

**AN EMPIRICAL EXPLORATION OF SUPPLY CHAIN  
CONSTRAINTS FACING THE CONSTRUCTION INDUSTRY IN  
SOUTH AFRICA**



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**THESIS SUBMITTED IN FULFILMENT OF THE  
REQUIREMENTS FOR THE DEGREE:  
DOCTORIS TECHNOLOGIAE (BUSINESS) IN THE FACULTY  
OF MANAGEMENT SCIENCES,  
VAAL UNIVERSITY OF TECHNOLOGY.**

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## **DECLARATION**

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## ACKNOWLEDGEMENTS

“Live as if you were to die tomorrow, learn as if you were to live forever”, these profound words, uttered by the revered Mahatma Gandhi stood at the forefront of my mind during the compilation of this thesis and even more so as I contemplate the acknowledgments. Our lives are undeniably influenced by those around us and it is therefore important for me to acknowledge as follows:

- I am grateful for the presence of The Supreme Creator in my life and offer this thesis to His Lotus Feet with love, devotion and humility.
- My thesis promoter, Prof. David Pooe of the University of Johannesburg, thank you for your patience, expert advice and for guiding me through this arduous academic journey.
- My thesis co-promoter, Dr. C. Mafini of the Vaal University of Technology, thank you for your guidance and assistance throughout the compilation of this thesis.
- My wife, Veni and sons, Bradley and Caylen, it is your unstinting belief in my abilities that has kept me motivated to take on this challenge and I will be forever grateful for your love and support.
- I recognise the role of my mom and late dad, who instilled in me the social, moral, religious and academic values that have continued to serve me so well to date.
- My sincere appreciation to my colleagues at the Aveng Group, as well as individuals and companies that participated in the research process.
- I acknowledge the pivotal role of grandparents, family, teachers, lecturers, mentors and friends that have encouraged and supported me and played a role in shaping my thoughts, intellect and social awareness, allowing me to arrive at this final academic destination.
- A final tribute to my esteemed forefathers, whom I recognise as brave pioneers and adventurers and who suffered untold humiliation and hardships as indentured labourers on their arrival in South Africa. I salute your bravery, I salute your sacrifices, I salute your strength in rising from the cane fields and I thank you for the opportunities that you have created for your descendants. I honour your legacy and reflect on my roots with pride.

## **ABSTRACT**

The South African Construction Industry is one of the largest contributors to the gross domestic product of the country as well as to employment. It has, however, been experiencing significant challenges due to multifaceted factors. The main objective of this research was to identify the supply chain management constraints within the South African Construction Industry and how these can be overcome. This study is by nature descriptive and exploratory and contains qualitative elements. The problems were identified through a literature review, focused group discussions and interviews with major construction companies in South Africa.

The findings also indicate that the main supply chain management constraints are to a greater extent internal and typical of supply chain methodologies and approaches. These constraints are among others the lack of coordination, collaboration and commitment between suppliers and clients within the supply chain, poor leadership in key areas of systems, design problems (many changes and inconsistent information), deficient internal and external communication and information transfer, inadequate management within the supply chain, mainly poor planning and control just to mention a few.

A model based on supply chain system management as well as the Theory Of Constraints (TOC) has been developed that can be a useful tool to address the constraints in the construction sector. Originating from the study are applicable recommendations for the South African construction industry supply chains, covering key themes that have been articulated in the study, particularly benchmarking to the theory of constraints. Such recommendations include further research core components of supply chain such as, collaborations, logistics and how each of system components can be linked to performance of the supply chain management system.

**Keywords:** supply chain management, theory of constraints, construction industry

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# CHAPTER 1

## INTRODUCTION AND BACKGROUND TO THE STUDY

### 1.1 INTRODUCTION

The construction industry is one of the largest and oldest industries in South Africa and makes a significant contribution to the country's economy (Fayazbakhsh *et al.*, 2013:17). However, the industry faces a number of challenges against a backdrop of slow growth in the economy, socio-economic stress, chronic resource shortages, institutional weaknesses and a general inability to deal with the key issues. Evidence from research suggests that these challenges have become greater and more severe in recent years (Esper *et al.*, 2010:161-179; Gligor & Holcomb, 2012:295-309; Gligor & Autry, 2012:24-43). Therefore there is a need to focus more attention on these challenges in order to generate relevant and current solutions to the problems.

In order to compete internationally, focus can no longer be on the management, survival, growth and competitiveness of individual organisations, but should rather be on supply chains (Blanchard, 2007:22). If supply chain management is well executed, it efficiently integrates suppliers, manufacturers, warehouses and other intermediate value-adding partners so that production and distribution are synchronised with customer demand, thereby reducing the overall system or pipeline costs and satisfying service level requirements (Hugo *et al.*, 2004:66; Esper *et al.*, 2010:161). In this regard, Wisner *et al.* (2005:16) acknowledged that activities in the supply chain are well coordinated when members of the supply chain work together when making delivery, inventory, production and purchasing decisions that impact on the profits of the supply chain. Consequently, if one activity fails or performs poorly, supply along the supply chain is interrupted, which subjects the effectiveness of the whole supply chain to various risks. This emergence of supply chain management as one of the key performance areas for business growth and success provides the incentive for greater attention in the discipline from both management and research practitioners.

### 1.2 BACKGROUND TO THE STUDY

Supply chain management has become a central issue for many organisations as it offers the prospect of making significant cost savings and improving value by enabling companies to work more effectively together across the entire supply chain (Van Weele & Arjan, 2012:19). Its main goal is to reach solutions with optimised profit for all supply chain partners. However, there is

often a great disparity between potential benefits and the practice (Simatupang *et al.*, 2012:12). This situation occurs because there are several difficulties or constraints in supply chains which need to be solved through efficient supply chain management practices (London & Vrijhoef, 2002:139). This creates a need to investigate the nature and impact of the constraints on supply chain management.

According to Waller (2003:677), constraints pertain to anything that limits an organisation, operation or a system from maximising its output or meeting its stated goals or objectives. Some constraints are physical in nature, with typical examples being insufficient plant capacity, labour, capital, raw material and land (Hugo *et al.*, 2004:66). Other constraints may be of a non-physical nature: these include poorly motivated employees, worker absenteeism, lack of training, poor operating procedures, lack of flexibility on part of the union and bad scheduling (Goldratt & Cox, 2000:123). Additionally, very long lead times, large numbers of unfulfilled orders, high levels of unnecessary inventories, the lack of relevant inventories, large numbers of emergency orders, high levels of devolution, lack of key customer engagement, frequent changes and the absence of control related to priority orders also form part of supply chain constraints (Dettmer, 2000:12). Such constraints or bottlenecks occur when there are materials or units accumulating upstream because the next operation has insufficient capacity to accept the load (Waller, 2003:677).

Within the context of the South African construction industry, supply chain management involves integrating the operations of all organisations involved with the delivery of a particular product or service (London & Vrijhoef, 2002:129). The integration in the construction industry in South Africa is such that supply chain partners act as a homogenous entity, thereby ensuring that profit and performance are enhanced throughout the supply chain (London & Vrijhoef, 2002:149). Flores and Primo (2008:12) affirmed that the present needs of the market in the South African construction industry has made the logistic process increasingly complex. It is characterised by higher levels of demand, especially when related to achieving a competitive advantage. Additionally, in this industry, supply chain partners have not been achieving the gains related to profitability and efficiency. This is because in general each entity tends to consider and prioritise its own local constraints, when in fact it should be holistically considering all global constraints related to supply chain management (Flores & Primo, 2008:12). This is in opposition to the suggestion of Wang *et al.* (2012:3741) that the design and analysis of the supply chain *as a whole* are critical to develop an efficient supply chain management system. Therefore, continued discourse and research on supply chain management within the construction industry in South Africa is necessary in order to keep abreast with developments.

### 1.3 THEORETICAL FRAMEWORK

For the purposes of this study, the Theory of Constraints (TOC) is used as the research theory that enables the study to identify constraints or bottlenecks prevalent in the South African construction industry. Through the TOC methodology, a supply chain is analysed by defining it as a group of dependent elements such that the system's global performance is dependent on the efforts of all the elements (Dettmer, 2000:12). The theory is based on the recognition that, in all organisations, nearly all products and services are created through a series of linked processes (Bozarth & Handfield, 2006:221). According to the TOC, every system must have at least one constraint, which is explained by the fact that, if there was nothing to limit the system's performance, it would be infinite (Spencer, 2008:13).

To administer this constraint, the TOC approach includes some issues, such as the drum-buffer-rope scheduling method, the buffer management and the five-step focusing process, which are described later in the study (Goldratt & Cox, 2000:119). Smith (2012:45) asserts that the TOC and constraint management as a whole, constitutes a systems management methodology which measures the constraints of a system in a way that maximises the system's capacity. This implies that constraint management is actually a way of focusing on the most critical aspects of the system, which makes the TOC an effective approach in addressing the critical subject of supply chain constraints in any particular industry (Finch, 2008:660).

Lau and Kong (2012:1) draw attention to the view that constraints in construction projects limit their ability to achieve greater performance. According to Lau and Kong (2012:1), the construction sector should strive to identify the constraints in the working environment of any given construction project and apply the Theory of Constraints, which provides practical steps for making organisational decisions in situations in which constraints exist. If constraints are better understood at the outset, it is likely that better performance will be assured. Presently, constraints in the construction industry are not fully understood. Reinaldo *et al.* (2010:2) have identified five categories of constraints, namely, (1) economic constraints, (2) legal constraints, (3) environmental constraints, (4) technical constraints, and (5) social constraints. In this study, the rationale is that the management and understanding of these constraints should begin with inputs such as information from customers, raw materials, inventory, equipment, machinery, labour and finances. This process is continued at all levels of the supply chain and is important in managing it (Flores & Primo, 2008:19). In this way, productive change is realised which can correct the negative impact of the constraint(s) on supply-chain profitability (Lau & Kong, 2012:2)



## 1.4 PROBLEM STATEMENT

The temporary project-based nature of construction projects hinders integration of construction supply chains (Fayazbakhsh *et al.*, 2013:17; Blowfield, 2013:19). Construction projects often undergo project delays, cost overruns and non-conformance to quality, leading to poor performance and dissatisfied parties (Thomas & Foster, 2007:166; Zaghoul & Hartman, 2013:243). An understanding of the driving forces behind such problems is necessary if the performance of the industry is to be improved. Change can also be a major contributor to challenges faced in the construction industry. Unexpected change which occurs throughout the design and construction phase hinders project success to a significant extent (Bower, 2000:12). In addition, Heng *et al.* (2013:157) speculate that since construction supply chains are highly dynamic in that organisational structures as well as project teams change frequently, it is unlikely that project participant's work together long enough on a project to build enough trust and to share information willingly. This creates a need for further empirical research that could capture both the driving forces behind the challenges faced by the industry as well as the changes taking place in the industry.

There is scant evidence of previous research conducted in the field of supply chain constraints in the construction industry. The limited research that is available (e.g. Thomas & Foster, 2007; Reinaldo *et al.*, 2010; Zaghoul & Hartman, 2013) were based in American, Asian and European environments. It appears that supply chain management research in the construction industries in developing countries such as South Africa has largely been neglected. This is despite the fact that managing and controlling constraints for achieving greater performance in the construction working environment is a critical element of successful supply chain management (Flores & Primo, 2008:17). This creates an impetus to conduct localised empirical studies from which strategies that are tailor-made for the South African construction environment can be drawn. In view of this, this study was intended to address the existing gap in this area by generating solutions that are directly applicable to the unique dynamics associated with the South African construction industry.

In an increasingly competitive and globalised environment, it is indispensable for industries to have supply chain management aligned with the strategy of the company (Waller, 2003:677). Therefore, the construction industry is compelled to redirect its management processes in order to break existing operational paradigms and implement new management philosophies that make it possible to redirect the supply chain management goals toward their profits and their strategic

objectives (Thomas & Foster, 2007:176). As suggested by Reinaldo *et al.* (2010:2), scientific research focusing on the construction industry remains an important avenue for the generation of such new perspectives. In that context, the current study is both relevant and significant in that it is intended to identify challenges existing in the construction industry supply chain and intends to propose innovative ways of minimising them, thereby contributing to the better performance of that industry. This study intended to demonstrate that it would be important for the construction sector to understand the constraints experienced in the supply-chain system as it may be necessary to consider the TOC. Therefore, the purpose of this study was to investigate the constraints in the supply chain facing the construction industry in South Africa.

## **1.5 RESEARCH OBJECTIVES**

For the purposes of this study, research objectives were classified into three categories, namely the primary objective, theoretical objectives and empirical objectives.

### **1.5.1 Primary objective**

The primary objective of this study was to investigate the constraints in the supply chain facing the construction industry in South Africa.

### **1.5.2 Theoretical objectives**

In order to achieve the primary objective, the following theoretical objectives were set for the study:

- To conduct a literature review on the construction industry.
- To conduct a literature review on supply chain management.
- To conduct a literature review on the Theory of Constraints.
- To conduct a literature review on constraints facing supply chain management in the construction industry.

### **1.5.3 Empirical objectives**

The following empirical objectives were set for the study:

- To identify supply chain constraints in the construction industry in South Africa.

- To establish the factors influencing supply chain constraints in the construction industry in South Africa.
- To suggest approaches for mitigating the supply chain constraints facing the construction industry in South Africa.
- To develop a model for minimising the supply chain constraints in the construction industry.

## **1.6 RESEARCH DESIGN AND METHODOLOGY**

The research design involved planning, preparation and execution of a research project (Saunders *et al.*, 2003:389). It also involved activities of collecting and analysing data, developing and modifying theory, elaborating or refocusing the research questions, identifying and addressing validity threats (Remenyi *et al.*, 2005:15). This suggests that the research design process covers all issues from theoretical reading, methodology, empirical data gathering, analysis and the writing process (Creswell & Miller, 2000:124).

This study adopted a qualitative research design. Qualitative research provides insights which are drawn from the research in a natural situation and aims to gain an in-depth understanding of a situation (Zikmund, 2008:302). Qualitative research was selected for use in this study because it allows further probing which gives participants the opportunity to respond in their own words, rather than forcing them to choose from fixed responses, as quantitative methods do. This approach has the ability to evoke responses that are meaningful and culturally salient to the participant and rich and explanatory in nature (Willis, 2007:8). In this study, the research design involved the review of related literature followed by the empirical study.

### **1.6.1 Literature review**

The literature review serves to inform whether the problem identified has been researched, provides ideas on how to proceed, assists in designing the study, points out methodological problems that may be encountered and identifies appropriate data collection instruments (Zikmund, 2008:302). For the purposes of this study, literature related to procurement policies, procedures and documents used in the construction industry as well as other information related to supply chain management, the TOC and general supply chain constraints were reviewed. This data was obtained from journal articles, textbooks, magazines, newspapers and the Internet.

## **1.6.2 Empirical study**

The empirical study involved the following procedures:

### **1.6.2.1 Selection of participants**

In this study, purposive sampling was adopted. According to Welman *et al.* (2007:59), purposive sampling is based on the researcher's knowledge of the research area and the important opinion makers within that research area. It involves the selection of participants based on their experience and knowledge of the particular research field (Zikmund, 2008:400). The participants in this research were junior and senior managers drawn from organisations that participate in the construction industry supply chain. The researcher's knowledge of the South African construction industry enabled the researcher to approach senior and high profile individuals, including chief executive officers, to participate in the study.

### **1.6.2.2 Data collection methods**

For the purposes of this study, data was collected using two main avenues of inquiry - focus group discussions and in-depth interviews.

### **1.6.2.3 Focus group discussions**

Focus group discussions were held in each of the study areas as one way of comprehensively bringing specific voices in construction into the research. According to Yin (2007:212), a focus group discussion is a form of group interviewing in which a small group of individuals is led by a moderator (interviewer) in a loosely structured discussion of various topics of interest. Focus group discussions were deemed as applicable as they enable different groups that are identical in demographic and characteristics to have different thoughts on the same subject. The researcher, who has wide experience in the construction industry, facilitated these meetings. It was envisaged that focus group discussions, each comprising between seven and twelve participants (Yin, 2007:212) drawn from a cross-section of construction companies, be held until a point of saturation was reached, where no new perspectives emerged from participants.

As noted earlier, it was common that attitudes and opinions differed from group to group, regardless of their apparent homogeneity. Due to the very subjective nature of focus groups, two focused discussions were held with each key stakeholder segment, to confirm any findings. Thus, junior and senior project and supply chain managers were seen as distinct and important segments,

such that two groups were assembled. The course of the discussion was planned in advance and tailored to address the empirical objectives of the study. As recommended by Lee and Lings (2008:228), a digital voice recorder was used to record the focus group discussions. Permission to record the discussions was requested from the participants.

#### **1.6.2.4 *In-depth interviews***

Purposive sampling was conducted in order to select 25 senior managers from selected construction companies. Semi-structured interviews were conducted with each selected participant. Semi-structured interviewing describes a range of different forms of interviewing whose defining characteristic is that they have a flexible and fluid structure (Lee & Lings, 2008:228). The aim is usually to ensure flexibility in how and in what sequence questions are asked and in whether and how particular areas might be followed up and developed with different interviewees (Maxwell, 2005:96). The structure of a semi-structured interview was organised around an interview guide. This contained topics, themes or areas to be covered during the course of the interview, rather than a sequenced script of standardised questions. This was done so that the interviews were shaped by the interviewee's own understandings as well as the researcher's interests and is non-predictive.

The interviews were held at designated sites after an informed consent document, as well as permission from the key stakeholders had been obtained. It was envisaged that each interview would run for a period ranging between 20 and 30 minutes. The in-depth interviews were recorded using a digital voice recorder, in line with the prescription by Lee and Lings (2008:228). Permission to record these proceedings was sought from each participant prior to the interviews.

### **1.7 DATA ANALYSIS AND INTERPRETATION OF RESULTS**

Before analysis, the data collected from both the in-depth interviews and focus group interviews was transcribed from the voice format into a text format, as recommended by Kvale and Brinkmann (2009:178). This was achieved by soliciting the services of a trained professional transcriber. Thereafter, the interview and focus group transcripts were read through a number of times in order to draw out the key points and themes emanating therefrom, in a process known as content analysis (Maxwell, 2005:96). The researcher used ATLAS.ti software package for data analysis. ATLAS.ti is a workbench for qualitative data analysis, particularly for large sections of text, visual and audio data that is largely relevant to this form of study (Smit, 2002:3)

The researcher read the data transcripts a number of times and certain themes began to appear (Maxwell, 2005:96). The themes were then grouped into more manageable groups of sub-themes, before a summary table of the main themes originating from the participants' views was drawn up (Thorpe & Holt, 2008:116). These themes formed the basis of the conclusions and recommendations for this study.

## **1.8 MEASURES OF TRUSTWORTHINESS**

Trustworthiness entails validity and credibility of information provided to an enquirer (Saunders *et al.*, 2003: 99). In this study, Maxwell's (2005:106) four trustworthiness indicators, namely credibility, conformability, transferability and dependability were adopted.

### **1.8.1 Credibility**

Credibility is perceived as a quality that emerges on evaluation of information or research work by experts (Donaldson *et al.*, 2009:52). In this study, credibility was ascertained through the triangulation method. Triangulation entails the use of different data collection methods within one study in order to ensure that the data is authentic (Saunders *et al.*, 2003:99). Triangulation is also a way of trying to enhance validity by looking at the issue from different angles, for instance types of method or different analysis techniques. It can also be used to enhance the richness of the data set (Lee & Lings, 2008:239). In this study, triangulation was established by collecting data using a combination of focus group interviews, semi-structured interviews as well as from previous literature. Moreover, comparisons were made on the data collected from interviews with participants, field notes and those obtained from the literature sources.

### **1.8.2 Conformability**

Conformability refers to the ability to convince readers that the researcher was not influenced by biases that are based either on one's own personal values or theoretical background (Lee & Lings, 2008:210). To ensure conformability in this study, an audit trail was completed throughout the study to demonstrate how each decision was made. Further, member-checking (Corbin & Strauss, 2008:292) was applied as the researcher interacted with the participants during the interview planning stage and after interviews in order to gather any additional material from written feedback and compliments.

### **1.8.3 Transferability**

Transferability is the extent to which the findings of the study can be transferred to other contexts (Lee & Lings, 2008:228). In this study, transferability was ascertained through noting the specific details of the research situation and methods and comparing them to a similar situation that they are more familiar with within the construction supply chains. If the specifics are comparable, the original research would be deemed more credible. The researcher ensured a highly detailed description of their situation and methods.

### **1.8.4 Dependability**

Dependability or reliability relates to how well a researcher can assure readers of his/her findings and the way he/she arrived at them from the raw social context (Corbin & Strauss, 2008:292). In this study, dependability was ascertained through avoiding mistakes in conceptualising the study, collecting the data, interpreting the findings and reporting results. The more consistent the researcher is in this research process, the more dependable are the results.

## **1.9 ETHICAL CONSIDERATIONS**

Ethical considerations are required in research in order to remove misconduct in scientific research. Unethical activities include *inter alia* violating non-disclosure agreements, breaking participants' confidentiality, misrepresenting reports, deceiving people, using invoice irregularities and avoiding legal liabilities (Cooper & Schindler, 2008:34). In this study, the following ethical considerations were followed:

- **Scientific validity:** The research was conducted in a manner that ensures its academic integrity and scientific validity. Unethical practices such as fabrication and plagiarism were avoided.
- **Participation:** The privacy of participants was observed and the anonymity of participants was maintained. Anything learnt about participants during their involvement in the study was maintained in confidence.
- **Sharing results:** All researchers are directed at broadening the base knowledge in the field. Knowledge of this research was shared with participants in the study.
- **Requesting for permission to conduct the study, the right to non-participation and protection from harm** were observed.

Over and above these, the ethical issues were highlighted in the research introductory letter that was sent to the participants on their acceptance to participate in the interview. The letter provided an undertaking of confidentiality between the researcher and each participant.

## **1.10 DEFINITION OF KEY CONCEPTS**

The following are key terminologies occasionally used throughout the study.

### **Supply-chain Management**

The supply chain was defined as “the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer” (Christopher, 1992). The supply chain involves the upstream suppliers of raw materials to companies that manufacture products and supply-finished goods downstream through distribution centres to retailers that sell them to the end users/consumers (Barnes, 2008: 211).

