.3.4 Competitors poaching key staff and attendant loss of corporate intelligence	
		2.3.5 Employee staff on site/Health and safety risk	
2.3.6 Damage to organisations properties and assets			

Risk Type	Risk Grouping		Risk Factors	Impacted by Discounted Fee? Yes/No
		2.3.7	Statutory/legislative compliance (compliance with a series of Acts): <ul style="list-style-type: none"> <li>- Basic Conditions of Employment Act, 1997</li> <li>- Skill Development Act, 1998</li> <li>- Broad-Black Economic Empowerment Act, 2003</li> <li>- Construction Sector BEE Charter to the BBBEE Act</li> <li>- Preferential Procurement Policy Framework Act, 2000</li> <li>- Employment Equity Act, 1998</li> <li>- The King Commission Report on Corporate Governance</li> <li>- Occupation Health and Safety Act, 1993</li> <li>- Construction Regulation to the Occupation Health and Safety Act, 2003</li> <li>- Companies Act, 1981</li> <li>- Income Tax Act, 1991</li> <li>- Value Added Tax, 1991</li> <li>- Engineering Profession Act, 2000</li> </ul>	
	2.4 Operational Risk	2.4.1	Threats for Information Communication Technology and globalisation	NO
		2.4.2	Identification, reporting and actioning of project non-conformance (Quality Management Systems)	
		2.4.3	Project management issues	
		2.4.5	Data management; data storage, data protection and data sharing	