### **Theory of Constraints (TOC)**

The Theory of Constraints (TOC) philosophy was developed in 1990 by Goldratt (Goldratt, 2001-2009:9). This theory assumes that there are only a few constraints in any given system; usually just one. A constraint is defined by Goldratt & Cox (1992:12) as “any element or factor that limits the system from doing more of what it was designed to accomplish (*i.e.* achieving its goal)”. Systems’ constraints may be physical (e.g. machinery, specialised personnel or raw materials), policy (when the policies of an organisation are not adjusted in response to changes taking place within the environment it operates) or behavioural (existing practices in an organisation). The TOC philosophy is based on the recognition that nearly all products and services are created through a series of linked processes (Bozarth & Handfield, 2006:222).

## **1.11 CHAPTER SUMMARY**

This thesis is divided into the following chapters:

### **Chapter1: Introduction and background to the study**

This chapter outlines the background of the research and the research problem. The theoretical and empirical objectives plus the research question are also addressed. The chapter also attempts to define common terminologies used in the construction supply chain industry.



## **Chapter 2: Overview of the construction industry in South Africa**

This chapter provides an overview of the construction industry in South Africa. The chapter also addresses the nature and development of the industry as well as the challenges and opportunities it is facing currently.

## **Chapter 3: Supply chains and supply chain management**

This chapter focuses on supply chains and supply chain management. It also looks into construction supply chain and demonstrates how the two are related.

## **Chapter 4: Theoretical background of the study**

The chapter discusses the systems theory and the Theory of Constraints. It also explains the relevance of these two theories for the study.

## **Chapter 5: Research methodology and design**

This chapter outlines the research design, sampling methodology, data collection and data analysis procedures employed in this study.

## **Chapter 6: Data presentation and analysis**

This chapter provides the findings of this research.

## **Chapter 7: Conclusions and recommendations**

This chapter presents some concluding remarks on the research and offers a few recommendations. It highlights the most important findings of the study.

## **CHAPTER 2**

### **THE CONSTRUCTION INDUSTRY IN SOUTH AFRICA**

#### **2.1 INTRODUCTION**

This chapter reviews the literature focusing on the developments within the construction industry in South Africa. It discusses South Africa's construction industry, including the role of construction, the characteristics of the construction industry and the difficulties as well as challenges experienced in construction projects in the country. This discussion is important because investigating the supply constraints within the construction industry requires an understanding of the industry locally and globally. It is also important to draw a comparison between the South African and the global supply chain industry.

#### **2.2 RECENT DEVELOPMENTS IN THE GLOBAL CONSTRUCTION INDUSTRY**

The construction industry delivers its products in complex environments that are unique to each specific project with regard to attributes such as workforce, technologies, contract arrangement, location and owner requirements. The global construction industry contributes about 15% of the world economy (Construction Industry Development Board, 2013:8). The construction sector is one of the most important industries in an economy. The efficiency and effectiveness of the sector's products determine the overhead costs paid for built infrastructure by the entire economy and this has a critical influence of the competitiveness of each nation (Toakley & Marosszeky, 2009:21).

Many governments are actively promoting more efficient and effective local construction industries to improve resource utilisation and productivity for the greater good of their local populations. Love *et al.* (2004:19) cite studies in Australia, Finland, Hong Kong, Norway, Sweden, Singapore and the United Kingdom that call for radical improvements in the quality and productivity in the construction industries of these countries. Many studies in these and other countries point towards a general lack of proper focus on Supply Chain management in the construction industry (Love *et al.*, 1999; Oakland & Aldridge, 2005; Smith & Li, 1999). This lack of emphasis seems to be a global phenomenon and has been attributed to various factors such as the fragmented nature of project supply chains, a lack of holistic understanding of supply chain management principles, the difficulty in applying a consistent approach to supply chain

management across multiple unique project environments and the perceived lack of clear financial benefits from implementing quality systems

In the current competitive environment, Toakley and Marosszeky (2009:21) mentioned that there are trends in the construction industries that companies need to consider to ensure that they keep abreast with the competition. In order to keep pace with these trends, companies monitor industry-related activities across the board. For example, Toakley and Marosszeky (2009:21) further asserted that industry publications keep track of not only the latest information and project announcements, but the latest construction industry trends. They can cover these trends in in-depth stories, interview the major players who have helped in developing the trends or simply note the trend through numeric data. While historically these publications have been magazines or newspapers that have come out in print, more recent activity has trended towards the Internet. There are now many websites - including those that are part of the same parent company as the print products - offering news and analyses on the latest construction industry trends on a daily basis.

According to Oakland and Aldridge (2010:32), one of the most important current trends in the construction industry is the introduction of Building Information Modelling (BIM) technology to the marketplace. BIM goes beyond traditional three-dimensional modelling since it not only performs the tasks conducted by previous programmes, but can also perform these tasks in real time. For instance, besides the ability to make a complete design of the building, BIM is able to correctly show special relationships including geographic information. Furthermore, BIM monitors the quantities and properties of building components, as well as scheduling and budget issues. It contains all the information in a single workspace, which supporters say will greatly accelerate the design and building processes.

As mentioned by Kujawa and Prinsloo (2013:12), another key development in the construction industry is the movement towards sustainable, or green construction. Increasing numbers of contractors are beginning to specialise in sustainable construction in a fashion that improves efficiency with a less impact on the environment. As emphasised by Kujawa and Prinsloo (2013:12) some contractors look to the LEED (Leadership in Energy and Environmental Design); which is an ecology-oriented building certification programme under the auspices of the U.S. Green Building Council (USGBC). The authors emphasise that the programme concentrates its efforts on improving performance across five key areas of environmental and human health:

energy efficiency, indoor environmental quality, materials selection, sustainable site development and water savings.

Furthermore, Cheng *et al.* (2013:2) mentioned that it has special rating systems that apply to all kinds of structures, including schools, retail and healthcare facilities. Rating systems are available for new construction and major renovations as well as existing buildings. According to the authors, the development of the LEED (Leadership in Energy and Environmental Design) programme has helped spur this innovation in the construction industry. With contractors working to build LEED-certified buildings, their approach and development of construction projects are rapidly changing.

### **2.2.1 The South African construction industry in a global context**

Generally, the construction industry is a sector of the economy, which is responsible for the planning, design, construction, maintenance and eventual demolition of buildings and works (Kujawa & Prinsloo, 2013:12). It is essentially a service industry that obtains its inputs and outputs from various sectors of the economy with which it is interrelated and interlinked, often in quite complex ways (Loxton, 2004:17). The importance of construction derives from its role in the generation of constructed physical facilities and in employment, which in turn, play a critical and highly visible role in the development of the country. Construction encompasses all civil engineering work and all types of new building projects (including housing), as well as the maintenance and repair of existing facilities (Kujawa & Prinsloo, 2004:12). In South Africa, as much as one half of the total construction output may be in civil engineering projects – transport facilities, power projects, irrigation, drainage and water supplies, among others (Loxton, 2004:17). Housing generally makes up less than one third of the total output. The remainder is in other buildings such as hospitals, schools, offices, factories, hotels and agricultural buildings (Kujawa & Prinsloo, 2004:12).

South Africa has not escaped challenges related to the lack of a focus on quality in the construction industry. The South African construction industry is under pressure due to a combination of factors such as skills shortages, lack of standardisation, delays in payment, increased fee competition and variable quality (Loxton, 2004:11). A report on the status of the construction industry highlights that only about half of the projects are delivered on schedule, within the budget and relatively defect free and that there is low satisfaction with the performance of contractors and consulting professionals (Construction Industry Development Board (CIDB), 2004:12). In their discussion of some of the problems caused by poor performance of contractors in the South

African construction industry, Dlungwana *et al.* (2012:12) identified quality as one of the predominant problems facing the industry. It appears that quality of construction projects remains a major challenge in the construction sector in South Africa.

A decline in the demand for construction services in South Africa in the last decades of the previous millennium led to instability and interconnected structural problems within the industry. In 2000 the South Africa Government enacted legislation (Government Gazette, 2000:12) that called for the establishment of a Construction Industry Development Board (CIDB). The purpose of the CIDB is to implement an integrated strategy for the reconstruction, growth and development of the construction industry in South Africa. Government has a vision of developing a growing, internationally competitive local construction industry, and creating sustainable employment and addressing historic imbalances. This seems to imply that the industry will require strong leadership and the promotion of best practices.

Increasing infrastructure spending has made South Africa an attractive market for foreign contractors (Price Water House Coopers (PWC), 2013:5). The South African construction industry has recently come under increasing pressure due to globalisation and the opening up of local markets. The recent award of a major infrastructure project to Chinese contractors has rocked the local industry (PWC, 2013:5). Creamer (2006:11) notes that concerns have been raised that Chinese contractors entering the market are subsidised by their government and are competing based on non-market related cost structures and may ultimately overwhelm the local construction industry. Hill (2009:19) mentions that the South African Federation of Civil Engineering Contractors (SAFCEC) questioned whether the South African industry was ready to meet the challenge of international competition, specifically from China, which has developed a surplus capacity in its domestic construction industry. China was reportedly “churning out” engineers and is able to offer engineering service on a very cost competitive basis (SAFCEC, 2013:13). Urgent action was called for to prepare the South African local industry for global competition (Hill, 2009:26). SAFCEC (2013:13) advocated for in depth dialogue between all stakeholders to ensure the preservation of the local construction industry.

Issues that were to be addressed included ensuring that foreign companies abided by South African law and that the needs of South Africa were taken into consideration. Despite calls for measures to protect the local construction against foreign competition, the Minister of Public Enterprise in July 2006, made it clear that government was not going to intervene to protect local companies from foreign multinationals competing for tenders in South Africa (Mantshantsha,

2006:14). The minister stressed that the local construction industry had to become internationally competitive, in line with the vision that government articulated for the construction industry (Government Gazette, 2000:9).

Recent trends are also showing a reduction in skills in the construction industry in South Africa. For instance, the Engineering Council of South Africa (ECSA, 2014:11) noted that the number of professional engineers registering have declined in recent years. The numbers of students registering for engineering and related studies have also declined. ECSA also recorded a fourfold increase in the number of complaints over registered professionals in the last three years (Venter, 2013:21). The ratio of engineers to the general population in South Africa also compares dismally when matched to other countries (Theunissen, 2012:18). South Africa has one engineer for 166 people, China has 130, India has 157, the UK has 311 and the USA has 389. Furthermore, as noted in a summary of an industry status by Van Huyssteen (2012:11), even where clients are satisfied with the quality of the delivered construction product, they are often dissatisfied with the level of quality of the professional services offered.

In the longer term, prospects for the industry will be influenced by the South African government's medium-term expenditure framework and investment programme over the next three years in areas such as infrastructure projects (Aveng, 2011:5), as well as a number of other significant influences such as the Accelerated and Shared Growth Initiative for South Africa (ASGISA) and the Joint Initiative for Priority Skills Acquisition (JIPSA).

This section analysed the literature focusing on the global construction industry. The literature showed that the South African construction industry is one of the developed and complex construction industries in the global perspective. It also emerged that the South African construction industry is not immune to global supply chain management drivers. Therefore, measures should be taken to ensure that such strategic dynamics within the construction sector are understood properly.

### **2.3 PROFILE OF THE CONSTRUCTION INDUSTRY IN SOUTH AFRICA**

A report produced by Boutek (2010:12) pointed to the weaknesses and what the industry would need to do to measure improvements. The report also evaluated the South African construction industry against global standards on competitiveness. The commissioned work provided information that was used in the South African Construction Industry Status Report 2010 of the CIDB (CIDB 2010:12). The first part of the report examined the impact of the economy and the

regulatory environment on the performance of the construction industry. It further assessed the capacity of the public sector to translate government's increasing capital expenditure budget into improved construction industry delivery. The report argued that these influences played a fundamental role in ensuring enhanced construction industry performance in the medium term.

The second part of Boutek's (2010) report examined the imperatives of sustainable construction activities internationally. It also examined the socio-economic context driving the global debate on sustainable growth and development with an assessment of twenty four key areas to which construction activities needed to become responsive. Of these, contractor competitiveness was one (CSIR, 2012:15). At the time of commissioning the report, the CSIR had just been launched and there were a total of 457 contractors that were registered. Currently, the construction industry is comprised of 113 937 active registered contractors (PWC, 2013:5). Of that number, no less than 78% are made up of what the industry would classify as SMME contractors and elucidated in the definition in the South African context as a full spectrum of businesses other than large corporations and publicly owned enterprises.

SMME firms include categories known as micro-enterprises, survivalist-enterprises, informal sector enterprises and formal small and medium-sized enterprises. It also covers all businesses in all stages of evolution otherwise referred to as start-ups, emerging or expanding enterprises. The term also characterises family-owned, black-owned, women-owned or co-operatively owned enterprises (DTI, 2005). This finding indicates that the construction industry's make-up is largely out of balance with the initiatives of government: where the percentage spent on economic infrastructure are targeted at large contracting firms when in fact the capacity of the industry is made up of SMMEs.

Smallwood (2006:22) lists eleven (11) resources that when amassed by contractors, render them capable to perform within an active construction industry. Smallwood's articulation supports the work of Fellows (2012:19) in which the definitions of requisite contractor resources are listed as: capital, management skills, other skills, having premises and facilities. There is general consensus in industry on these as no counter-argument exists against them. However, statistical evidence exists which suggests that the SMMEs to whom government's development interventions are targeted do not possess even half of these resources. Without these resources, SMMEs are rendered incapable to perform and are consequently not competitive (Fellows, 2012:19).

The CIDB (2014:3) is currently engaged in a process of establishing a register for professional

services. At the time of completing this research there were only two registers within the suite of services offered by the CIDB and these are the Register of Contractors (RoC) and the Register of Projects (RoP). The RoP Services will provide a comprehensive overview with regards to all participants engaged in the value chain of the construction sector from the design and management sub-components. It will also look at the individual size of the firms engaged in design and management consulting within the sector and the percentages in relation to the size of the sector. For the purposes of this study, not much would be explored on the side of design and consulting firms even if they fall within the definition of SMMEs because the consulting participants are not yet known. The focus of this research is largely within the graded contractors between grades 9 to 5 as justified throughout this study.

One of the issues that is generally not considered about the South African construction industry is that it still relies on labour brokers and at the time of conducting this research there was a recurrent political discourse on whether or not they ought to be scrapped (Watermeyer, 2010:5). The case for abolishing labour brokers within the construction industry is geared towards establishing more permanent employment of labour that will reduce the intermittent nature of contract labourers and create stability of employment within the construction industry (Watermeyer, 2010:5). Currently, construction workers earn significantly less if contracted through brokers (Naledi, 2010:18).

However, the conundrum is that because the construction industry is largely project-driven, it is unlikely that firms would make permanent appointments as most of them would not be able to sustain large workforces. The outcome of this debate, initiated by organised labour, has relevance for the South African construction industry and in particular the construction SMMEs as they employ about 80% of the contract workforce for delivery on construction projects (Watermeyer, 2010:5).

When asked to assess the character of the South African construction industry and offer submissions related to where further strengths may be required Ofori (2013:19) makes the following interesting observations:

- a greater understanding of the industry by construction SMMEs is imperative;
- an increased maturity in policy development by the sector is required;
- better awareness of nature and needs of SMMEs, especially in construction is necessary;



- development of more appropriate and better-focused policies, programmes, initiatives for SMME development is crucial;
- more readily available guidance books and on-line resources for better training programmes is required;
- better and user-friendly tools and techniques, many of which are computer-based are required;
- greater understanding of value-chain benefits and benefits of competition is essential; and
- greater solidarity among businesses and their leaders to foster common interests is imperative.

Ofori (2013:19) further suggests that if the above mentioned activities can be implemented, a new breed of SMME entrepreneurs would emerge and they would be:

- more aware: going beyond being better informed;
- able to inspire (employees, clients and partners) in order to attain greater joint performance;
- strategic in orientation;
- better able to deal with risk and uncertainty; and
- adept at participating in alliances and partnerships.

From another perspective, the strategies and operational relationships between construction project parties are directly related to the type of construction project that could be classified in different ways. According to Statistics SA (2013:21), the following are the three major construction categories:

- Heavy and highway: construction of highways, bridges, airports, pipelines, dams and tunnels.
- Non-residential buildings: either institutional or educational buildings (such as schools or universities, warehouses and government buildings) or industrial (such as petroleum refineries or nuclear power plants).
- Residential: construction of single-family homes, multiunit town houses, or high-rise buildings.

Statistics SA (2013:25) further mentions that the types of projects most common in the South Africa construction industry and which are considered to be the backbone of South Africa's development efforts, include the following:

- Public housing
- Schools or Universities
- Industrial facilities
- Commercial buildings
- Power plants
- Dams
- Irrigation system
- Roads and transportation
- Water purification plants
- Health and sanitation facilities
- Government buildings

In summary, aspirant leadership and entrepreneurship is essential for the growth of the construction industry in South Africa and across the continent (Ofori, 2013:19). Although several funding and support initiatives are already in place, a greater need for leadership is essential for sustainable development. The research subjects targeted in this research may provide insights in which the sector achieves that ambition. Leadership is critical at project and enterprise levels for construction companies (Ofori, 2011:19).

#### **2.4 THE ROLE OF THE CONSTRUCTION INDUSTRY IN THE ECONOMY**

According to the Council for Scientific and Industrial Research (2003:9), construction makes up more than half of the total national capital investment in most countries and can amount to as much as 10 percent of the gross domestic product (GDP). *Who Owns Whom* (2008:11) highlights that the construction industry accounts for 3.8 percent of GDP in South Africa and has been the fastest growing sector of the economy in the past five years. Statistics South Africa (2007:9) estimates that the total income for the construction industry in 2007 was R169.25 billion.

Infrastructure and construction activity in South Africa has largely been underpinned by the government's infrastructure investment programme. For instance, the government's spending priorities over the past few years have included infrastructure investments to support industrial development through ensuring that adequate public infrastructure is in place and as a means of

creating jobs (Jurgens, 2010:31). The 2010/2011 budget speech tabled by the Minister of Finance, Pravin Gordhan, indicated that government had planned to spend approximately R864 billion on infrastructure over the next three years. About 85.3 percent of this funding was to be channelled towards the provision of infrastructure for electricity generation, roads, pipelines, bulk infrastructure for water and sanitation and housing (Jurgens, 2010:31).

*Who Owns Whom* (2010:9) estimated that in South Africa, infrastructure construction as a percentage of the total construction industry in 2009 was approximately 56 percent. They further projected that expenditure on public sector capital was expected to reach 9.8 percent of GDP by 2012/13. According to research conducted by CSIR (2003:32) the construction industry has a multiplier effect on the economy as a whole because it is considered that one job in construction gives rise to two further jobs in the construction and other sectors of the economy.

The construction industry is a key barometer of economic performance (Statistics SA, 2010:8). The construction industry contributes a significant percentage of the gross domestic product (Statistics SA, 2010:8) of countries and provides employment to a substantial proportion of the working population. The construction industry plays a major role in the economy and investment in the construction sector (including residential, non-residential and civil construction works). The industry recorded an expansion of 0,9% y/y for 2011 quarter four and has improved from the negative growth rates that were recorded between 2010 quarter one to 2011 quarter three. The total construction investment that took place in 2011 quarter four amounted to R171,73bn from R170,27bn in 2010 quarter four (Statistics SA, 2010:31).

Statistics SA (2011:9) noted that investment growth in civil works increased by 2,3% year on year in 2011 quarter four improving from a 1,7% y/y growth rate measured in 2011 quarter three. GFCF measured R110,36bn in the fourth quarter of 2011, up from R107,89bn in 2010 quarter four and increasing from R109,65bn investment values recorded in 2011 quarter three. There has been a serious contraction in the investment in residential buildings in the last 17 quarters. GFCF in residential contracts for the last quarter of 2011 amounted to R24,29bn from R24,83bn in 2010 quarter four. Although the residential sector remains under pressure, there has been an improvement in demand for housing, specifically smaller more affordable units, which is likely to enhance construction investment within the sector slightly.

The State of the Construction Industry (2012:11) report recorded an annual contraction rate on non-residential investment of 1,3% in 2011 quarter four from the previous quarter's decline of 2,6% per year. Non-residential investment fell to R37,08bn in the last quarter from R37,56bn in

2012 quarter four. Investment by general government grew by 3,1% per year in 2012 quarter four, escalating from the 1,1% per year increase measured in the 2012 quarter three. GFCF in monetary value rose from R52, 24bn (2012 quarter three) to R53, 83bn (2012 quarter four).

Private enterprises and public corporations recorded increases of 5, 5% per year and 7,7% per year in 2012 quarter four, respectively. The total investment value for private sector investment amounted to R248, 15bn, while public corporations amounted to R86, 5 1bn in 2012 quarter four. Civil construction works made the largest contribution to total GFCF of 28, 4% for the fourth quarter of 2012, from the previous quarter's contribution of 31%. The non-residential sector's investment held a share of 9, 5% total GFCF, slowing from the 11% contribution recorded in 2011 quarter three. Residential investment construction contributed 6, 3% to total GFCF, after a 7% contribution measured in the third quarter. Off the total investment expenditure that took place in the construction sector, 64, 3% went into civil projects, 21,6% was invested into the non-residential sector, while only 14,1% of total expenditure was invested into the residential market (Statistics SA, 2013:12)

According to Quarterly Financial Statistics (2011:8), profitability in the construction sector improved in the last two quarters of 2011, up 6, 4% per year in 2011. These profitability growth numbers came off a low base, but showed substantial improvement from the -44, 4% per year and - 81, 3% per year declines in profit values measured in the first and second quarters of 2011, respectively. Profitability improved to an average estimated rate of 5, 7% in the second half of 2011, compared to an average of 1.7% in the first half of 2011. Spending on capital expenditure (including buildings, improvement, plant, machinery, furniture and fittings and vehicles) fell by 40% per year in the 2011 quarter four, although spending on vehicles did increase by 25% since 2011 quarter three.

Quarterly Financial Statistics (2012:13) further reports that in 2011, actual construction expenditure was R7.3 billion below the forecast for the year. For new construction expenditure, the difference was only R1.5 billion with the R6.5 billion and R8.5 billion underspent by municipalities and extra-budgetary accounts, respectively. However, these were partially offset by higher expenditures in public corporations (R11.3 billion) and National Government (R2.0 billion). The remainder of the difference is explained by delays in major renovation projects. The private sector, usually led by the mining industry, has also been a significant contributor to total construction expenditure. The growth in the order book during 2013 was 1%, as opposed to 16%

for 2012. The secured order book now only covers 1.2 times current-year revenue as opposed to the 1.5 times of the prior year (Statistics SA, 2012:21).

In summary, it appears that the South African construction industry contributes a significant percentage to Gross Domestic Fixed and Capital Formation. The industry is critical to infrastructure development and provides a sizable contribution to fixed capital formation relative to other industries (Statistics SA, 2011:9). Construction is relatively labour-intensive in that it uses a larger number of workers per unit output than most other industries and is an important employer of labour. The industry employs 5 – 15 % of the labour force in South Africa (UNIDO, 2013).

## **2.5 CHALLENGES FACED BY CONSTRUCTION INDUSTRY IN SOUTH AFRICA**

Construction industries in all countries face many difficulties and challenges (Kujawa & Prinsloo, 2004:12). However, the problems facing the construction industry in South Africa are significantly more fundamental, more serious and more complex. In South Africa, these difficulties and challenges sit alongside the general situation of socioeconomic stress, chronic resource shortages and a general inability to deal with key issues (Kujawa & Prinsloo, 2004:12). Whilst in all countries, the construction industry faces conditions of uncertainty and risk; the sources of such risk are more severe in South Africa and may include instability, low productivity, unskilled labour force, corruption, government influence and informal sector activities.

### **2.5.1 Instability**

Construction is one of the first industries to feel the effects of an economic recession (United Nations Industrial Development Organisation (UNIDO, 2013:22). This phenomenon, coupled with financial and other business risks, makes the development of this sector difficult. The construction industry is volatile; however, instability and volatility are more severe in South Africa where resources are scarcer (Kujawa & Prinsloo, 2004:14). Discontinuities and fluctuations which characterise construction demand are also volatile in South Africa (Vogt *et al.*, 2010:12). For this reason, local contractors are not able to maintain and develop permanent supervisory staff and skilled labour, nor can they establish an appropriate supply of basic equipment. Although clients (usually the government) may require the use of local contractors to do the work, there may be very few qualified local contractors available (Vogt *et al.*, 2010:12).

### **2.5.2 Relatively unskilled labour forces**

Construction activity in South Africa draws mostly on unskilled labour. A reliable supply of labour will be affected largely by the seasonal demand for agricultural labour (Kujawa & Prinsloo, 2004:14). South Africa promotes labour-intensive construction to provide social and economic advantages for the population, even though this procedure might hinder the quality and completion of the construction projects (UNIDO, 2013). Although labour is abundant in South Africa there tends to be a shortage of skilled labour (Institution of Civil Engineers, 2010:14).

Modares and Sepehri (2009:15) reveal that within the construction environment companies have not focussed on development procurement/supply chain skills and competencies and they have kept buyers at the level of administrative clerks in the past. World class practices in procurement were unheard of and most procurement decisions were made by site agents, contract managers and engineers. When viewed in the context of global advancements in practices, construction companies in South Africa tend to be around 12-15 years behind their international peers and are still stuck in a tactical buying mind-set, whilst the world is progressing towards strategic sourcing and or commodity management. Most procurement staff scored poorly when measured against the key competencies required of procurement professionals (UNIDO, 2013:12). This problem is based on the general premise that as the supply chain management environment is changing, there is a changing skill set required for success (Handfield, 2013:1).

Furthermore, Sharp (2011:11) mentioned that there is a crisis in training in South Africa. The proportion of trainees in the workforce appears to have declined by half since the 1970s and there is increasing concern about skill shortages in the industry. Too few people are being trained to replace the ageing skilled workforce and too few are acquiring the technical and managerial skills required to get full value from new techniques and technologies. Construction also lacks a proper career structure to develop supervisory and management grades. The lack of skills is apparent in that, in terms of logistics performance, South Africa is currently ranked as number 23 in the world. The country's ability to perform more effectively is largely hampered by logistics competence (Logistics Performance Index, 2012: 6).

### **2.5.3 Low levels of productivity, overruns and excessive wastages**

Research into construction projects in some South African companies indicates that by the time a project is complete, the actual cost exceeds the original contract price by 30% while change orders result in an 8.3% cost overrun (Jain & Benyoucef, 2008:32). Both housing and public

buildings experience delays in completion and face constant modifications as work progresses. This has proven to be a serious and very expensive problem in South Africa's construction industry (Jain & Benyoucef, 2008:32). The successful execution of construction projects, keeping them within estimated cost and the prearranged schedules, primarily depends on the existence of an efficient construction sector. The sector must be capable of sustained growth and development to cope with the requirements of social and economic development and to utilise the latest technology in planning and execution. Adequate planning at the early stages of a project is critical for minimising delays and cost overruns (Modares & Sepehri, 2009:15).

#### **2.5.4 Corruption, fraudulent practices and the inability to adopt best practice**

The State of the Construction Industry (2012:21) report mentioned that the cost of materials, fraudulent practices and kickbacks and fluctuations of material prices are among the most important factors leading to high construction costs in South Africa. Contractors, therefore, may need to increase their budget to allow for 'hidden taxes/costs' in South Africa. Further, the system of competitive bidding does little to alleviate these constraints. In theory, the system of accepting the least cost bid should encourage efficiency; however, contractors, particularly small ones, have very little room for manoeuvre in pricing a tender. The design is fixed, the cost of the material to be used is fixed and rates for hired equipment are fairly standard. Modares and Sepehri (2009:25) emphasised that a contractor therefore makes a profit by limiting overhead costs, raising labour productivity and/or rationalising site organisation.

Furthermore, Modares and Sepehri (2009:25) held the view that small contractors also have the difficulty of obtaining credit, as there is no continuity of work and no assurance of jobs. They cannot afford or obtain credit for the purchase of plant and equipment. As a result, they are often trapped in a sequence of inefficient technology, leading to low productivity. In contrast, the large contracting firms, which are often foreign owned, are well versed in the procedures governing the industry and also have little difficulty in providing the necessary bonds and guarantees.

#### **2.5.6 Government influence**

Many of the construction projects in South Africa are so large and costly that they can only be accomplished by direct government involvement. The government of South Africa generally sets the rules for the development of contractual relationships, thereby influencing the public construction sector. The private sector also feels this influence through policies and legislation regarding licenses and permits, sanitary and building codes, minimum wage rates, corporate

taxes, rules on importation of materials and terms and availability of financing for construction (World Bank, 2014:14). While the construction industry in developed countries is affected by political institutions, it is not as strongly affected as in South Africa. Contractors may, therefore, need to exercise caution, accept greater levels of risk and purchase additional insurance to cover possible losses. Government responsibility to ensure that improvements are made to the construction industry is best done by encouraging local contractors to increase their capabilities and enlarging the capacity of local material industries (World Bank, 2014:14).

### **2.5.7 Informal sector activities**

The informal sector is defined as unregulated and unprotected individuals and enterprises engaged in economic activities in construction. This includes the supply of labour and production of building materials and components for both the formal construction sector and directly in response to client needs (Institution of Civil Engineers, 2010:14). According to Modares and Sepehri (2009:15), the characteristics of the informal sector are: low quality of construction output; instability; resistance to progress and change; and a considerable inertia in using modern materials and/or techniques. The problems and difficulties faced by construction industries in South Africa and the measures to manage them have been extensively investigated and many studies and recommendations have been made to address these difficulties (State of the Construction Industry, 2012:22).

The government has implemented some of these recommendations; however, the results have been disappointing and the problems continue. Kujawa and Prinsloo (2004:19) commented on the lack of progress in implementing these recommendations, claiming that this is due to: the inappropriateness of some of the recommendations and the initiatives adopted; poor executive capacity of the implementing agencies; lack of resources for implementation of initiatives; and neglect of the construction industry by governments and their lack of commitment to solving its problems. Another important reason for the lack of progress in the development of the construction industry is the absence of measurable targets in programmes for improving the industry's performance.

## **2.6 COMMON SUPPLY CHAIN MANAGEMENT BOTTLENECKS IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY**

Kujawa and Prinsloo (2004:19) revealed that, in relation to constraints, bottlenecks associated with the industry can be identified in three overlapping areas: problems of shortages or



inadequacies in industry infrastructure; problems caused by clients and consultants/engineers; and problems caused by a contractor's incompetence/inadequacies. The following were cited as common bottlenecks identified by Institution of Civil Engineers (2010:14) in the South Africa building construction process:

### **2.6.1 Owners**

The most frequently cited cause of delay for construction projects in South Africa is the change of orders from the owners. For marketing reasons, Modares and Sepehri (2009:25) mentioned that change in orders tend to occur more often in private projects because the owners are in the habit of changing plans to meet customer demands. Contractors accuse owners of being slow in decision making and requests from owners are usually made at short notice, thereby impacting on a contractor's plan. Some change in orders can be large, requiring extensive re-design. As a result contractors waste resources while waiting for owners to decide on specialty contractors and designers, decorative materials and suppliers and provision of adequate information on the changes required (Jain & Benyoucef, 2008:32).

### **2.6.2 Engineers/Designers**

There is a general consensus that one of the major causes of project delays is due to the designer's incomplete drawings, particularly inconsistent detailing of drawings. Investigations also identified several instances of incorrect dimensioning of walls and openings, differences in dimensions between plans and sections, inadequate detailing of difficult locations (Handfield, 2013:1). Ofori (2011:14) mentioned that delays are also linked to the boom in the construction industry, which resulted in many design offices being overloaded and understaffed. Consequently, project designs are often rushed to tender in a short time to meet bid deadlines, with no proper feasibility studies and without detailed briefing. Therefore many contracts go for bidding with incomplete information and require extensive changes during construction. The rush to complete designs also creates problems of coordination between the architectural, structural, mechanical, sanitary, electrical and other systems (Organisation for Economic Cooperation and Development (OECD), 2006:41).

OECD (2013:13) recently mentioned that other reasons for design-originated delays include the problems of personnel or project teams. These problems are related to a lack of technical staff in the construction industry and shortage of design professionals. The site personnel delegated by design practices are often unqualified and may not have been involved in the original design.

They are thus not able to effect changes without reference to their design offices. Another problem is that, generally design offices give higher priority to new projects, creating a lack of supervision and attention to those projects using already-allocated personnel (World Bank, 2014:21).

### **2.6.3 Consultants**

The appointment of a consultant as a service to a client is common practice in South Africa due to the shortage of skilled engineers and staff. The consultant management firm designs the buildings, ensures that all works accord with drawings and specifications, supervises and coordinates the various activities of the parties to the project. However, consultants are accused of creating delays due to their lack of experience, incompetence, personal interests and uncompromising attitude (World Bank, 2014:21). Van Huyssteen (2012:32) made an assertion that many consultant management personnel are unwilling to accept contractors' proposed changes, even if the changes are reasonable, because they believe the contractors lack experience.

Contractors usually complain that the consultant management firm maintain an uncompromising attitude and, rather than working in harmony to solve problems, are in the habit of finding faults. Contractors also argue that many consultant management personnel are often incompetent and in trying to protect themselves, are not able to distinguish what is important. Construction Industry Institute (2010:4) further identified that rather than plan inspections in accordance with the sequence of work, consultant management staff and inspection teams tend to wait to be approached to approve works. Last minute, non-approvals cause delays and waste contractors' resources.

### **2.6.4 Contractors**

The contractor is blamed for the majority of project delays, generally being accused of poor management and technical performance. A contractor's lack of technically qualified and experienced staff leads to poor site organisation and management of material and equipment. Poor management leads to inadequate planning, inadequate site management and lack of coordination. These result in cost, time and budget deficiencies. Contractors argue that the planning and schedule deficiencies are caused by clients who are in the habit of changing their minds very often, whilst insisting that short term planning is unnecessary (Van Huyssteen, 2012:32). Financing is cited as a specific problem for contractors when they are not paid regularly. Irregular payment on public projects is a major cause of liquidity problems for contractors. However,

unreasonably low bidding and contractor's financial difficulties are problems under the direct control of the contractor.

### **2.6.5 Construction resources suppliers**

In a study conducted by Barret (2010:32), demand exceeded the supply of major construction during the boom period where projects were rushed to meet the bid dates. The boom period also saw shortages of import materials. Local manufacturers could not expand production facilities fast enough to meet demand. Import restrictions on major construction materials are believed to be the major cause of shortages. Whenever import permits are granted to meet local demand, the quality of imported material deteriorates and creates problem with the delivery time of materials. Continued expansion in the construction sector of the economy creates supply problems, which drives up the prices of materials. The materials suppliers generally shop for the lowest-priced sources outside the country, with little regard for quality. Therefore, materials' suppliers can afford to charge high prices for poor services. Contractors also complained about the quality of imported materials (Government Gazette, 2010:2).

Materials are not the only resource in short supply in periods of economic boom. Qualified architects, contractors, engineers and skilled labour in general are in high demand during this period (Olivier, 2005:12). The staff shortage problem is felt at two levels, namely, at the technical and craft level. The shortage of workers is believed to be due to several factors. Demand increases greatly while supply of labour remains constant. The seasonal nature of employment in construction is another major problem. Many workers do not take on construction work all year round. The few skilled construction workers can easily get higher salaries by moving between jobs.

According to the Government Gazette (2012:8) many construction companies rely on labour suppliers for their site workers as a means of minimising labour management problems. This in turn creates coordination problems. When work is temporarily reduced on one site, the supplier transfers workers to other sites where they are needed. It is then difficult to get enough workers back on the first site when they are needed. These staffing problems have created serious quality control difficulties for project management. It is generally accepted that the often low-quality standards of buildings are due to the quality and supply of construction staff (Olivier, 2005:12).

### **2.6.6 Other sources**

Weirauch (2010:22) emphasises that delays associated with government authorities centre on the time taken in granting permits and approvals. The relevant authority in South Africa gives separate permits for substructure and super structure work. In South Africa there are also many authorities involved in approving plans before work commences. The authorities involved are land, housing, electric, water, road, environment and health. Therefore, construction projects can be delayed by permit problems and approval from the authorities. Working in countries such as South Africa also means having to contend with problems such as lack of transportation, storage space, accommodation, restricted working time and restricted plant movements, among others. Disputes with neighbours are another source of work stoppages, due to their impact on working space for equipment such as tower cranes, as well as restrictions on working times (Handfield, 2013:11).

In summary, the common bottlenecks in the South Africa construction industry can be classified into the following categories:

- Finance-related problems

The common finance-related problems are high cost financing, difficulty in getting loans, interference from owners in decision-making processes and shortages in funding.

- Owner-related problems

The common owner-related problems are lack of strategic management, changes in requirements, inadequate project feasibility studies, lack of clear bidding processes, excessive change orders, unclear responsibility, lack of capable representatives, owner's financial difficulties, owner's poor contract management skills and slow decision making.

- Contractor-related problems

Contractor-related problems include inadequate experience, construction errors, poor site management and supervision, equipment failures or allocation problems, inadequate labour skills, inadequate site manager authority, inadequate planning and scheduling, inaccurate estimation and poor contract management.

- Consultant-related problems

Consultant-related problems are attributable to designers and consultants in their preparation and approval of drawings, design errors, delays in work approval, lack of involvement and lack of responsibility.

- Project attribute problems

These problems derive from the characteristics of the project. They include ambiguous project scope, lack of constructability, inaccurate site investigation, pollution during construction, non-value added works, inadequate quality assurance and control, unrealistically imposed contract duration and obsolete technology.

- Coordination-related problems

These problems include poor communication, excessive use of subcontractors and nominated suppliers, excessive bureaucracy, fraudulent practices and kickbacks, misalignment of a client's expectation and jurisdictional disputes.

- Environmental-related problems

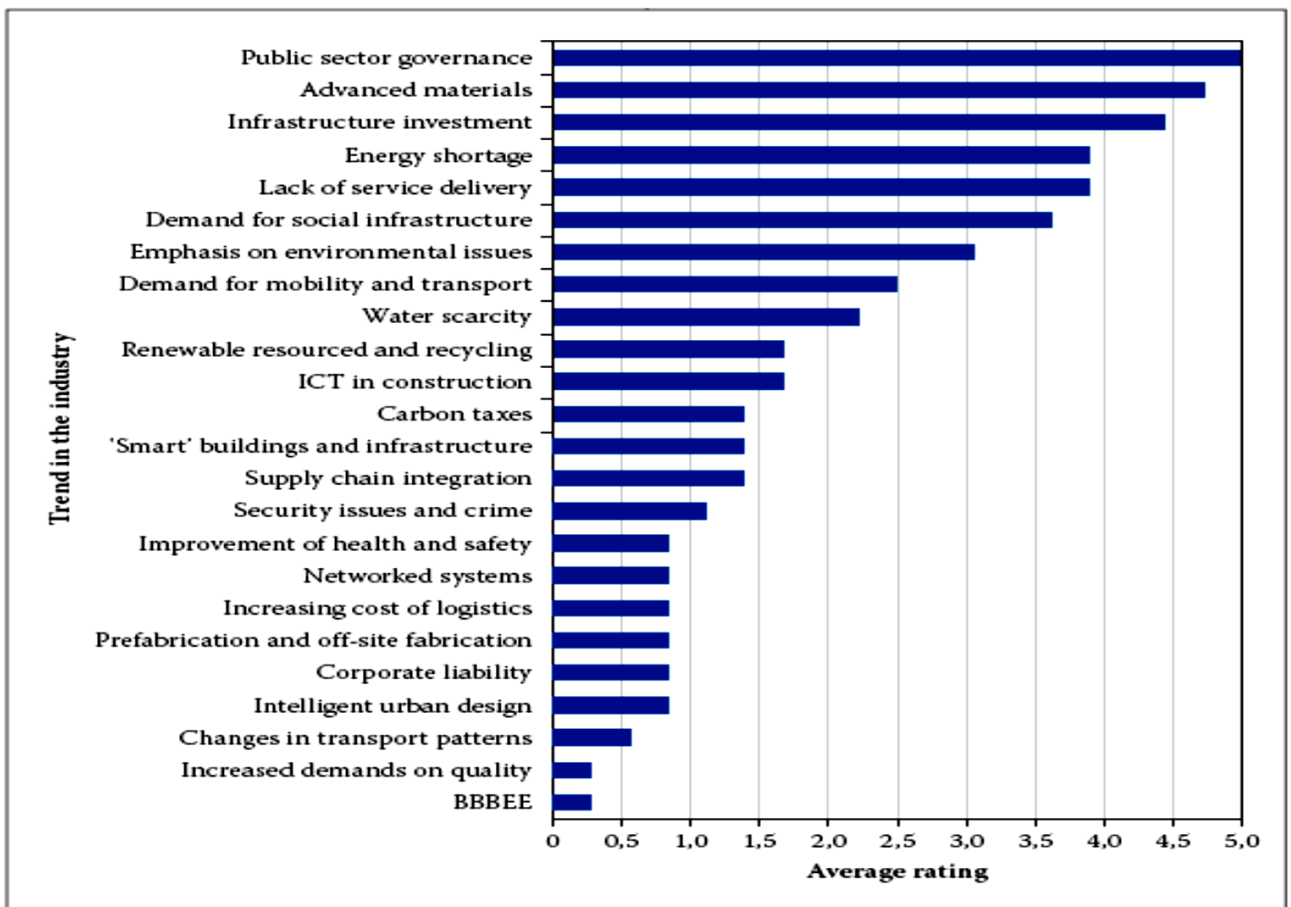
These refer to external problems caused by natural conditions such as inclement weather, or socioeconomic conditions such as material shortage or late delivery, labour shortage, price fluctuations, inconsistent policies and slow government permits.

As mentioned by Modares and Sepehri (2009:15) the construction industry, in general, is highly fragmented with significant negative impacts perceived low productivity, cost and time overruns, conflicts and disputes and resulting claims and time-consuming litigation. These have been acknowledged as the major causes of performance-related problems facing the industry (Van Weele & Arjan 2012:24). The application of supply chain management is a means of developing vertical integration in the design and production process and operation to link the process into a chain, focussing on maximising opportunities to add value while minimising total cost. As this application requires a significant shift in the mind-set of the participants toward collaboration, teamwork and mutual benefits, it is hardly surprising that only few sophisticated applications have been reported in the construction industry (Van Weele & Arjan, 2012:24).

## 2.7 THE FUTURE OF THE CONSTRUCTION INDUSTRY IN SOUTH AFRICA

Rust and Koen (2013:11) conducted a study and identified the construction industry in South Africa as an important contributor to and facilitator of socio-economic development and economic growth. The increasing load on and the ageing infrastructure impact the external drivers on the industry, and emphasises the need for the industry as a whole to face its challenges with innovative solutions. However, Rust and Koen (2013:11) mentioned that the construction industry is notorious for low levels of innovation efforts in construction and the supporting R&D programmes. The results from their study highlighted twelve drivers external to the construction industry that are expected to influence it in the medium term. The analysis of the ratings from the middle management group also identified seven ‘mega trends’ in the construction industry that will be shaping its immediate future. The findings related to the current trends in the construction sector are reported in Figure 2.1.

**Figure 2.1: Current trends in the construction industry**



Source: (Rust & Koen, 2013:11)

Despite the existence of the aforementioned challenges, Rust and Koen (2013:11) foresaw positive growth in the near future. “*South Africa’s increased role in the BRICS group of countries, as well as its unique position as a gateway to Africa, will strengthen its economic status over the long-term, which will also result in increased direct investment into the country.*”

Construction Industry Institute (2013:9) pointed to another positive development which is the R827 billion injection into infrastructure developments that the government was planning between 2013 and 2016, which was set to stimulate activity in the construction sector. Furthermore, it is estimated that the infrastructure project pipeline is valued at approximately R4 trillion over the next 20 years, starting in 2015 which indicates that positive growth lies ahead.

A recent example of a successful joint government and private sector initiative working together was the Gautrain project. In this case the goal was to provide thousands of commuters with an affordable alternative transport system and at the same time make a significant contribution, in terms of creating opportunities for South African construction companies, the economy and job creation. Many of such projects in South Africa’s future will continue to take place (Rust & Koen, 2013:11).

## **2.8 CONCLUSION**

This chapter reviewed literature focusing on the developments in the construction industry in South Africa. The discussion revealed that the construction industry is so fragmented and complex that it faces many challenges that would need to be addressed through integrated approaches and strategies. Such approaches may provide answers to cope with the increasing complexity of construction projects. Except for the most trivial projects, the delivery process for a constructed facility consists of several phases and a multitude of professionals from various disciplines working together to advance the project. Many organisations usually adopt project-focused construction, with a short-term perspective, emphasising competitive aspects of supply chain management without paying particular attention to understanding the nature of the industry as well relevant bottlenecks. Consequently, supply chain relationships in construction are generally of the arm’s length type rather than being partnerships. The next chapter discusses the concept of supply chain management and its linkage to the construction industry

# CHAPTER 3

## SUPPLY CHAIN MANAGEMENT AND CONSTRUCTION

### SUPPLY CHAIN CONCEPTS

#### 3.1 INTRODUCTION

This chapter discusses the supply chain management and construction supply chain concepts, the supply chain management in the construction industry and the critical aspects for best practice in construction supply chain management. It further highlights the Strategic perspective of supply chain management in construction and operational perspective of supply chain management in the industry. It articulates the issues of supplier management. The section also addresses the construction supply chain in South Africa and the need to manage it. Finally issues of unfair competition in the South African construction sector are discussed. Overall, it is intended to draw attention to the Supply chain Industry relating to the concepts and theories of supply chain management and specifically demonstrating views about the nature of the industry.

#### 3.2 CONCEPTUALISATION OF SUPPLY CHAIN MANAGEMENT

Supply chain management is a relatively new term in the construction industry. It involves integrating the operations of all organisations involved with the delivery of a particular product or service. This extends from the primary producer all the way to the end-user. Supply chain management has become a central issue for many clients and companies. This is because it offers the prospect of making significant cost savings and improving value by enabling companies to work more effectively together across the entire supply chain. Vrijhoef and Voordijk (2003:12) note that effective operational and management practices are necessary to make supply chains work. Operational issues look at how materials are ordered and delivered to site, how trade contractors are selected, how they are involved with designing and planning the works and how invoicing and other 'transaction' costs can be reduced.

Some scholars (Hines, 2006:8; Gattorna, 2006:13; Harrison & Van Hoek, 2011:33) state that supply chain management is also pervasive and universal, based on the fact that it is difficult to find any aspect of business that has nothing to do with supply chain management. For example, during quality management, one cannot improve the quality standard of products or services measured by the end-consumer without managing the suppliers and buyers in the supply chain at



all. This shows that the role of these key stakeholders cannot be underestimated and that organisations need to place emphasis on managing supplier and buyer relationships.

There is no single universal definition for a supply chain. However, as defined by Hines (2006:12) and Gattorna (2006:13), a supply chain is as a group of interconnected participating companies that add value to a stream of transformed inputs from their source of origin to the end product or service that are demanded by a designated customer or consumer. The supply chain has also been defined as 'the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer' (Christopher, 2005:19). It consists of a network of key business processes and facilities, involving end users and suppliers that provide products, services and information (Tan, 2001:12). Gunasekaran and Kobu (2007:2819) further mention that traditionally, marketing, distribution, planning, manufacturing and purchasing units and organisations along a supply chain often operate independently. The link within the aforementioned definitions is that a supply chain consists of more than one participating company which do not belong to the same business ownership, but are interconnected on the common commitment to add value to the stream of material flow that runs through the supply chain.

A supply chain is very much an extended concept of an organisation which adds value to its products or services and delivers them to its customers (Tan, 2001:12). Maloni and Benton (2007:23) held the view that in the last three decades, the concept and theory of business management have undergone profound changes and development. Many old ways of doing business have been challenged and new ideas and approaches have been created, with business process re-engineering, strategic management, lean thinking, agile manufacturing, the balanced scorecard and blue ocean strategy being typical examples. Maloni and Benton (2007:23) further pointed out that supply chain management is undoubtedly one of those new and well grown management approaches that has emerged and rapidly developed across all industries around the world.

According to Maqsood and Akintoye (2002:19) one can imagine a supply chain as something that resembles a "chain", in which the "links" are the participating companies that are inter-connected in the value adding process. The link on the upstream side of the material flow is the supplier's supplier; and on the downstream side of the material flow is the customer (Maloni & Benton, 2007:23). There is usually an Original Equipment Manufacturer (OEM) in between, which is

sometimes represented by OBM – Original Brand Manufacturer, or sometimes simply by the “focal company.”

The competitiveness of OEMs depends on supplier performance in terms of cost, quality and on-time delivery. Consequently, supply, sourcing and purchasing professionals believe strongly that more and stronger supplier partnerships are critical to achieving competitive supply chain performance.

Supply chain management is the management of material and information flow in a supply chain to provide the highest degree of customer satisfaction at the lowest possible cost as mentioned by Liker and Choi (2006:23). Furthermore, the authors mentioned that supply chain management requires the commitment of supply chain partners to work closely to coordinate order generation, order taking and order fulfillment thus, creating an “extended enterprise” spreading far beyond the producer’s location. Supply chains encompass the companies and the business activities needed to design, make, deliver and use a product or service (Liker & Choi, 2006:23). Businesses depend on their supply chains to provide them with what they need to survive and thrive. Every business fits into one or more supply chains and has a role play in each of them (Harrison, & Van Hoek, 2011:23). In this way, the survival of such businesses will largely be dependent on how well supply chain management processes are handled and managed by both companies.

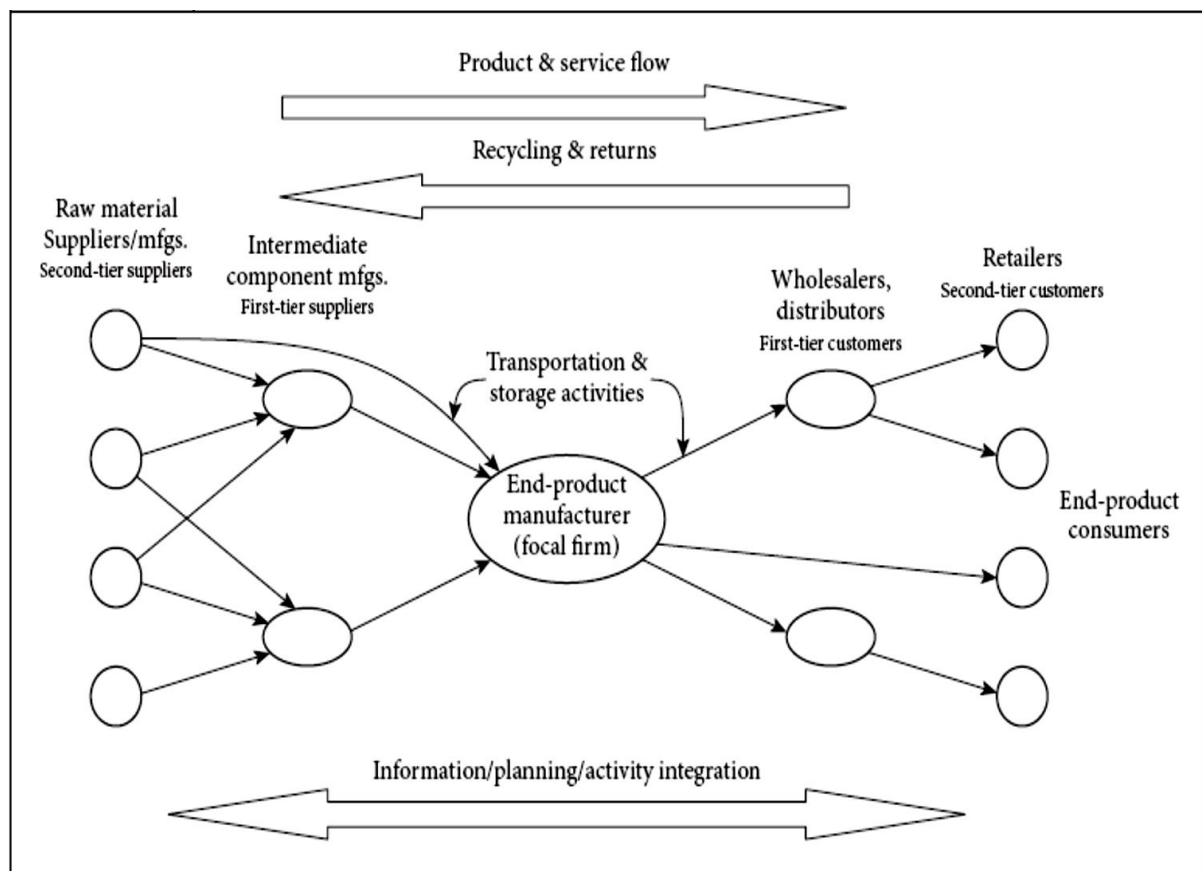
Supply chain management integrates key business processes from initial raw material extraction to the final or end customer, including intermediate processing, transportation and storage activities and final sale to the end customer (Maloni & Benton, 2007:23). Cooper and Ellram (2003:12) suggest that supply chain management is a broad based function which encompasses all business and operational processes involved in but not limited to Procurement, Manufacturing and Finished Goods Transportation, warehousing and Distribution and Inventory Management. Today, the practice of supply chain management has become extremely important to achieve and maintain competitiveness such that many firms are now beginning to realise the advantages of supply chain integration (Christopher, 2005:1). Important elements in supply chain management are in the areas of purchasing, operations and production and distribution.

As markets, political forces, technology and competition change around the world, the practice of supply chain management must also change (Benton, 2007:3). Van Weele and Arjan (2012:24) argue that in a globalised business scenario characterised by geographically spread markets, raw material procurement sources across the world and cheaper manufacturing and labour markets, the business of meeting demand with supply is constantly changing and evolving. Economic

forces and heightened competitive pressures are driving organisations to constantly change their business strategies. Organisations throughout the world are taking bold steps to break down both inter- and intra-organisational barriers to smooth uncertainty and enhance control of supply chains (Stevens, 2008:11).

Supply chain management represents the cross-functional integration of activities that cross the borders of individual organisations (Maloni & Benton, 2007:32). It seeks to bring together activities that traditionally were split between independent entities creating a mutually beneficial win-win supply chain partnership (PE Consulting, 2007:2). Furthermore, supply chain management looks across the entire supply chain rather than just at the next entity or level and aims to increase transparency and alignment of the supply chain's coordination and configuration, regardless of functional or corporate boundaries (Cooper & Ellram, 2003:12). The typical elements of supply chain management are illustrated in Figure 3.1.

**Figure 3.1: Elements of supply chain management**



Source: Cooper and Ellram (2003:12)

As illustrated in Figure 3.1, the firm in the middle of the figure is referred to as the focal firm and the direct suppliers and customers of the focal firm are first-tier suppliers and customers. The first-tier suppliers' suppliers are the focal firm's second-tier suppliers and the first-tier customers' customers are the focal firm's second-tier customers. Some supply chains, such as an automobile supply chain, may have many tiers, while others such as a law office, may have very few tiers (Cooper & Ellram, 2003:12).

In summary, supply chain management covers the full range of activities from the earliest level of incoming raw materials through the internal processes in an industry and on to the outgoing products through the distribution and marketing channels. Therefore, supply chain management is the planned continuous improvement of processes and relationships that exist to support the movement of these products and services through the supply chain.

### **3.2.1 The emergence of supply chain management**

As articulated by Holti *et al.* (2000:14), the earliest appearance of the term 'supply chain management' can be traced back to the early 1980s. More precisely, Holti *et al.* (2000:14) emphasised that it first appeared in a Financial Times article written by Oliver and Webber in 1982 describing the range of activities performed by the organisation in procuring and managing supplies. However, the early publications of supply chain management in the 1980s were mainly focused on purchasing activities and cost reduction related activities. The major development and the significant increases of publications in the areas of supply chain integration and supplier-buyer relationship came in 1990s, when the concept as it is known today was gradually established (Cooper & Hartley, 2011:13-14).

It is clear that supply chain management is not one of the legacy academic subjects that existed for hundreds or thousands of years, but rather a young and even emerging subject (Benton, 2007:201). It is only recently that the business world started making use of this concept. The reason behind this emergence is that today's business environment has changed and is characterised by globalisation, more severe competition, heightened customer expectation, technological impact and geopolitical factors, among others (Cooper & Hartley, 2011:13-14). Under such a renewed business environment, the authors stress that an organisation focused management approach is no longer adequate to deliver the required competitiveness. As such, the arena of competition is moving from 'organisation against organisation' to 'supply chain against supply chain' (Benton, 2007:201). Managers must therefore understand that their businesses are

only part of the supply chains that they participated in and it is the supply chain that wins or loses the competition.

Supply chain management is a concept that has originated and flourished in the manufacturing industry. The first signs of supply chain management were perceptible in the JIT delivery system as part of the Toyota Production System (Shingo, 1988:131). This system aimed to regulate supplies to the Toyota motor factory just in the right - small - amount, just on the right time. The main goal was to decrease inventory drastically and to regulate the suppliers' interaction with the production line more effectively. Even today, manufacturers utilise Just-In-Time (JIT) and other management programmes to improve manufacturing efficiency and cycle time (Taylor, 2004:13-21). After its emergence in the Japanese automotive industry as part of a production system, the conceptual evolution of supply chain management has resulted in an autonomous status of the concept in industrial management theory and a distinct subject of scientific research, as discussed in literature on supply chain management (Bechtel & Yayaram, 1997:12). Along with original supply chain management approaches, other management concepts (e.g., value chain, extended enterprise) have been influencing the conceptual evolution towards the present understanding of supply chain management.

Zhang *et al.* (2009:21) reveal that during the 1950s and 1960s, most manufacturers emphasised mass production to minimise unit production cost as the primary operations strategy, with little product or process flexibility. In the 1970s, material requirements planning (MRP) was developed and managers realised the impact of huge WIP inventories on manufacturing cost, quality, product development and delivery lead-time (Zhang *et al.*, 2009:21). The intense global competition of the 1980s forced world-class organisations to offer low-cost, high-quality and reliable products with greater design flexibility. However, since the 1980s, computer technology has advanced at such a phenomenal rate that it is currently far ahead of the ability of the supply and logistics field to adequately utilise the new technologies (Ellram *et al.*, 2007:23). Still, supply chain and logistics planning is primarily based on the distributed models that came as the result of personal computers. Esper *et al.* (2010:18) mentioned that these technological advances have provided tremendous value in addressing traditional supply chain and logistics areas such as warehousing and distribution, transportation and manufacturing logistics. However, there are also many non-traditional areas such as health care logistics and humanitarian logistics which can obtain great value from building on the concepts and technologies that have already proven successful in the traditional supply chain and logistics areas (Taylor 2004:34).

In one way, the concept of supply chain management represents a logical continuation of previous management developments (Van der Veen & Robben, 1997:13). Although largely dominated by logistics, the contemporary concept of supply chain management encompasses more than just logistics, but combines particular features from concepts including Total Quality Management (TQM), Business Process Redesign (BPR) and JIT (Van der Veen & Robben, 1997:14). The evolution of supply chain management continued into the 1990s as organisations further extended best practices in managing corporate resources to include strategic suppliers and the logistics function. The adoption of supply chain management has been as effective as demonstrated by the fact that many manufacturers and retailers today have embraced it to improve efficiency and effectiveness across the supply chain Taylor (2004:34). The evolution of supply chain management is illustrated in Table 3.1.

**Table 3.1: Evolution eras of supply chain management**

	<b>Era</b>	<b>Description</b>
1	Creation Era	The term supply chain management was first coined by an American industry consultant in the early 1980s. However, the concept of supply chain in management, was of great importance long before in the early 20th century, especially by the creation of the assembly line.
2	Integration Era	This era of supply chain management studies was highlighted with the development of Electronic Data Interchange (EDI) systems in the 1960s and developed through the 1990s with the introduction of Enterprise Resource Planning (ERP) systems.
3	Globalisation Era	This era is characterised by the globalisation of supply chain management in organisations with the goal of increasing competitive advantage, creating more value-added and reducing costs through global sourcing
4	Specialisation Era Phase One- Outsourced Manufacturing& Distribution	In the 1990s industries began to focus on “core competencies” and adopted a specialisation model. Companies abandoned vertical integration, sold off non-core operations and outsourced those functions to other companies.
5	Specialisation Era Phase Two - Supply Chain Management as A Service	Specialisation within the supply chain began in the 1980s with the inception of transportation brokerages, warehouse management and non-asset based carriers and has matured beyond transportation and logistics into aspects of supply planning, collaboration, execution and performance management.
6	Supply Chain Management 2. 0	Web 2. 0 is defined as a trend in the use of the World Wide Web that is meant to increase creativity, information sharing and collaboration among users.

Source: Jain *et al.* (2010:19)

The eras show the trends as improved supply chain management principles combined with new information (e-business) technologies that may not have been given much macroeconomic attention in the past. The effective implementation of supply chain management can help firms reduce costs, increase revenues, boost efficiencies and expand market opportunities. Such

improvements have resulted in a reduced bullwhip effect (production volatility that more closely resembles sales volatility), lower inventory levels, reduced logistical costs and streamlined procurement processes. Such evidence suggests that these improvements are linked to macroeconomic benefits such as lower inflation, more stable economic output, higher productivity growth and better standards of living.

### **3.2.2 Industries and sectors where supply chain management is practiced**

Supply chain management is implemented within the ambit of networks involving different service organisations, which operate independently as well as in collaboration (Jain *et al.*, 2010:10). Each organisation handles its own service operations such as demand management, capacity management and forecasting, among others (Jain *et al.*, 2010:10). As revealed by Ponomarov and Holcomb (2009:21), supply chain management literature concepts appear to be concentrated in a handful of industry sectors. Examples of such industry sectors include consumer good retailing, computer assembling and automobile manufacturing. However, Gligor and Holcomb (2012:10) held the view that industries that have adopted supply chain management practices stretch from service industry of accommodation, education, recreation, health to tangible aspects of construction, property and business services, finance, mining, agriculture forestry and fisheries and many more. This demonstrates the wide applicability of supply chain management in different service organisations all over the world. Table 3.2 reports on some of the key service operations that have been studied in the past.



**Table 3.2: Application areas of supply chain management in area of study**

<b>Application areas of supply chain management in area of study</b>	<b>Authors</b>	<b>Area of Study</b>	<b>Authors</b>
<b>Healthcare</b>	(Vries & Huijsman, 2011; Wu & Yang, 2009; Avery, 2008; Baltacioglu, Ada, Kaplan, Yurt & Kaplan, 2007).	<b>Telecommunication</b>	(Pramod & Banwet, 2010).
<b>Tourism and Hotel</b>	(Cho, Lee, Ahn & Hwang, 2011; Zhao, Hu & Ren, 2011; Zhao, Hu & Ren, 2011; Haihong & Liu, 2010; Zhang, Song & Huang, 2009).	<b>Management Consulting</b>	(Giannakis, 2011).
<b>Logistics</b>	(Li, Liu & Cheng, 2008; Song & Xu, 2011; Du & Rong, 2010; Mohan & Zailani, 2010; Zhang, Chen & Zhang, 2009; Wu & Yang, 2009)	<b>Application Services</b>	(Demirkan & Cheng, 2008).
<b>Education</b>	(Habib & Jungthirapanich, 2009).		

Source: (Shukla *et al.*, 2011:7)

Supply chain management has been widely researched and acknowledged in numerous application domains during the last decade. Amidst fierce competition in all industries, supply chain management has gradually been embraced as a proven managerial approach to achieving sustainable profits and growth. This is accomplished primarily by focusing on the whole supply chain management process to deliver the right products or services, in the right quantity, to the right place, at the right time and with the maximum benefits.

### **3.3 SUPPLY CHAIN MANAGEMENT IN THE CONSTRUCTION INDUSTRY**

The Construction Industry (CI) is distinct from other industries. These differences exist in aspects such as the physical nature of the product, the structure of the industry and the organisation of the building and construction process (Petrovic-Lazarevic & Djordjevic, 2002:27). The product of the Construction Industry is mostly large and expensive and since it is located in a specific

geographic area not generally transportable. Buildings and other structures are usually made to meet the requirements of each customer.

### **3.3.1 Composition**

Three separate groups of people are involved in a construction process, namely the client, the designer and the contractor (Petrovic-Lazarevic & Djordjevic, 2002:11). The client is an initiator of the building and construction process. The designer is a planner of principal activities. The contractor executes the building and construction job in residential sector, non-residential sector and engineering construction area (Lin & Mills, 2001:21). In this aspect, the work system in the Construction Industry is based on projects. Each project incorporates several organisations and subcontractors that operate with their own objectives and pressures. In order to organise a building and construction process to function smoothly, the project manager has to control overall costs, time and quality of actions undertaken.

Project management activity is temporary, but exposed to a constant pressure of time and cost constraints, competitive tendering and a practice of awarding contracts to the lowest bidder (Lin & Mills, 2001:21). Firms in the Construction Industry consist of large organisations with usually over 20 employees and small to medium enterprises with five to twenty employees (Lin & Mills, 2001:21). Large organisations have their project management sectors with an appointed project manager for each project. The project manager is then in charge of organising the whole building and construction process including supply of material and equipment and upon completion of the object to follow a special legal procedure to deliver the object to the client (Petrovic-Lazarevic, 2009:33).

The last two decades witnessed rapid growth in the concept of supply chain management being adopted by organisations in all types of industries and has been defined in a number of different ways, as determined by the industry (Cooper & Ellram, 2003:18). As such, supply chain management should be defined differently in different industries. In the context of the construction industry, supply chain management not only deals with management of materials, but also with relationships between contractors, suppliers and distributors as well (Titus & Bröchner, 2005:223).

### 3.3.2 Partnerships and trust

In the literature, relationships between parties, or partnerships, are seen as a commitment between the client and supplier, cooperating to meet separate but complementary objectives (Blayse & Manley, 2004:33). Cooper and Hartley (2011: 294–95) argue that the partnership approach results in greater accuracy, speed and flexibility in responding to consumer and environmental demands, development of new technology and products as well as more cooperation in maximising profits at chain level.

Partnerships can take many forms. According to Welling and Kamann (2001:12) supply chain partnerships in construction industry can be at the firm level or the project level. At the firm level supply chain partners can have stable and long-term working arrangements among a limited number of firms. This is known as permanent networks (Dubois & Gadde, 2000:32). At the project level, relationships are more temporary as they are usually established for the duration of the project - what Dubois and Gadde (2002:12) described as “*loose couplings*”. Koskela and Vrijhoef (2001:31) argue that temporary partnership is an inhibitor to innovation. This opinion is supported by Dulaimi (2002:15), who in looking at the need for integration and innovation in construction, note that the construction industry was criticised for its low investment in research and having fragmented supply chains which affected its capacity to compete internationally.

Another type of partnership is identified by Love *et al.* (2004:14) who referred to alliances as being either strategic or project. In this instance, project partnering is a relationship that is established for a single project which “focuses on short-term benefits”, whereas strategic partnering is a long-term relationship across many projects which “seeks gains for the long term”. From these definitions of alliances, the terms cooperative and collaborative have been linked by some authors to project and strategic alliances. Collaborative strategic alliances refer to parties working together for the short term and cooperative strategic alliances are for longer term partnerships (Cooper & Hartley, 2012:204).

Although partnership plays an important role of supply chain management in construction industry, according to Moberg and Speh (2003:8) development of trust and commitment is also significant. Trust is the willingness to rely on an exchange partner in whom one has confidence (Wu & Weng, 2010: 392). It indicates that the partner can be trustworthy in one dimension but not in another. Wang *et al.* (2004:32) suggest that traditionally, trust develops from specific events and repeated interaction, in relationship development. Thus, trust is strongly associated with commitment and loyalty. Another way of developing trust is a cue-based trust, or trust

generated by an initial encounter with a stimulus, usually a symbol or sign, which is associated in the viewer's mind with trust (Wang *et al.*, 2004:32). The authors explore the issues of the ethical benefits of trust-based partnering and state "that engaging in trust-based partnering encourages parties to adopt higher ethical standards and achieve improved ethical performance in all their business dealings". Therefore, trust may affect the efficiency and effectiveness of a firm's operations, depending on the partners they choose.

Wu and Weng (2010:392) further noted that within a supply chain, inter-organisational trust is important in maintaining a competitive advantage. If trust is developed through contacts between parties, it then becomes a bond or a tie that brings partners together. Bonding can take two forms: structural and social (Van Weele, 2010:121). Structural bonds are those economic and strategic ties that link buyers and sellers, such as legal contracts and agreements. On the other hand, social bonds are made up of personal and social ties between individuals in organisations. Van Weele (2010:121) further noted that structural bonds are important in any business relationship, but those organisations that have strong social bonds generally have a greater commitment in their relationships. Social bonds focus more on the interpersonal relationships between and in organisations; they may include creating a family type atmosphere and consideration for the other party when making decisions. Thus, one way of achieving this is to build relationships with suppliers who are able to learn, improve and grow. It is crucial that supplier relationships between parties be based on trust.

While construction has changed in complexity over time, the primary objective of the industry is basically the same as it was 100 years ago: to build infrastructure, roads, schools, homes, hospitals, factories and other businesses (Dubois & Gadde, 2000:32). In 2010, approximately R 30 billion was spent in South Africa in the construction industry (Statistics SA, 2011). Unlike the widgets produced in manufacturing, the finished product in construction is customised and cannot be mass-produced (Tiziana & Mikolaj, 2005:42). The operations function that shows improvement in the manufacturing sector has quite a different profile in the construction industry. The probability of failure remains constant for traditional construction organisations (Statistics SA, 2011). As such, supply chain constraints which are the focus of this study need to be mapped and understood from structure partnerships and trust.

### **3.3.3 Collaboration risks and labour related issues**

According to Modares and Sepehri (2009:15) a unique project delivery system is the cornerstone of the construction industry. The industry is fragmented and distinguished by a collection of large

and small firms, related bulk material suppliers and many other support professionals (Modares & Sepehri, 2009:15). The typical supply chain for any given construction project could include architects and engineers, prime contractors, specialty subcontractors and material suppliers that come together at one time to build a single project for a specific owner. This complex supply chain is characterised by adversarial short-term relationships driven by the competitive bidding process.

Except for the architect, support engineer, or other construction professional whose fees are negotiated, the “low bid wins” is the pricing model that repeats itself in each link of the supply chain (Van Weele & Arjan, 2012:43). The latter authors drew emphasis that the project owner selects a prime contractor who is the lowest bidder. In turn, the prime contractor uses price as the basis for selecting subcontractors and suppliers. This approach continues even if a subcontractor hires his or her own subcontractor; again, the low bid wins. In most private and some public markets, it is an industry practice after the contract is awarded and the overall project price is known, for the prime contractor to “shop” the prices of subcontractors before deciding which to use. Likewise, prime contractors may receive unsolicited quotes from subcontractors who aggressively peddle their low prices after the contract award (Tiziana & Mikolaj, 2005:42). This adversarial behaviour causes dissatisfaction throughout the supply chain and results in arms-length, one-time, project focused relationships (Van Weele & Arjan 2012:43).

In relation to this, Dubois & Gadde (2000:32) emphasise that time is one of the most critical factors in construction operations and has significant legal consequences. The project owner sets rigid beginning and ending dates for the construction process. Gligor and Holcomb (2012:17) added on that delays are costly and are specifically addressed in contract documents in anticipation of liquidated and other damages. Pricing in construction can be lump sum, cost plus, negotiated, or unit price. According to Gligor and Holcomb (2012:17), all pricing in construction depends on the time that the contractor determines it will take to complete a job. Barring any circumstances caused by the project owner and outside of the control of the contractor, the contractor must meet the time set by the project owner or lose money. Time factors are even more complicated in construction because the working environment may be outside for part or all of a project, which means that progress, is influenced by weather conditions.

Shukla, Garg and Agarwal (2011:7) revealed that the labour-intensive construction operation is characterised by decentralisation. They asserted that the prime contractor may self-perform a portion of the work as other specialty subcontractors move in and out of the project as their

sections of work are ready and that over time, the jobsite is transformed from a temporary production facility with materials and heavy equipment to the actual completed project, such as a school or a hospital (Shukla *et al.*, 2011:22). Ponomarov and Holcomb (2009:21), however, made reference to the view that there is little or no coordination and collaboration between the design professionals, prime contractors, subcontractors and suppliers involved during the life-cycle aspects of the project. Information generated by various sources, at many levels of abstraction and detail, contributes to the fragmentation.

On the hand Taylor (2004:34) held the view that traditionally, the project information exchanged between architects/engineers and a prime contractor is compliant and has been mainly based on paper documents. These documents come in the form of architectural and engineering drawings, specifications, bills of quantities and materials and change orders. This lack of communication and implementation leads to significant negative impacts such as low productivity, cost and time overruns, change orders, inadequate design specifications, liability claims and generally, conflicts and disputes which directly impact the customer by increasing project completion time and cost (Taylor, 2004:34).

Zhang and Chen (2009:21) explained further that as flawed as the individual entities of a construction supply chain may be, they are even more troublesome because a new supply chain or operations component must be developed each time a new project begins. The reality is that the learning that takes place in manufacturing is circumvented in construction by the changes that occur from one project to the next. Ellram *et al.* (2007:23) on the other hand asserted that construction supply chain management poses an excellent opportunity to at least mitigate some risks by partially integrating some of the lessons learned from the manufacturing sector.

Many companies are struggling to improve supply chain efficiency through collaborative efforts and contend that businesses largely rely on their suppliers to reduce costs, enhance quality and develop innovations faster than their competitors' suppliers. One way of achieving this is to build relationships, manage risks and labour as well as issues related to suppliers who are able to learn, improve and grow.

### **3.3.4 Business sustainability**

As stated by Kujawa and Prinsloo (2009:39) the percentage of firms that broke even or showed a positive net income underscores just how risky the construction industry can be. For example, 40 percent of firms in the commercial construction market showed either no profit or lost money

(Tiziana & Mikolaj, 2005:42). The public sector building market was slightly better with only 28 percent of firms either losing money or breaking even. However, the stark reality is that across all categories, construction firms that are profitable show only modest returns from three to five percent. The authors further mentioned that when one considers the risk, these gains cannot compete with investment earnings in a normal financial market.

It is not surprising then that South Africa construction firms have a one-in-five chance of being successful after five years (Kujawa & Prinsloo, 2009:39). In other words, the risk of bankruptcy is 80 percent after five years. Moreover, with the fragmented project delivery system, with each new project there is an equal probability that any one or all of the firms could fail. The risk of failure for any individual construction business enterprise can be decreased by as much as 60 percent with increased knowledge (Van Weele, 2010:121).

### **3.3.5 Information Technology**

Studies have revealed that supply chain management that is driven by information technology (IT) is recommended for the construction industry (Ellram *et al.*, 2007:23). The construction supply chain management concept has the potential, through information and communication technologies, to overcome some of the fragmentation problems according to the authors. When the manufacturing definition of supply chain management is extrapolated to construction, construction supply chain management is defined as the strategic management of information flows, activities, tasks and processes, involving various networks of independent organisations and linkages (upstream and downstream) which produce value that is delivered to the owner in the form of a finished project (Van Weele, 2010:121).

Jain and Benyoucef (2008:32), however, noted that the upstream activities within construction supply chain management from the perspective of a prime contractor involves the project owner and engineering/design teams as they engage in preparing for the construction process. The downstream activities, which include material suppliers and subcontractors who interact with the prime contractor to carry out the task of building the project, require substantial coordination among project partners. Jain and Benyoucef (2008:32) suggest that to manage the downstream and upstream elements of the supply chain, the prime contractor must develop an enabling structure and an efficient communication system for effective relationship management as part of the overall project management. Modares and Sepehri (2009:15) were particular that construction supply chain management can easily lead to a natural evolution toward productive relationships throughout the construction process. The considerable documentation, contracts, change orders,

purchase orders, specifications and so on generated both upstream and downstream during the life cycle of a construction project is another reason why the need for construction supply chain management is significant. Therefore, when integrated with continuous improvement, construction supply chain management can successfully address major problems of the construction industry and its project owners.

According to Modares and Sepehri (2009:15) construction supply chain management can systematically reduce sources of uncertainty through the active cooperation of all entities in the supply chain in four functional areas: preconstruction design and contractor selection, construction, information management and risk management. In this sense, technology and communication are not merely the exchange of information, but the constellation of a message with representational, functional and action characteristics, which is part of a communication process aiming to coordinate objective action. In fact, objective action is basically embedded in communication: preceded by as well as succeeded by performative conversations. Both conversations are respectively aimed at the agreement about a future objective action by one of the actors involved and at the agreement about the result of the objective action.

### **3.3.6 Critical aspects for best practice in construction supply chain management**

According to Van Weele and Arjan (2012:24) the construction industry has seen fierce price competition in the past decade, making survival a more arduous task. The competitive strategies of low-cost, high-quality, on-time project completion and flexible leadership allow firms the ability to compete by positioning operational efficiency as a competitive weapon (Wu & Weng, 2010: 397).

In today's business environment, this competitive edge is not only a must for a market leader in the construction industry, but a necessity for all construction industry firms just to survive (Wu & Weng, 2010:397). Maloni and Benton (2007:23) emphasised that the creation and maintenance of operational leadership, however, is a difficult and complex process and construction firms must foster a set of new, critical elements in order to develop best practice construction operations. Some critical phases of a construction supply chain: design, materials procurement and logistics and site coordination s requires that the business environment is such that companies can benefit.

There are several established best practices for forecasting the benefits of construction supply chain management as was stated by Vrijhoef and Voordijk (2003:15). First, the construction industry must develop a sincere attitude adjustment toward a strong dedication to operational



efficiency (Cooper & Hartley, 2011: 94–95). The belief and commitment toward developing operational efficiency as a profit driver requires a high level of organisational support that must be communicated throughout the firm (Vrijhoef & Koskela, 2000:13). Operational analysis must play a prominent role in business strategy for successful construction operations. This leads to a second necessary operational element of continuous improvement (Vrijhoef & Koskela, 2000:13). An established competitive advantage means little if the construction firm is not able to sustain it from project to project and, thus, construction industry leaders must retain a fundamental spirit of anticipation (instead of reaction) to changes and problems (Wu & Weng, 2010: 92). Realising that most major advances result from small changes over time, the construction industry must create an environment of continuous project and process (work method) improvement. This requires employee training and empowerment as these small changes will more effectively come from the quality of the work force.

The next component required to position operations efficiency as a source of advantage is the elimination of waste. To be able to reduce costs and react to change, construction firms must be lean and flexible. This necessitates a general attitude toward elimination of excess in materials, personnel and processes. “Lean” construction has helped propel many responsive construction companies to success according to Solomon and Flores (2001:11). The authors also mentioned a fourth element, technology that fosters the environment for best practice operations. Further to this, Ballard (2000:34) emphasised that knowledge of company capabilities, competitors and the business cycle is critical to success. Modern technology can also be utilised to enhance information flows both inside and outside the firm. Technology may be exploited to facilitate improved project selection, planning, scheduling, work methods and materials flows. This “Lean” construction approach enhances the responsiveness and allows the construction firm to be on the cutting edge of competition as mentioned by Ballard (2000:34).

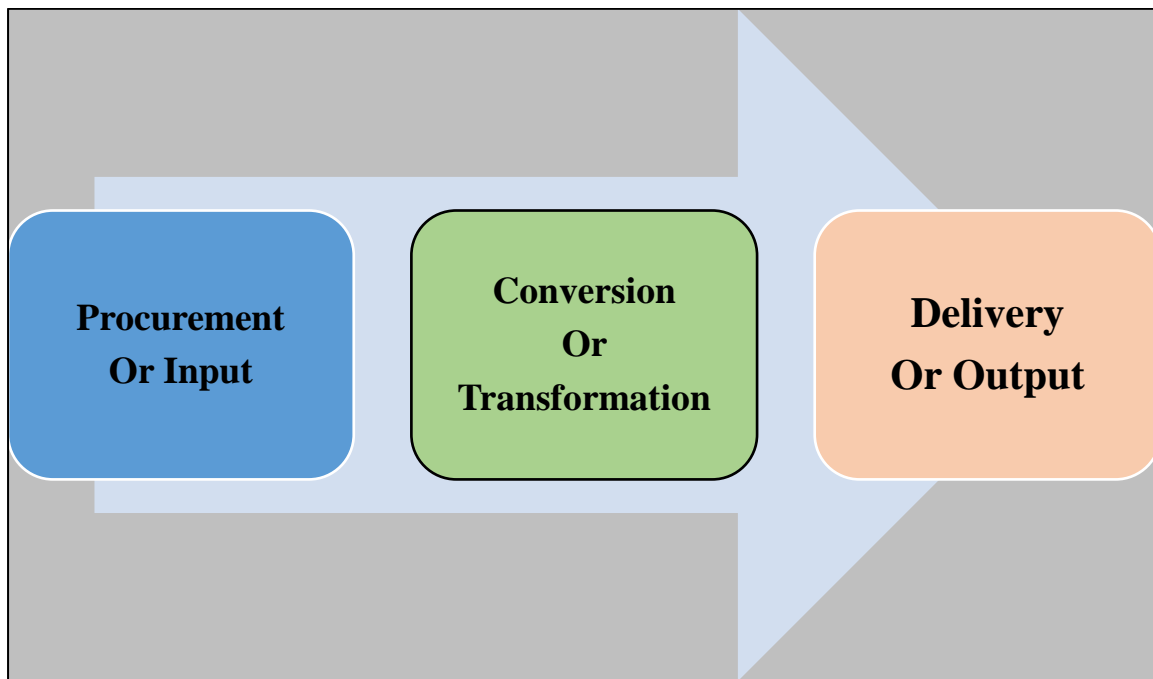
According to Solomon and Flores (2001:11), the critical elements of attitude, process improvement, waste elimination and technology are necessary in allowing operational efficiency to serve as a competitive advantage within a construction firm. An operations-oriented strategy, however, must extend beyond an individual construction firm. According to the authors, the project is delivered to the project owner via supply networks of firms consisting of architects, engineers, contractors, material suppliers and related supply chain members. Most firms are simply a link in the supply chain and a chain can only be as strong as its weakest link.

Therefore, construction firms cannot be responsive without responsive subcontractors or material suppliers and technology implementation. Another example supported by Ballard (2000:34) is that a prime contractor cannot produce high-quality projects without quality materials and well-informed subcontractors, pushing quality responsibility down to its subcontractors and material suppliers.

### **3.4 STRATEGIC PERSPECTIVE OF SUPPLY CHAIN MANAGEMENT IN CONSTRUCTION**

The strategic view is the challenge for project organisations to provide client value by managing constraints without incurring significant project schedule and cost overruns (Venkataraman & Pinto, 2008:213). The procurement portion of the project supply chain, which is typically long, is the area where the greatest opportunities for cost reduction and enhancing value of the whole supply chain exist (Venkataraman & Pinto, 2008:222). The first phase (procurement) is crucial for a successful project outcome especially in an industry that is characterised with fragmentation, specialisation and adversarial relationships within the SC (Venkataraman & Pinto, 2008:223). Granted that there is no single procurement strategy that works best for all situations in construction, a careful analysis of client needs and implementation of procurement strategies that is best for the realisation of the needs seems a positive way forward in the industry. Figure 3.2 indicates the phases of a project supply chain.

**Figure 3.2: Phases of a project supply chain**



Source: Venkataraman and Pinto (2008:223)

Kumaraswamy (2000:677) point out that in Hong Kong, methods used for selecting the overall procurement system, contractors and subcontractors are not only critical, but they also require an integrated approach in order to synergise chosen options within each procurement sub-system that is aimed at a project-specific desired performance. The argument of Venkataraman and Pinto (2008:223-224) that supply chain relationships and supplier development are key aspects of procurement may hold true. These authors further highlight that value optimisation in projects cannot be achieved in the absence of close and trusting relationships among project partners, that is, when all members of the supply chain are involved in translating the design concept into reality, they are better able to ensure that appropriate cost criteria are met. Just as important as the relationships between SC partners is to project success so also is the integration of various components of the project supply chain. This is evident in the application of concurrent engineering principles, which Nicolini (2001:46) suggests leads to project supply chain integration, which in turn improves value, eliminates inefficiencies and reduces project costs in the UK construction industry.

The next phase shown in Figure 3.2, which is the conversion stage, is required for value optimisation. This is the phase whereby the project's product is actually created and the degree of value that can be achieved at this stage is dictated by the efficiency and effectiveness of the

procurement phase (Venkataraman & Pinto, 2008:224). The final phase of the project supply chain process is the delivery of the completed project to the client (Figure 3.2). The importance of the phase is anchored on client satisfaction, that is, with clients becoming increasingly risk-averse, the willingness of the project organisation to assume some additional risks is certain to add value and provide a distinct competitive advantage to the whole SC (Venkataraman & Pinto, 2008:225).

According to Hutchins (2002:112), in addition to strategic initiatives, the following practical steps may be undertaken to add value to projects:

- flowchart the project supply chain processes before the project is initiated: this process will show the various links or steps involved in completing the project and each step will potentially have a customer and a supplier. The flowchart can identify potential areas of redundancies, waste in the chain and can facilitate the use of lean management initiatives to eliminate them;
- standardise processes: standardisation of processes throughout the project supply chain by the use of methods such as simultaneous design, concurrent engineering, lean manufacturing, mistake proofing, total productivity maintenance and collaborative teamwork will ensure consistency;
- control process variation: it is essential that processes across the total project supply chain are monitored and controlled for variation, including lead times, quality in materials and production processes. Once the supply chain processes are stabilised, they can be improved;
- pre-qualify suppliers through supplier certification: ensure that suppliers in each link of the project supply chain process are ISO 9001 certified. This certification guarantees a pool of quality suppliers;
- audit project supply chain processes and take corrective and preventive actions: processes should be audited periodically for improvement and risk identification.

Corrective action should be taken to eliminate the root causes of non-conformance and deficiencies that were uncovered through the audit, while preventive action will ensure that these problems do not reoccur and measure project supply chain performance: without the availability of specific quantifiable performance metrics, project supply chain performance in terms of both efficiency and customer satisfaction cannot be gauged. For this reason, performance metrics should be developed and used and competitive benchmarking should be performed. These tools

will immediately convey how the project supply chain has been performing over time, or in comparison with best-in-class competitors.

### **3.5 OPERATIONAL PERSPECTIVE OF SUPPLY CHAIN MANAGEMENT IN CONSTRUCTION**

The operations function creates value by converting raw materials and components into finished products at every phase of the supply chain and is responsible for ensuring quality, reducing waste and shorter process lead times (Venkataraman & Pinto, 2008:214). Efficiency of the process at this stage is very crucial. It is notable that the unionist view considers logistics as a sub-process in supply chain management (Hatmoko, 2008:14).

#### **3.5.1 Logistics**

In project management, the logistics function, which entails the transfer, storage and handling of materials within a facility, as well as incoming and outgoing shipments of goods and materials, requires a thorough understanding of client requirements. It includes expulsion of waste throughout the supply chain to reduce costs and ensures timely completion and delivery of projects (Venkataraman & Pinto, 2008:214). Empirical findings by Perera *et al.*, (2009:134) suggest that active involvement in the management of logistics not only result in improved main contractor/subcontractor interface, but subcontractor/subcontractor interface as well. This means that when subcontractors attempt to meet the product and service quality expectations of the trade that will be building upon their work, improved project culture and quality is achieved. The same study also discovered that a significant shift towards increased focus trades that were involved in the pre-start process. This in turn leads to stronger supplier-customer relationships, leading to significant improvements in quality.

In addition, inventory management that is also part of logistics is necessary because inventories do not only represent a substantial portion of the supply chain cost, but they also impact customer service levels and constitute a cost trade-off decision in logistics. In project environments where inventory-related costs are substantial, effective inventory management can be achieved only through the joint collaboration of all members of the supply chain (Venkataraman & Pinto, 2008: 215). The importance of logistics is underscored by the 2003 report of the Building Research Establishment (BRE), which indicated that 30% of construction costs are attributed to the transportation of construction materials (BRE 2003 cited by Shakantu, 2009:224).

### **3.5.2 Supplier management**

The ability of suppliers to provide quality raw materials and components when they are required at a reasonable cost can lead to shorter cycle times, reduction in inventory-related costs and improvement in end-customer service levels. This translates to added value in the chain in spite of the fact that suppliers constitute the back-end portion of the supply chain (Venkataraman & Pinto, 2008: 213). Venkataraman and Pinto (2008:214) state that without the involvement, cooperation and integration of upstream suppliers, value optimisation in the total supply chain cannot be a reality. Managing the dynamic interrelationships and interactions that exist among suppliers is considerably more complex and requires effective integration of project activities into the larger framework of supply chain management. For instance, in the construction industry, empirical results indicate that subcontractor involvement and integration is facilitated through early procurement by subcontractors, subcontractor selection which is not based solely on lowest price; compensation including joint profit sharing; suitable risk allocation and use of collaborative tools and approaches (Eriksson *et al.*, 2007:12).

### **3.5.3 Construction supply chain in South Africa**

The construction industry's performance is closely related to the individual performance of the construction supply chain. Given that clients are the first members of the construction supply chain, clients and their procurement practices are the drivers of industry behaviour, performance and transformation (CIDB, 2004:18). Clients and their procurement processes bring together a changing range of players and expertise that constitute the construction supply chain. Each procured project assembles a range of design professionals, contractors, subcontractors and suppliers to deliver specific client requirements. Fragmentation of procurement practices through different authorities and client bodies has generated concerns in the industry over the years. This client practice relates to the wide variety of tender and contract documentation, variable preferential practices, delayed evaluation and award of contract as well as the cancellation of tenders and re-tendering, which leads to cost overruns, increased risk and wasteful use of scarce resources (CIDB, 2004:22).

However, the CIDB (2004:21) reiterates the assumption that the introduction of supply chain management principles, the standard for uniformity in construction procurement and the implementation of the Construction Industry Development Board contractor grading system in public contracts will begin to address these issues and spur improved procurement efficiency in the industry. It is also apparent from research findings (CIDB, 2004:22) that definite process

improvement is achieved when modern procurement methods are used to promote partnering, teamwork and concurrent engineering methods that yield win-win benefits to all members of the construction supply chain.

Similarly, the contracting sector of the industry is plagued with process related issues. Contractors expressed the view that design professionals do not have enough knowledge in developing specifications and documentations, changes in construction processes and technologies. These results in adversarial and time-consuming processes to settle variation orders, unnecessary design rework by contractors and eventual construction delays (CIDB, 2004:22). Pursuant to the attempt made to address perceived process and other issues plaguing the industry, the CIDB embarked upon the registration of contractors in order to effectively target the development of contractors; provide information about the size, distribution and capability of contractors; facilitate sustainable empowerment; assist contractors to develop proper track records; provide risk management tools for contractors and clients and also establish a foundation for implementing the National Contractor Development Programme (CIDB, 2011:7).

Although progress is being made by the Construction Industry development board in this context the CIDB is still very far from achieving its objectives in this regard. In particular, there is a genuine reason for concern with regard to the unusually high percentage (89.3%) of grade one registered contractor. This suggests that organisations with low contracting capacity dominate the register (CIDB, 2011), which grades all contractors according to their capability to perform. The capability to perform in turn is determined by the financial and competency based work capabilities exhibited by contractors in previous projects. These developments are reported in Table 3.3.

**Table 3.3: The proportion of CIDB registered active contractors by grade**

<b>Contractor grading designation</b>	<b>Maximum Contract Limit (R)</b>	<b>Active Contractors by grade (No.)</b>	<b>Proportion (%)</b>
9	No limit	133	0.1
8	130 000 000.00	194	0.2
7	40 000 000.00	575	0.5
6	13 000 000.00	1 428	1.3
5	6 500 000.00	1 864	1.7
4	4 000 000.00	2 131	1.9
3	2 000 000.00	1 397	1.2
2	650 000.00	4 333	3.9
1	200 000.00	100 147	89.3
Total		112 202	100

Source: CIDB (2011:11)

As revealed in Table 3.3, the register is dominated by emerging contractors, which the Construction Industry development board described as mostly black owned construction contracting entities with significant developmental potential, but without requisite finance and / or competence that acts as impediments to their ability to become established construction firms (CIDB, 2011). In addition, recent research conducted among contracting organisations that are members of the Master Builders South Africa (MBSA), indicates that contractors concur with view of (Emuze, 2009:104-107) that:

- Supply chain management is vital for project success;
- short term objectives and a price oriented approach persist in the industry;
- the number of irregular clients, which necessitates short term view of project objectives, is high;
- the construction supply chain is fragmented;
- strict and inflexible adherence to contents of contract data is common;
- the use of modularisation in order to reduce construction time is poor;
- risk management competency is scarce in the industry;



- inefficient and ineffective problem solving mechanisms, especially between contractors and subcontractors is a problem;
- the uptake of lean construction as a management tool to eliminate waste in the construction process is poor;
- open book accounting is still a mirage and
- the penetration of information technology in the industry is still weak.

Given the ripple effects associated with these issues, knowledge sharing and transfer is possible in a collaborative working environment in the South African construction. Collaboration can simplify the construction process by removing bottlenecks occasioned by individual perceptions and attitudes. The quality of service between suppliers, subcontractors and contractors can be improved as well as the quality of service delivered to clients and other project stakeholders. Closer relationships have the potential to break down barriers such as organisational and individual cultures. A consistent workload is beneficial to long term relationships that may persuade subcontractors to focus on value rather than profit.

Contractors can also adopt collaborative procurement methods to promote innovation and creativity in construction projects. The procurement method may facilitate the negotiation of common project goals and objectives in an agreeable manner. Collaboration can also mitigate avoidable communication problems as well as logistics related issues. Furthermore, in order to engender continuous project performance improvement in the industry, Emuze (2009:108), *inter-alia*, recommends the following:

- ensuring the early involvement of key project team members that have expert knowledge so that an appropriate level of client satisfaction and value can be defined;
- establishing subcontractor and supplier relationships by selecting teams based on value rather than lowest price;
- integrating pre-construction and construction activities and adopting common processes such as ICT;
- managing the project parameters of cost, schedule, quality and health and safety in unison;
- developing and monitoring continuous improvement programmes;
- developing and implementing appropriate risk management processes;
- dealing with risks and rewards equitably by using modern commercial arrangements such as collaborative contract forms, target cost and open book accounting;

- using non-adversarial forms of contract and ensuring that contractual relationships are appropriate for expected project objectives;
- mobilising and developing people in order to ensure employee satisfaction through integrated teams; and
- adopting the Latham / Egan collaborative working principles.

The above therefore indicate that performance improvement in the supply chain is not a simple and straight forward process. Organisations need to innovate and design systems that address the core aspects of supply chain performance. Proper planning and key risk management processes seem to be among the core concepts of any system planning and integration if the chances of effectively addressing performance issues are likely.

### **3.6 THE NEED TO MANAGE THE CONSTRUCTION SUPPLY CHAIN**

The construction supply chain is simply a network of firms that agreed to work together in order to realise objectives relative to construction projects (Beer & Noria, 2000:21). The authors emphasised that the days of vertical integration or rather the era whereby a single firm can conceive and realise a construction project can be deemed to be simply over for now. Prevailing circumstances in the industry necessitate a proactive approach to the management of actors / and firms involved in project conception and realisation. Venkataraman and Pinto (2008:211) contend that as a direct result of factors such as globalisation, best value for customer money, inventory management and complexities, risks and uncertainties attached to projects necessitate the adoption of supply chain management approaches.

Venkataraman and Pinto (2008:211) suggest that project supply chain complexities underscore the importance and need for project-based organisations to manage their total supply chain in a more formal and organised manner. This depicts that supply chain management approaches such as partnering, information and risk sharing can greatly reduce uncertainties and complexities attached to project and management approaches. Supply chain management approaches such as lean construction, TQM, purchasing, distribution and logistics management will not only enable organisations to realise major gains through the elimination of constraints in the process, but also will provide opportunities for businesses to improve their operations. Shakantu (2009:227) contends that the construction industry could benefit from supply chain optimisation tools such as integration of logistics functions and reverse logistics that have proved to be effective tools to improve transport utility in other industries such as manufacturing. This denotes that the optimisation of the usage of transport vehicles can significantly improve construction efficiency.

Based on the assumption that clients, cost, flexibility, quality and time are drivers of supply chain management, their performance provides a barometer that can successfully measure the performance of a construction supply chain (see Table 3.4). Supply chain management can potentially introduce performance improvements in the construction process that will galvanise / or accelerate infrastructure delivery not only in South Africa, but in any developing country (Beer & Noria, 2000:32). The trend towards outsourcing and the increasing importance of intangibles heightens the need for fragmentation and variety in product and service offerings. This necessitates greater thought and skill in managing decoupling points and postponement of final product composition, which in turn necessitates greater attention to issues of alignment and logistics and by implication issues relative to supply chain management (Shakantu *et al.*, 2007:103). The metrics used to measure the performance of a supply chain are reported in Table 3.4.

**Table 3.4: Project supply chain performance metrics**

Category	Performance issues
Time	<ol style="list-style-type: none"> <li>1. Was the project completed and delivered on time?</li> <li>2. What is the potential variability in project completion times?</li> <li>3. Was the completed project operational on time to the satisfaction of the client?</li> <li>4. Were the purchased materials and manufactured components delivered on time by upstream suppliers?</li> <li>5. What is the potential variability in procurement lead times?</li> </ol>
Cost	<ol style="list-style-type: none"> <li>1. Was the completed project within budget for each of the project supply chain members?</li> <li>2. What was the total project supply chain cost? <ul style="list-style-type: none"> <li>• Procurement cost of purchased materials</li> <li>• Manufacturing cost</li> <li>• Inventory-related cost</li> <li>• Transportation cost</li> <li>• Project acceleration costs</li> <li>• Cost of liquidated damages</li> <li>• Other relevant costs: administrative, etc.</li> </ul> </li> </ol>
Quality	<ol style="list-style-type: none"> <li>1. Did the project meet the technical specifications and does it provide the functionality required by client?</li> <li>2. Was the client satisfied with the service provided during project start-up, transfer and implementation?</li> <li>3. Were the purchased raw materials and manufactured components defect-free?</li> <li>4. Was the completed project's product reliable and durable during its life cycle?</li> </ol>
Flexibility	<ol style="list-style-type: none"> <li>1. Was the client accorded reasonable freedom within a reasonable timeframe to make changes to the project scope, design and specifications?</li> <li>2. Were upstream suppliers responsive to the reasonable needs of their downstream partners in terms of delivery time and quality issues</li> </ol>

Source: Coyle *et al.* (2003:490)

There are various metrics that can be used to measure the supply chain, all of which can help to provide an overview of how the supply chain is performing, not just in terms of spend and cost, but also in terms of supplier information as well as operational aspects. However, the four mentioned in the table above seem to be more comprehensive measures of supply chain performance.

### **3.7 UNFAIR COMPETITION IN THE SOUTH AFRICAN CONSTRUCTION SECTOR**

Dorée (2004:144) argues that improvement of the construction industry requires further non-conventional procurement methods and less selection based on the lowest bid, in line with construction reform policies adopted around the world. Key drivers of the construction sector, according to Dorée (2004:144), should be based on value and quality-driven competition, integrated team delivery and long-term commitments. Dorée (2004:144) asserts that the construction sector is susceptible to ruinous competition that cannot be sustained. With the rise in competition, unethical issues in the construction industry arise and contractors and supply chain managers have always been perceived as the main culprits and blamed for the defects that happen in the industry.

The developed countries too share similar experiences, with other countries where there has been bid rigging in the construction sector. This shows that both the firms', strategies and procurement processes facilitate bid rigging (Haberbusch, 2000:99; Lee & Hahn, 2002:121; Sohail & Cavill, 2008:182; Gupta, 200:71). The main challenge is to ensure that such collusive practices are eradicated at all levels of the procurement chain. Therefore, assertions by others like Dorée (2004) that competition in the construction sector is not feasible, suggest that without some form of cooperation between firms the benefits of competition cannot be realised. The construction sector like any other sector with no features of a natural monopoly can be competitive if there is rivalry between the firms. Robust competition will allow some firms to prosper whilst others will not; the solution cannot be cooperation but innovation and rivalry.

The confirmation of settlements by the Competition Tribunal of South Africa (2013:6) (Competition Tribunal) in July 2013 marked a major milestone in the Competition Commission of South Africa's (CCSA) investigation of bid rigging and collusion in the construction sector. With 140 projects affected by the collusive practices eligible for settlement, the CCSA reached a settlement with firms on 57 projects for a combined administrative penalty of R1.46 billion. Investigations of collusive practices in the construction sector are not unique to South Africa, as other countries such as the United Kingdom (UK), United States of America (USA), South Korea and Netherlands have looked into similar issues before. There are certain activities that were ingrained in the construction sector to the point where firms found collusion a normal business practice. The challenge, after the dismantling of the construction cartel, is to ensure the collusive practices do not resurface again and that the firms chart a new sustainable competitive path. Firms

in the construction sector have an important role to play in the economy and should ensure that they align their businesses to the prevailing regulatory environment.

### **3.7.1 Construction sector collusion in South Africa**

As an economy develops, investment in infrastructure is an important engine of growth, creating jobs and facilitating further investment. Large infrastructure projects are commissioned by government and typically put out to tender and are often undertaken by local construction firms. However, given the amount of money involved and the market and regulatory conditions in a country, these processes may give rise to cartels. The section below shares current scenarios related to cartel movement and collusions within the South African Construction sector and how the Competition Tribunal had dealt with such behaviour.

#### ***3.7.1.1 The investigation of key construction companies in South Africa***

According to Competition Tribunal (2013:7), the first signs of collusion in the construction sector came as a consequence of a corporate leniency application (CLP) by Murray & Roberts, through its subsidiary, Rocla, in 2007. This case exposed a cartel in the production of pipes, culverts and manholes as well as bid rigging in the supply of precast concrete products (Competition Tribunal, 2013b:8). The cartel, as detailed in the case between the *Competition Commission v Southern Pipelines Contractors/Conrite Walls*, operated from 1973 to 2007 in Gauteng, Kwazulu-Natal and the Western Cape. Having endured for such a long period, the cartel was structured such that one member of the cartel was designated a ‘banker’ to compile a list of all contracts available during a specific period. Cartel members allocated regions and market share. The effects of the cartel were catastrophic. As the Competition Tribunal (2010:4) explained, “cartel members enjoyed a quiet and hugely profitable life, as evidenced by the drop in prices by between 25-30% post the disbandment of the cartel...” Further an in-depth study of the cartel showed overcharges ranging from 16.5-28% in Gauteng and 51-57% in Kwazulu-Natal (Khumalo *et al.*, 2014).

In the light of the uncovered collusion in the construction products involving some of the top-tier construction firms, CLPs in the sector as well as international trends on bid rigging, the sector reached the radar of the CCSA. This led the CCSA to prioritise the broader infrastructure and construction sector in 2008. The focus on the sector was also due to the infrastructure programme Government was embarking on and therefore it was vital that prices of inputs to the infrastructure programme were not inflated by anti-competitive behaviour and practices. With the sector under the spotlight, the CCSA embarked on an in-depth study of the entire value-chain of the

construction sector and at the same time CLPs started flowing in (Competition Tribunal, 2013b:7).

Armed with the information on possible anti-competitive conduct in the sector, the CCSA launched investigations of bid-rigging and collusion in the construction sector in 2009 (Competition Tribunal, 2013a). During the investigations, the CCSA established that bid rigging and collusive conduct was rife in the sector. In the circumstances, the CCSA decided, in February 2011, to invite firms involved in bid rigging and collusion to settle their contraventions provided they fully disclose the extent of their involvement and, where applicable, pay an administrative penalty.

In 2013, the CCSA concluded settlements with the majority of firms that were involved in the bid rigging and collusion on various projects, for which the contraventions occurred between 2006 and 2009. The total administrative penalties out of the settlement process amounted to R1.46 billion. Table 3.5 provides the information on the projects that were affected by the scourge of bid rigging and collusion.

**Table 3.5: Projects affected by the construction cartel: prescribed versus non-prescribed**

	<b>Prescribed</b>	<b>Non-Prescribed</b>	<b>Total</b>
<b>Number of projects</b>	160	140	300
<b>Number of projects (%)</b>	53%	47%	100%
<b>Value of projects</b>	R9.9 billion	R37.1 billion	R47 billion
<b>Value of projects (%)</b>	21%	79%	100%
<b>Total project settled:</b>			<b>57</b>

Source: Competition Commission SA (2014:9)

As revealed in Table 3.5, a total of 300 projects were affected by bid rigging and collusion for the period of at least between 2000 and 2009. Of these projects, 160 (53%) fell outside the prescription period, set out in section 67 of the Competition Act, within which a complaint can be brought against parties involved in prohibited anti-competitive practices; hence the distinction between prescribed and non-prescribed projects in Table 3.5. Therefore, the projects considered for settlement were those deemed non-prescribed, constituting 47% of the affected projects. At the conclusion of the CCSA's settlement process, there were settlements on 57 projects out of the total non-prescribed projects of 140. The value of the non-prescribed projects amounted to R37.1

billion (79% of the total projects), largely accounted for by the FIFA World Cup stadia construction and the Gauteng Freeway Improvement Plan (GFIP). In terms of value, the CCSA's investigation and settlement covered a substantial portion of the projects affected by bid rigging. The projects affected by cartels in the construction industry in South Africa are reported in Table 3.6.

**Table 3.6: Projects affected by the construction cartel: private versus public**

	<b>Private</b>	<b>Public</b>	<b>Total</b>
<b>Number of projects</b>	75	225	300
<b>Number of projects (%)</b>	25%	75%	100%
<b>Value of projects</b>	R19 billion	R28 billion	R47 billion
<b>Value of projects (%)</b>	40%	60%	100%

Source: Competition Commission SA (2013:11)

The uncovered bid rigging and collusion in the construction affected both private and public sector projects. However, most of the rigged projects were for the public sector (75%) whilst the residual was for private sector projects (25%). In terms of value, the rigged projects for public and private sector accounted for 60% and 40% of the infrastructure spend, respectively. In total, projects to the tune of R47 billion were affected by bid rigging and collusion across the private and public sector projects.

### **3.7.1.2 Key large infrastructure projects affected by unfair competition in South Africa**

A number of projects in both public and private sector were affected by the bid rigging and collusion in the construction sector, details of which are found in the settlement agreements confirmed by the Competition Tribunal. Firms that settled with the CCSA revealed the information of the projects where bid rigging occurred. Table 3.7 shows the firms that settled as well as the administrative penalties confirmed by the Competition Tribunal.



**Table 3.7: Construction collusion settlements**

<b>Firms</b>	<b>Administrative penalty</b>
<b>WBHO</b> (Wilson Bayly Holmes)	R311 288 311
<b>Murray &amp; Roberts</b>	R309 046 455
<b>Stefanutti</b>	R306 892 664
<b>Aveng</b>	R306 576 143
<b>Basil Read</b>	R94 936 248
<b>Raubex</b>	R58 826 626
<b>Haw &amp; Inglis</b>	R45 314 041
<b>Rumdel</b>	R17 127 465
<b>Giuricich</b>	R3 552 568
<b>Vlaming</b>	R3 421 662
<b>Tubular</b>	R2 634 667
<b>G Liviero</b>	R2 011 078
<b>Hochtief</b>	R1 907 793
<b>Norvo</b>	R714 897
<b>Esofranki</b>	R155 850
<b>Total</b>	<b>R1 464 406 466</b>

Source: Competition Tribunal (2013:21)

In the construction of roads, the top construction firms, namely, Grinaker LTA (an Aveng subsidiary), Basil Read, Haw & Inglis, WBHO, Concor and Raubex, reached an agreement at the Road Contractors meetings in 2006 to allocate tenders for the construction of roads. In addition, the firms agreed that firms not interested in winning the bid or not allocated project would submit cover bids to ensure that those interested win the bid, which practice is commonly referred to as cover pricing (Competition Tribunal, 2013b:9)

Another major project was the construction of the new FIFA Soccer World Cup stadia. The bid rigging agreement was concluded in 2006 by Grinaker LTA, WBHO, Murray & Roberts, Group Five, Concor and Basil Read. These firms met twice to allocate, amongst each other, the construction of the stadia, namely, Mbombela (Nelspruit), Peter Mokaba (Polokwane), Moses Mabhida (Durban), Soccer City/FNB Stadium (Gauteng), Nelson Mandela Bay (Port Elizabeth) and Greenpoint (Cape Town). The firms, moreover, agreed to exchange cover prices in their

respective bids to ensure that the agreed allocations are realised and also agreed on a profit margin of 17.5% to be attained from the construction of the stadia.

The collusive practices on the construction of roads and stadia were instigated by the top-tier of South Africa construction firms graded for large projects in CIDB's GB and CE categories for grade 9 firms. Although there are just over 50 firms registered for CDIB 9 in the GB and CE categories, in reality only the top-tier of these firms are capable of handling large infrastructure projects. There has not been emerging construction firms that have been able to challenge the stronghold of the top-tier construction firms. It, therefore, made it easier for the top firms to reach an agreement as there would be no credible threat of rivalry from the other CIDB 9 category firms. (Competition Tribunal, 2013a:8).

In the private sector, projects affected included industries/sectors such as mining (Anglo Platinum, Xstrata Iron Ore), paper and pulp (Mondi and Sappi), university residences (Universities of Pretoria and Cape Town) as well as private residences. The uncovered bid rigging also extended to mining infrastructure projects in Burkina Faso, Zimbabwe and Botswana (Competition Tribunal, 2013b:8). By implication, construction companies will always opportunistically use these situations to their advantage to collude to fix the official bidding costs way above their value, resulting in enormous cost overruns which will have to be paid by the South African government with public funds. While there could have been sufficient grounds for the South African government to open a full investigation into the operations of a construction cartel; the overwhelming evidence of South Africa's Competition Commission Report (2013), especially in relation to the 2010 FIFA World Cup, should be an eye opener in strategically and stringently dealing with cartels

### **3.7.2 Forms of collusive anti-competition**

As mentioned by the Competition Commission (2013a:9) the construction sector, as revealed in settlements by firms with the CSSA, has been riddled with collusive practices for a number of years. The extent of such conduct has not been fully exposed in the settlements as more than half (53%) of the rigged contracts were not considered for settlement given that the contraventions had prescribed in terms of the Competition Act.

What has been revealed is that the collusive practices took at least four forms, namely, (1) agreement on allocating customers and profit margins to be attained from a contract, (2) cover pricing, (3) payment of loser's fee to a bidder who submitted a cover price and (4) subcontracting

as a way of compensation to losing bidders (CCSA, 2013). Each of these formulations of bid rigging and collusion is discussed in detail below, highlighting how the modus operandi of the firms unfolded.

### ***3.7.2.1 Scenario 1: Allocating customers and fixing profit margins***

This form of bid rigging occurred mainly at a higher level, where firms gathered together to allocate customers for anticipated construction work. The instances uncovered in the settlements were the road contractors meeting (for anticipated GFIP and other road construction works), FIFA World Cup stadium allocation (for construction of world cup stadia), Wade list meeting (for electrical work) and Cape club meeting (for construction works in the Western Cape). In the meetings, firms would allocate bids and, in some instances, agree on the profit margins to be attained. The firms were found to have been involved in this form of conduct without the knowledge of the clients.

### ***3.7.2.2 Scenario 2: Cover pricing***

Cover pricing has been defined in the settlements as an instance of collusive tendering as follows (Competition Tribunal, 2013b:9): Cover pricing occurs when conspiring firms agree that one or more of them will submit a bid that is not intended to win the contract. The agreement is reached in such a way that among the colluding firms, one firm wishes to win the tender and the others agree to submit non-competitive bids with prices that would be higher than the bid of the designated winner, or the price would be too high to be accepted, or the bid contains special terms that are known to be unacceptable to the client.

The settlement by firms as confirmed by the Competition Tribunal revealed that a significant number of the collusive tendering was in the form of cover pricing, for both public and private sector contracts. Firms, individually or as joint ventures, decided on cover prices based on capacity constraints or as an act to inflate the bid price.

Cover pricing arising from capacity constraints, often rife in private sector projects, occurs when firms are invited to bid for work and have neither available capacity nor appetite for the work. In this instance, an invited firm would then request a cover price from another firm to bid such that the invited firm does not win the tender. Some of the firms argue that this form of cover price takes place as firms are generally reluctant to turn clients away.

In instances of cover pricing as means to inflate tender costs, firms would agree on projects they should share amongst themselves and use cover pricing to ensure that the outcome is achieved. This form of cover pricing is solely designed to ensure that the rivalry in the identified projects is eliminated thus making it opportune for the firms to extract higher than normal profit margins.

Despite the form of the cover pricing or phony bids, it has been established in the countries that have uncovered bid rigging in the construction sector that such conduct is orchestrated to deceive the buyer that there is competition when there is not, with the ultimate goal of achieving higher prices. In essence, construction firms were able to consistently influence the outcome of bids for infrastructure projects through cover pricing. As shown in the details of the settled projects affected by bid rigging, firms have particularly been successful in ensuring that contracts are allocated to the chosen firm. It is only in very few instances of cover pricing (on settled projects) where one of the firms engaged in cover pricing did not win the tender, see for example the projects to construct the N2 Section 10-Gamtoos to van Staden River, Peter Mokaba Sports Stadium, Millwood Village Residential Project and Kempton Park City.

Cover pricing has been the form of collusive pricing that allowed firms to continuously rig bids to influence the outcome of a tender process. In this way firms have been able to allocate contracts, eliminate competition and achieve higher prices that would not have been achieved absent the bid rigging.

### **3.7.2.3      *Scenario 3: Payment of losers' fee***

In certain instances, cover pricing was combined with payment of losers' fee, which meant that participants to the cover pricing scheme were paid a losers' fee. This was a ploy by the construction firms to ensure that those participating in the cover pricing scheme were compensated, in some instances with payments in excess of R1 million.

### **3.7.2.4      *Scenario 4: Subcontracting***

Collusive tendering also occurred whereby participating firms were guaranteed subcontracting work for submitting false bids to clients. When the identified firm wins the tender, participating firms were rewarded with subcontracting work.

In conclusion, the construction firms engaged in collusive tendering/bid rigging in the form described in the scenarios above. For many years, before the investigations by the CCSA, the firms were rigging the procurement processes on major infrastructure projects in South Africa

with impunity. As the law has caught up with the firms, the challenge for the industry will be to adapt to a competition culture by abandoning the collusive tendering practices.

### **3.8 CONCLUSION**

This chapter discussed the supply chain management and construction supply chain concepts, the Supply chain management in the construction industry and the critical aspects for best practice in construction supply chain management. It further analysed literature focusing on the Strategic perspective of supply chain management in construction, operational perspective of supply chain management in the industry as well as issues related to supplier management. In articulating these issues, it emerged that South African construction is indeed complex and diverse. The chapter also discussed literature on the construction supply chain in South Africa and the need to manage the construction supply chain and finally issues of unfair competition in the South African construction sector. The literature revealed that unethical behaviour in construction is common among major players and efforts are needed to monitor them. The next chapter analyses the literature focusing on the supply chain and how the Theory of Constraints (TOC) can be linked and used within the construction industry as a tool for addressing supply chain bottlenecks.

# CHAPTER 4

## SUPPLY CHAIN MANAGEMENT AND THE THEORY OF CONSTRAINTS (TOC)

### 4.1 INTRODUCTION

Today, many organisations implement the Theory of Constraints (TOC) approach to guide their improvement programmes to enhance their supply chain performance. This chapter discusses the Theory of Constraints (TOC) and how the construction industry can benefit from applying its principles. The current discourse on TOC will be articulated in relation to the construction supply chain constraints. It begins by reflecting on the historical discourse of TOC over time and its application in modern times.

### 4.2 HISTORICAL BACKGROUND OF THE THEORY OF CONSTRAINTS

The TOC, coined by Goldratt (1990:8) has been widely known as a management philosophy that aims to initiate and implement breakthrough improvement through focusing on a constraint that prevents a system from achieving a higher level of performance. The TOC paradigm essentially states that every firm must have at least one constraint (Goldratt, 1999:4). Goldratt & Cox, 1992: 3 define a constraint as any element or factor that limits the system from doing more of what it was designed to accomplish (i.e. achieving its goal). The owner of a system is assumed to establish its goal. The fundamental goal of most business entities is to make money now and in the future. Other stakeholders may develop necessary conditions that must be met to allow the system to continue operating (Goldratt, 1999:21). The TOC thus encourages managers to identify what is preventing them from moving towards their goals -as well as necessary conditions -and find solutions to overcome this limitation.

The TOC comprises a set of three separate but interrelated areas – namely, logistics, performance measurement and logical thinking (Cox & Spencer, 1998:7). The TOC applications to logistics include the drum-buffer-rope scheduling method, buffer management and the VAT analysis. According to Cox and Spencer (1998:7), under the VAT, assigning categories or structures to different types of production processes can help identify barriers within each type of production process. The theory outlines three identifiable structures, known as V, A and T. A “V” structure exists in cases where a production process uses a few raw materials to produce a range of products. An “A” structure uses several raw materials in the production of a few different products. “T”

structured processes use the same raw materials to produce several similar product types. The VAT structure analysis provides management with an overall perspective of where potential barriers exist within a particular type of production process. Measurements are required to determine whether or not the system is accomplishing its goal of making money. Performance measurement includes operating measures (i.e. throughput, inventory, operating expenses) and local performance measures (i.e. throughput-dollar-days and inventory-dollar-days). Logical thinking comprises the five-step focusing process and the thinking processes (Goldratt, 1990:12).

The TOC solutions initially attempted to resolve core problems in production systems using methods such as the drum-buffer-rope scheduling, constraint-focused performance measurement and buffer management (Goldratt & Cox, 1992:23). Further development of the TOC incorporates solutions for marketing and sales (Goldratt, 1994), project management (Goldratt, 1997:19) and supply chain management. Blackstone (2001:9) provided an exhaustive review of the latest developments of the TOC applications, which are later dealt with in the forthcoming sections.

Over time, the development of the TOC and accounts of its application have proliferated with the publication of a considerable number of articles, proceedings and books based on the TOC approach (Mabin *et al.*, 2001:11). Rahman (1998:42) reviewed the TOC approach on manufacturing firms and applied the TOC approach to addressing problems in different types of organisations. Beyond business firms, Klein and Debruine (1995:91) and Dettmer (1998:321) used the TOC thinking processes to identify core problems in public policies. Womack and Lowers (1999:211) applied the TOC approach to the healthcare system to improve its performance.

The above authors agree with the inventor (Goldratt) that the TOC is a systems based management philosophy that is used to assist in the continuous improvement of a system's performance by focussing on core problems that are preventing the system from achieving its goal (Blackstone, 2002:32; Mabin & Baldestone, 2003:28; Gupta & Kline, 2008:9; Inman, 2009:12). The TOC approach is based on systems thinking (Mabin, 1999:12; Mabin & Balderstone, 2003:28) and as such, considers the overall performance of the system rather than focusing on improving the performance of an individual task or component in the system (Taylor & Churchwell, 2004: 415-437)

Furthermore, the TOC recognises that every system has elements that limit its performance, called "constraints" (Rahman, 1998:42; Mabin, 1999:12; Smith, 2000:15; Blackstone, 2001:21; Gupta & Kline, 2008:32). It assumes that there are only a few constraints in any given system; usually

just one (Mabin & Baldestone, 2003:28). In this case, a constraint is defined by Goldratt and Cox (1992:23) as “any element or factor that limits the system from doing more of what it was designed to accomplish (i.e. achieving its goal)”. Systems’ constraints may be physical (e.g. machinery, specialised personnel or raw materials), policy (when the policies of an organisation are not adjusted in response to changes taking place within the environment it operates) or behavioural (existing practices in an organisation). It is claimed by Rahman (1998:43) that most organisations have more policy constraints than physical ones. The Theory of Constraints encourages managers to identify the constraints and find ways to eliminate them (Simatupang *et al.*, 2004:50).

Thus the evolution of TOC follows the natural scientific approach to system improvement. As the developer, Goldratt (1999:33) brought the mind of a scientist to the problems and needs of business, private sector organisations and individuals. His scientific approach has led to the breaking of several business paradigms and the development of new simplified approaches to managing systems. The next section presents a demonstration on how the TOC has gained momentum since its inception.

#### **4.2.1 Discourse on the Theory of Constraints in the twentieth century**

The inception of the TOC in the eighties was followed by its application and modernisation in the nineties. Chase and Aquilano (1995:12) described the TOC as a production and operations management strategy that centered on the concept of capacity-constrained resources (CCR), more commonly called bottlenecks. According to the authors, companies and organisations need to see the TOC from the assumption of the existence of one or more CCR in any system. However, systems with balanced loads and any resource, be it manpower, machines, procedures, raw materials, or markets, is said to be a CCR if it limits the performance metric of the system. This limitation may be due to the fact that its capacity is less than the demand placed upon it. Furthermore, the performance may be profit, production volume, or any other suitable criterion. The authors developed an example of a CCR which is the slowest operation in a continuous simple flow line of production of discrete parts. In more complex production system configurations such as a job shop with multiple routing of parts, it may not be obvious which CCR is in the system. In the mid-1990s, Chase and Aquilano (1995:12) asserted that the implementation of TOC in practice is achieved in a sequence of logical steps; e.g., these steps included:



#### 4.2.1.1 *Capacity-Constrained Resources (CCR) identification*

As stated in above, a CCR is defined as a resource which prevents the system from achieving a higher level of performance. It is then necessary to define precisely a metric for performance. In TOC, as it is applied in manufacturing environments, performance is considered to be profit which is defined as:

$$\textit{Profit} = \textit{Throughput} - \textit{Operating Expenses} \dots\dots\dots(1)$$

This was supported by Power *et al.*, (2001:1) that throughput is distinct as the sale prices of finished products and operating expenses are defined as the costs of raw materials employed in obtaining these finished products. The authors demonstrated that performance is associated with a given time horizon; e.g., week, month, year.

In demystifying the profit assumption, Chase and Aquilano (1995) explain that assuming that a manufacturing facility such as a workshop can make a number of finished products, each with its unit sale price, unit raw material costs and market demand, then maximum profit is obtained by making the most profitable mix of finished products subject to the multi-resource capacities available. Chase and Aquilano (1995:1) further define a CCR as the resource which has the highest ratio of utilisation to availability. Several authors supported the view that there exist a number of methods to identify a CCR. Fredendall and Lee (1997:1527) provide a heuristic procedure for determining a CCR. The most general and efficient method is based on linear programming (Mabin & Gibson, 1998:22).

#### 4.2.1.2 *Capacity-Constrained Resources (CCR)*

Chase and Aquilano (1995:23) further reveal that once identified, a CCR must be used effectively in such a way so as to obtain the desired performance of the manufacturing system. This is known as CCR management, which is implemented by a scheduling technique referred to as drum-buffer-rope (DBR). Mabin and Gibson (1998:32) add to the concept that it is well established that scheduling in job shops is extremely complex due to its combinatorial nature. DBR reduces this complexity by focusing attention on CCRs as opposed to all resources. In order to achieve the highest performance possible, Fredendall and Lee (1997:1559) viewed that CCRs must be scheduled with a view to avoiding unnecessary idle time which implies lost throughput.

The drum-buffer-rope constraint scheduling problem (DBRCSP) has been derived from a modification of the general resource constrained project schedule problem (GRCPSD) by Simon

*et al.* (1996:17). As with other project scheduling approaches, GRCPSD suffers from two inherent limitations:

- Each task/activity happens only once.
- Precedence among tasks/activities is specified explicitly than through the nature and amounts of material movement between tasks/activities.

These two limitations are removed by employing the state task network (STN) representation, originally developed by Simon *et al.* (1996:17).

#### **4.2.1.3 Performance improvement**

Somns *et al.* (1996:26) add to the debate that the identification and management of CCRs serve to achieve maximum performance for given capacity and demand levels. In order to go beyond this level of performance, measures have to be taken and the corresponding investments have to be made to increase capacity and/or demand. The operational performance criteria are;

- Throughput (TH) defined as the rate at which the manufacturing system generates revenue.
- Inventory (IN) defined as the investment made to generate revenue.
- Operating expense (OE) defined as the cost of transforming inventory into throughput.

In the context of TOC, Raham (1998:21) observed that system performance is improved by increasing inventory in order to increase throughput and/or decrease operating expense. From his interpretations, one can say that it is clear that the performance measurements of TOC are very different from traditional management accounting approaches. Apart from external constraints, such as market demand, internal CCRs by definition limit the performance of a manufacturing system (Mabin & Gibson, 1998:23). Consequently, the authors emphasise that CCRs must be the focus of all improvement efforts. For a CCR machine, its capacity may be increased by such measures as setup reduction, breakdown reduction and processing speed enhancement. All such measures naturally involve investments. In order to evaluate investments in system performance improvement, Somns *et al.* (1996:26) stated that organisations need to consider a setup reduction to illustrate the investment evaluation procedure.

In the 1990s, many business models became important value creators due to the proliferation of new and innovative business models (i.e. new ways of creating value). New firms with new business models threatened and replaced established companies and conventional ways of doing

business. The rate of transformation of organisations and the drivers to emend change meant that certain business contracts were not enough to manage the firm's (internal, external or strategic) constraints. This has led to developments in the 20<sup>th</sup> century that supported and perhaps benchmarked more in the TOC. A case here is the management of the firm's business model as a potential constraint is a key factor in the modern management theory.

#### **4.2.2 Discourse on the Theory of Constraints in the early twenty-first century**

In its brief 20-year history, Slack (2009:3) mentions that the TOC has developed rapidly in terms of both methodology and area of applications. As mentioned earlier, Goldratt (1998:221) developed a revolutionary method for production scheduling which was in stark contrast to accepted methods available at the time, such as Material Requirement Planning (MRP). Mabin and Baldestone (2003:4) reveal that central to the TOC philosophy was that any organisation (or system) has a constraint (or small number of constraints) which dominate the entire system. The authors assert that the secret to success lies with managing these constraints and the system as it interacts with these constraints, to get the best out of the whole system.

Brewer and Hensher (2001:3) suggested, for example, that the Drum-Buffer-Rope scheduling (DBRS) system, together with the general principles espoused in *The Goal*, were elements of TOC that became part of successful manufacturing management. Even so, some companies failed in their attempts to adopt Optimised Production Technology (OPT), the software package based on Goldratt (2000:37)'s method. Such failure was usually diagnosed as an inability or unwillingness by the organisation to discard old traditions and embrace the new philosophy and the new measures that were concomitant with successful adoption (Brewer & Hensher, 2001:12). The most common measures that need to be reviewed are accounting measures, as TOC promotes the use of global system-wide measures, rather than local measures (Goldratt, 2005:52). According to the author, the motivation for this is that if a system as a whole is to achieve its goal, it is best for the system's individual parts to work as a team in "sync" rather than at their own individual speeds.

Given that the major constraint to improvement was the resistance to changing these measures, it is not surprising therefore that this is the direction that TOC followed, to tackle this biggest constraint to adoption – behaviours (Maslennikova & Foley, 2000:5). Thus the TOC Thinking Processes (TP) was born: a suite of tools that allows people to learn and use the thinking processes that enable them to develop their own solutions to complex problems (Goldratt, 2005:42). This suite of tools enables analysis of a situation, using the rigour of cause and effect thinking

following strict logic rules, combined with the intuition and knowledge of the persons owning, or intimately involved with, the problem. Azevedo (2006:8) supports the view that the TP's enabled more complex problems ("messes") to be tackled and had much in common with other soft systems approaches that had been developed and used before TOC.

Boyd and Gupta (2004:17) introduced a theoretical model or the framework for TOC. They suggest, without testing, a positive relationship between an organisation with a throughput orientation and one that embraces the TOC concepts and organisational performance. More specifically, the authors suggested that there is a positive relationship between each of the three TOC dimensions or paradigms and performance. This work specifically looks at service organisations and their use of the principles underlying the paradigms and also uses customer service quality as a measure of organisational performance.

Since TOC is perceived as a management philosophy, it may have broad applicability. Schragenheim (2000:22) defines a management philosophy as "guiding real world managers to make better decisions, meaning to take a course of action that helps an organisation as a whole to better achieve its goal". Nothing in this definition limits the TOC philosophy to manufacturing or even any other sector. It then follows that TOC may have applications to other sectoral industries; For example, services can improve their processes and procedures just as can manufacturers. Goldratt and Cox (2006:11) reveal that there is a precedent for such applications of a manufacturing management philosophy to many sectors: For example, the application of just-in-time (JIT) (Inman and Mehra, 2001:22) and total quality management (TQM) (Sureshchandar *et al.*, 2001). Service industries often contain quasi manufacturing components within their operation in which the TOC logistics or scheduling paradigms may be adapted and utilised. The use of global performance measures and/or the TOC thinking processes can be beneficial in virtually any type of organisation.

There is a variety of anecdotal evidence to confirm that some organisations are using TOC as is discussed later. Aside from these success stories and case studies, however, there have been very few in-depth studies of TOC in supply chain management. To help fill this void, this study hopes to ascertain how supply chain management is utilising components of TOC and what results can be obtained. The use of empirical studies within other operational and management fields is useful in describing "the state of the art in operations management" (Bell *et al.*, 2005:169-183). The primary contributions of this research are the assessment of the use of TOC in supply chain management. While there may have been limited formal TOC training for managers, many of the

underlying principles may be gaining widespread acceptance through industry publications or books like *The Goal* (Goldratt & Cox, 2006:3).

The literature around the 20<sup>th</sup> century expanded the TOC as a tool whose application and success would include logical constructs to aid organisations in getting at the truth in the existing reality; its undesirable effects, core problems and conflicts. The philosophies developed tools to offer tests of reasoning to help assure validity of analysis. These tools included the identification of underlying core problems, the construction of win-win solutions and the planning of action steps to bring about necessary changes. The 20<sup>th</sup> century further benchmarked the TOC to develop tools that included capabilities for identifying potential negative consequences of planned actions, consequences which if not seen and addressed could lead to the failure of a plan for improvement. Solutions require action for change. What actions and when? How to change, the obstacles to be overcome and the action steps for implementation? Today, the elements of cause-and-effect logic, techniques for logic diagramming, tests of logic and conflict resolution tools to help assure the integrity of solution are addressed in any organisation. Lastly, the philosophical stand on the TOC in the 20<sup>th</sup> century which is popular and relevant today is the thinking processes that are producing results in a wide range of organisations. The next section shows how organisations have moved forward with TOC today, beyond optimisation and its philosophy.

#### **4.2.3 Recent developments on the Theory of Constraints**

The application of the TOC to address constraints has faced several challenges along and the originator had equally made attempts to adjust it. Goldratt (2008:46) expanded the TOC further to assess how the TOC can be taken beyond the ordinary constrained environment to a complex one. The author therefore adjusted the TOC in order to solve those unique problems in complex organisation. One of the defining characteristics of complex organisations by Goldratt (2008:48) is that they have many independently measured units that are all trying to maximise local measures. Furthermore, the significant problem complex organisations face is the coordination of these independent yet interdependent units. Sheu *et al.*, (2013:57) make the assumption that the independent units and departments within complex organisations use Drum-Buffer-Rope (DBR) and Critical Chain Project Management (CCPM) to manage their internal processes and proposed a key injection "Everyone in the organisation who has a significant impact on Throughput is measured by the same simple measure (that aligns all the actions of the organisation with the goals of the organisation)" and show how it invalidates several of the assumptions underlying the core conflict.

Shin *et al.*, (2012:35) demonstrate that within a complex environment today, TOC provides measures for supply chains to achieve coordination. The authors believe that in modern times, TOC supply chain measures can be used in complex organisations to create an effective method of coordination between units and departments and to give senior management new insight and greater ability to manage independent units.

Goldratt (2012:9) asserts that complex organisations suffer the same problems with on-time delivery, quality performance, sales, inventory management and unstable workloads. According to the author, those issues, however, are exacerbated by the problems of connecting the different parts of the organisation and motivating local managers to maximise global Throughput rather than local measures. This view is supported by Stevenson (2012:12) that the problem of multiple interactive constraints in a quickly changing environment is aggravated by many near constraints operating within local optima guidelines and without a clear, overriding schedule. Shin *et al.*, (2012:27) also reiterate that this problem is similar to the significant shift from a single project CCPM to a multiple-project CCPM. Goldratt (2012:6) state that in a single project CCPM, all conflicts are removed in the planning stage and Buffer Management (BM) manages the task variability in execution. The author further mentions that in multiple-project CCPM, eliminating every conflict is a poor solution that is inefficient, too long, expensive, temporary and impractical, all of which are common 21<sup>st</sup> century challenges.

Sheu *et al.* (2013:57) stresses that in complex organisations, the different product divisions, departments, resource silos, supporting plants, subcontracting entities and other individual business units within the organisation cannot all be synchronised for the same reasons that multiple projects cannot be synchronised in multiple-project CCPM. In addition, Goldratt (2012:13) assert that while the resources in one business unit are not always available to assist other business units, the effectiveness and efficiency of the overall organisation are tied to the availability and allocation of resources and cooperation between all interested elements. In the economics literature, these problems are referred to as diseconomies of scale - problems of communication, coordination and control that eventually overwhelm economies of scale as organisations grow larger and cause companies to become uncompetitive (Schroeder, 2014:9). Goldratt and Cox (2013:53) also address additional injections related to “Conflict Resolution” and “Resource Allocation” along with a negative branch about “Leadership Certification” as important aspects on the TOC beyond the 21<sup>st</sup> century.

The TOC implementation today benefits particularly complex environments, such as the large for-profit corporations, not-for-profit organisations and other environments have become relevant as assessment of their realities continues. As a central theory of this study The TOC Thinking Processes, The Strategy and Tactic Tree, TOC measurements, the Five Focusing Steps of TOC and other TOC elements are brought to bear in real case examples showing how they work together as an integrated system of tools for sustainable improvement in modern and complex environments.

It can also be said that in a complex corporation, questions are frequently asked about how the flow of ideas needed for development, production, sales and distribution of a new product can be planned and tracked across organisational silos? How can executives at the top know that ideas are flowing as they should and that inter-organisation commitments are being met? How can they see an issue coming before it is too late to recover? The next sections show that modern management of complex organisations would see the TOC as a realistic model for improvement in supply chain management.

### **4.3 SUPPLY CHAINS AND THE CONSTRAINT-BASED APPROACH**

Literature on TOC supply chain solutions deals mainly with managing the supply chain from a single enterprise perspective (Cox & Spencer, 2011:11; Jackson & Low, 2013:21). Umble (2011:9), for instance, describes how a manufacturing firm applied the TOC approach to direct the implementation of enterprise resource planning (ERP). Gupta (2007:283) also recognises that the TOC approach can be used to guide a single firm to concentrate on exploiting resources based on different logistics costs along the supply chain.

Little attention has been given, within the literature, to the application of the TOC concepts to the management of supply chains where collaboration must be fostered between independent firms. Covington (2012:22) applies the TOC thinking process to identify problems in the apparel supply chain and describes the bringing together of managers from different firms to cooperate in improving the overall supply chain profit. Stein (2007:12) proposes a conceptual model of locating the time buffer at different positions of participating members to protect actual sales from demand and supply uncertainty. Goldratt *et al.* (2000:16) conceptualised performance measures to maintain trust amongst the participating members to address this.

According to Walker and Cox (2006:3) supply chain dynamics and the interdependence of the logistics processes within the supply chain, means that many initiatives will have only a small

impact on supply chain profitability. Only those initiatives that focus on the constraint(s) and result in improvement in its performance will have a significant positive effect on supply chain performance. For a "for profit" supply chain, the constraint would be whatever keeps the chain members from generating more profits. Rahman (2002:809-828) further assert that such supply chain has at least one constraint otherwise infinite profit would result.

Thus the dilemma of supply chain can be resolved if the chain members realise that the real constraint to the overall system may reside outside their "local" control (hence "local" measures would not help to elevate their profits). To really elevate their profitability they must take a supply chain-wide view and try to help achieve better performance at the constraint. This approach, with the added coexistence of an appropriate mechanism to measure and share improvements, can lead to real benefits for all supply chain members.

Mabin, Davies and Kim (2006:13) draw reference to the constraint-based approach that recognises the importance of identifying the constraint(s), prevent the chain members from satisfying a necessary condition or achieving overall profitability. Agreement about the types and locations of the constraint(s) is crucial for initiating supply chain improvement. The nature of a constraint can be either physical or non-physical and its location can be either internal or external. Physical constraints can take the form of raw material shortages, limited capacity resources, limited distribution capacity and lack of customer demand. Non-physical constraints include obsolete rules, procedures, measures, training and operating policies that guide the way in which decisions are made. This view is supported by Dalton (2009:52-64) that the location of a constraint can be either internal or external. Internal constraints such as the raw material constraint, the capacity constraint and the distribution constraint are located inside the supply chain. External constraints include market constraints and supply constraints which arise outside the agreed boundaries of the collaborative supply chain.

Different types of constraints are interrelated with each other. Physical constraints are often driven by human behaviour (i.e., habits, decisions and actions). At the same time, Inman *et al.* (2009:341-356) observe that human behaviour is affected by metrics and policies around supply chain operations. When the goal of a supply chain is created, the chain members create policies that regulate and guide the behaviour of the supply chain – including performance metrics – to assess the attainment of the goal. However, with changes in the environment of the supply chain and within the supply chain itself, these policies and metrics often become unsuitable for motivating desired decision-making behaviour and thus result in negative impacts on supply chain



performance. People are comfortable with regular habits and predictable outcomes and hence often continue to use outdated policies and inappropriate metrics in making decisions even though supply chain technologies or the business environment has changed (Simatupang & Sridharan, 2012:31). Besides outdated policies and inappropriate metrics, flawed mental models and past training can be constraints that affect human behaviour. Counterproductive decisions and actions cause resources to be used in ways which do not maximise profitability. It is common that physical constraints reflect and are sustained by, obsolete policies and inappropriate metrics (Inman *et al.*, 2009:221).

The improvement process focused on the constraint can be summarised as follows:

- a) the current supply chain profitability is determined and dictated by the constraint that exists within it;
- b) the profitability can be improved through better exploitation of physical constraints and, ultimately, if the constraint is permanently removed; and
- c) when the constraint is removed, the supply chain moves to a higher level of profitability and immediately encounters another constraint.

This process continues again to find and manage a new constraint. The formal procedure of the focusing process is known as the five-step-focusing process (Goldratt, 1990), as shown below:



The second step is to decide how to exploit the constraint. This means optimising the existing capacity at the constraint, which is frequently wasted by making and selling the wrong mix of products and by improper rules for scheduling and controlling. The chain members need to ensure that the identified constraint is working on the right products to maximise profits. For example, if immediate product availability is causing a capacity constraint to go idle, the supplier has to observe the constraint and continuously replenish the constraint without delays (Goldratt, 2000:23).

The third step is to subordinate all other activities to the constraint. This means to change traditional rules and metrics that discourage all other activities to support decisions to exploit the constraint. In supply chains, this is an important area for collaborative decision-making as individual parts of the chain may be able to help exploit a capacity constraint through changes to the way they operate – i.e., being subordinated (Goldratt, 2000:23).

The fourth step is to elevate the constraint. This means to increase the capacity of the constraint to a higher level. For instance, a supplier can elevate the capacity constraint by redesigning products to allow postponement of product diversity until points in the supply chain where fast response to changing customer needs can be achieved (Lambert *et al.*, 2013:10).

The fifth and last step of the focusing process is to prevent inertia from stopping the process of continuous improvement. If the constraint is broken in step four, a new constraint may appear somewhere else in the supply chain. This means that the chain members need to focus on the new constraint, return to step one and repeat the process. Collaborative sharing of information will ensure that constraint changes are quickly identified and revised tactics, policies and measures are put in place to refocus the chain appropriately (Goldratt, 2000:23)

#### **4.3.1 The five steps in the Theory of Constraints**

An excellent way to deepen your understanding of the Theory of Constraints is to walk through a simple implementation example. In this example, the Five Focusing Steps are used to identify and eliminate an equipment constraint (i.e. bottleneck) in the manufacturing process as mentioned by Fredendall *et al.* (2002:50). Below is the practical summary of the five steps approach according to Fredendall *et al.* (2002:50-59).

#### 4.3.1.1 *Identifying the constraint*

- In this step, the manufacturing process is reviewed to identify the constraint. A simple but often effective technique is to literally walk through the manufacturing process looking for indications of the constraint.
- Look for large accumulations of work-in-process on the plant floor. Inventory often accumulates immediately before the constraint.
- Look for areas where process expeditors are frequently involved. Special attention and handholding are often needed at the constraint to ensure that critical orders are completed on time.
- Review equipment performance data to determine which equipment has the longest average cycle time. Adjust out time where the equipment is not operating due to external factors, such as being starved by an upstream process or blocked by a downstream process. Although such time affects throughput, the time loss is usually not caused or controlled by the starved/blocked equipment.
- Ask operators where they think equipment is not keeping up with demand. Pay close attention to these areas, but also look for other supporting indicators.
- The deliverable for this step is the identification of the single piece of equipment that is constraining process throughput.

These steps can be benchmarked to the construction industry in South Africa and this description of the global operating measures of the supply chain and the five step-focusing processes reveals that there are two implications for the chain members. The first implication is the importance of modifying the improper business rules amongst the chain members. For example, the traditional “rule” that says “each member gets sales from other chain members” needs to be altered to “the chain members get paid when they sell products to end customers”. This means that once the retailer has obtained payment from the end customer the downstream partners must be paid from their proportion of supply chain throughput (Goldratt, *et al.*, 2000:48; Covington, 2012:7). This incentive scheme encourages both parties to focus on the throughput and speed of flow because their individual profitability and cash flow depends on their collaborative efforts to increase supply chain throughput.

In addition to the five steps, Goldratt (2000:12) further provides a foundation for achieving change through TOC by defining a set of three essential measurements that drive the change process. He correctly realised that conventional accounting systems do not support TOC, or lean-

based efforts. Goldratt (2000:12) proposes replacing all traditional measures derived from the "product cost" accounting paradigm. The following measures are the only way to increase profit through TOC:

#### **i) Throughput**

The rate at which the entire organisation generates money through sale of a product or service. Throughput represents all the money coming into an organisation.

#### **ii) Inventory**

All the money the organisation invests in things it intends to sell. Inventory represents all the money tied-up inside an organisation. Goldratt's (REF) definition includes facilities, equipment, obsolete items, as well as raw material, work in process and finished goods.

#### **iii) Operating Expense**

Operating Expense is all the money an organisation spends turning Inventory into Throughput. It represents the money going-out of the organisation. Examples include direct labour, utilities, consumable supplies and depreciation of assets.

According to the author, all three of these measures are interdependent. This means that a change in one will result in a change in one or more of the other two. Therefore, to improve your organisation using TOC, you as the change agent would adhere to the following formula:

***Maximise Throughput while Minimising Inventory and Operating Expense***

These measures are the key to relating local decisions to the performance of the entire system. Goldratt (2000:12) advocates that all improvement opportunities should be prioritised by their effect on the three measures, especially Throughput, for which the only limit on how high it can be increased is market size.

## **4.4 APPLICATION OF THE THEORY OF CONSTRAINTS**

### **4.4.1 The nature of constraints according to the TOC**

Constraints are anything that prevents the organisation from making progress towards its goal. In manufacturing processes, constraints are often referred to as bottlenecks. Interestingly, constraints

can take many forms other than equipment. There are differing opinions on how to best categorise constraints; a common approach is shown in the following table.

**Table 4.1: The nature of constraints**

<b>Constraint</b>	<b>Description</b>
Physical	Typically equipment, but can also be other tangible items, such as material shortages, lack of people, or lack of space.
Policy	Required or recommended ways of working. May be informal (e.g. described to new employees as “how things are done here”). Examples include company procedures (e.g. how lot sizes are calculated, bonus plans, overtime policy), union contracts (e.g. a contract that prohibits cross-training), or government regulations (e.g. mandated breaks).
Paradigm	Deeply ingrained beliefs or habits. For example, the belief that “we must always keep our equipment running to lower the manufacturing cost per piece”. A close relative of the policy constraint.
Market	Occurs when production capacity exceeds sales (the external marketplace is constraining throughput). If there is an effective ongoing application of the Theory of Constraints, eventually the constraint is likely to move to the marketplace.

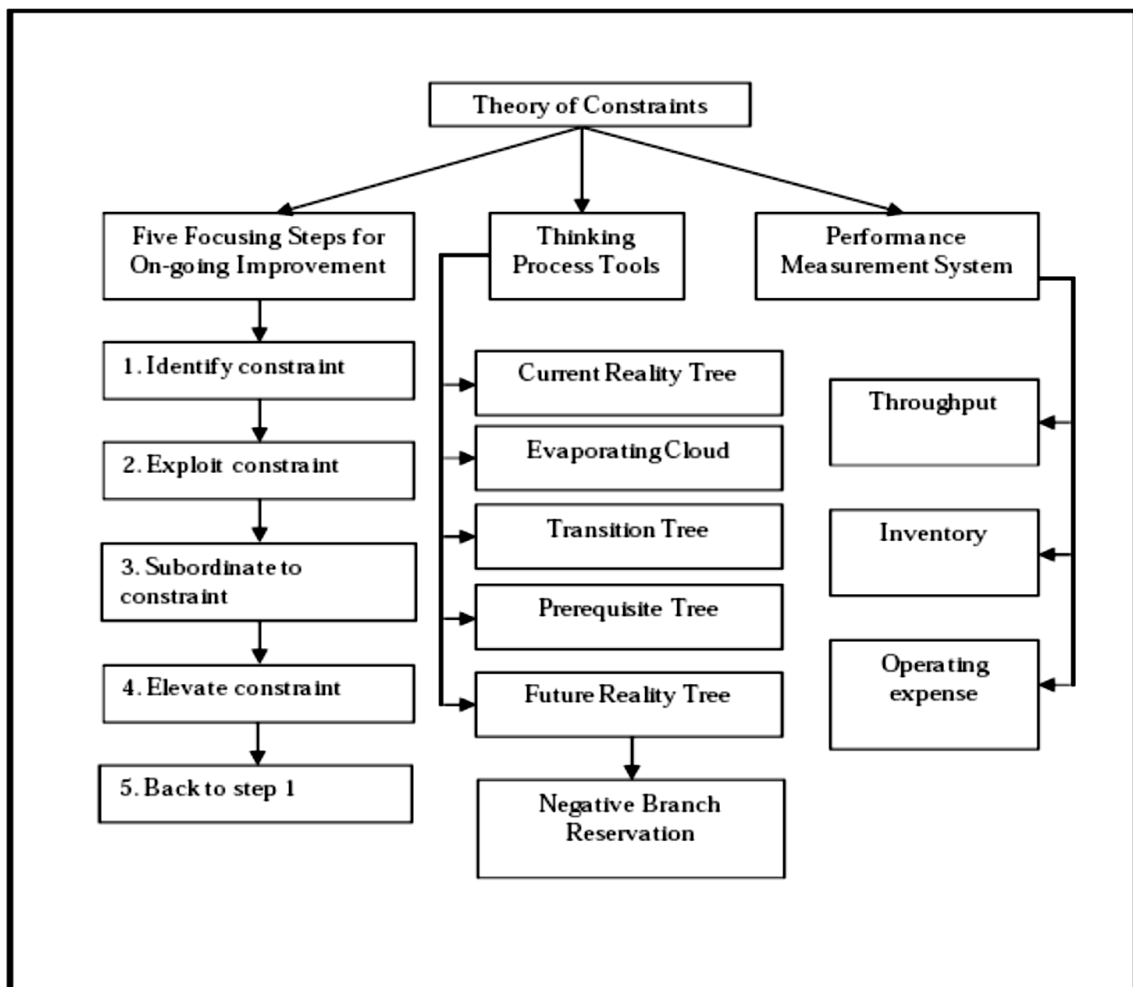
Source: (Chaudhari & Mukhopadhyay, 2003:799)

There are also differing opinions on whether a system can have more than one constraint. The conventional wisdom is that most systems have one constraint and occasionally a system may have two or three constraints. Chaudhari and Mukhopadhyay (2003:799-817) state that in manufacturing plants where a mix of products is produced, it is conceivable for each product to take an exceptional manufacturing path and the limitation may “move” depending on the path taken. This environment can be modelled as multiple systems – one for each unique manufacturing path. The Thinking Processes are designed to effectively work through these questions and resolve conflicts that may arise from changing existing policies.

## 4.5 FUNDAMENTAL CONCEPTS OF THE THEORY OF CONSTRAINTS

Theory of Constraints consists of three components (Mabin & Balderstone, 2003:8); (1) an operational strategy consisting of five focusing steps for continuous systems improvement, (2) Thinking Process (TP) tools for investigating, analysing and solving complex problems, and (3) a performance measurement system for assessing the performance of a system in achieving its goal.

**Figure 4.2: Components of the Theory of Constraints**



Source: Mabin & Balderstone (2003:8)

While the first concept of the three parts which is the five steps has been discussed, it is important to articulate what the other two concepts; which are the thinking process and performance measure entail:

#### 4.5.1 Logical thinking process

Goldratt (2000:13) introduces a staged logical thinking process to be used in conjunction with the five focusing steps. The thinking process assists with working through the change process by identifying the following: what to change, what to change to and how to effect the change. The thinking processes consist of logic tools used to identify problems, then develop and implement solutions. These tools include effect-cause-effect (ECE) diagramming and its components: negative branch reservations, the current reality tree, the future reality tree, the prerequisite tree, the transition tree, the evaporating cloud, the negative branch reservation and the ECE audit process. These tools allow an organisation to analyse and to verbalise cause and effect.

According to Mabin and Balderstone (2003:8), current reality tree, a cause-effect diagram, is drawn in order to discover the problems. These problems are known as undesirable effects. The cause of an undesirable effect is known as a root cause. The first goal is to find the causes of these undesirable effects. Each statement in a current reality tree that is not a derivative of another must be a root cause. If you build a tree that is comprehensive enough, at least one root cause will lead to most of the undesirable effects. This particular root cause is labelled a core problem, the major improvement target. The fewer root causes responsible for the undesirable effects, the better. The solution to this core problem is apparently not readily available. If it were, then the problem would have already been solved. Some conflict, therefore, must exist that prevents an immediate solution. This conflict becomes evident upon the construction of an evaporating cloud.

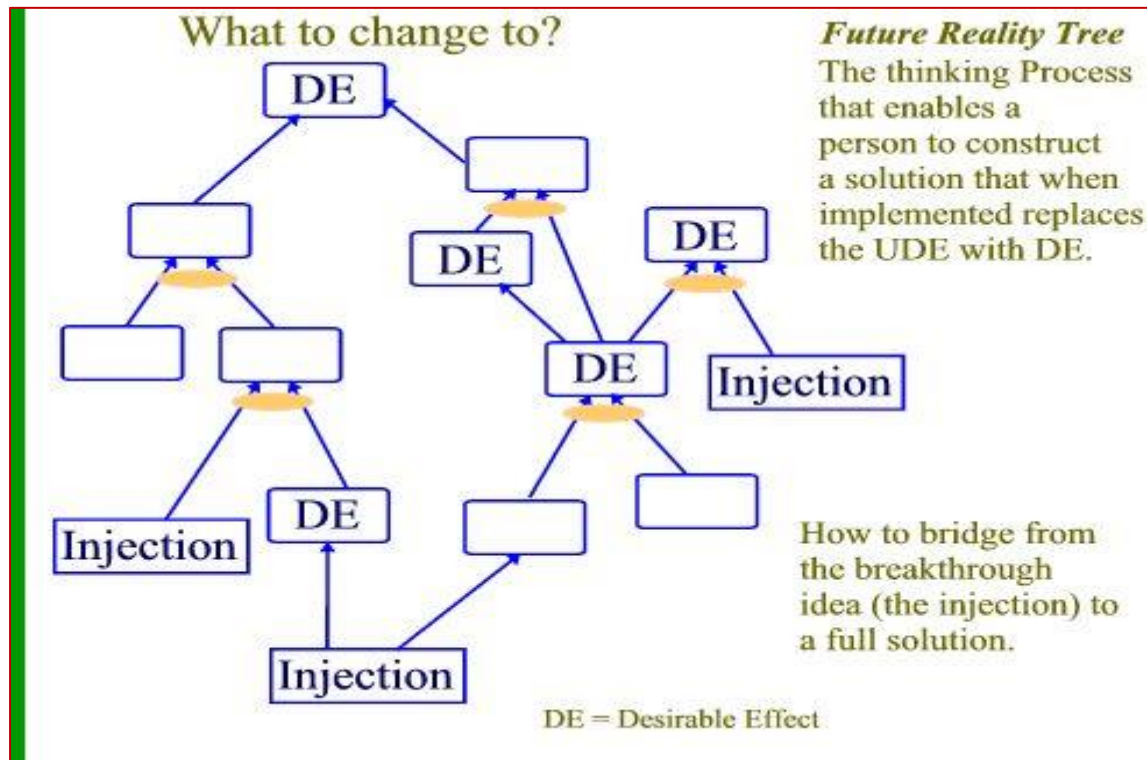
An evaporating cloud is a conflict-resolution tool. The process begins with a statement of the desired objective, one that is the opposite of the core problem. Then, the prerequisites necessary to achieve the requirements are listed. Any conflicts and assumptions that exist between the prerequisites are verbalised. For example, if one objective is to increase profit, then the requirements may be to improve the product and to decrease expenses. Prerequisites for each, respectively, may be to increase expenditures on capital equipment and to decrease expenditures, two obviously conflicting elements. The best solution is to remove the conflict; a compromise is not desirable. The next move involves finding an injection, a breakthrough idea that will evaporate the cloud. The "evaporating" refers to the tool's ability to dissipate conflict and to create a win-win solution. Usually, the original injection is not sufficient to fully solve the problem, but additional needed injections become clear when building the future reality tree.

A future reality tree is another cause-effect diagram. The tree starts with the proposed solution to the core problem and delineates the injection(s) and the ensuing desirable effects. The future



reality tree is a "what if." It provides the opportunity to evaluate and to improve a solution before it is implemented. It is noted that one should be careful not to allow the solution to cause new undesirable effects.

**Figure 4.3: The future reality tree**



Source: (Mabin & Balderstone, 2003:11)

According to Mabin and Balderstone (2003:11) the future reality tree allows organisations to map out future expectations given that they introduce something new into their reality; the injection that they developed to break the current reality problem or core conflict. A future reality tree enables organisations to test the future outcome using known cause and effect to check that what we want is what we will get.

Furthermore, Mabin and Balderstone (2003:11) mention that at its simplest, a future reality tree might be thought of as a current reality with all the undesirable effects (UDEs) changed to desirable effects (DEs). The presence of the new idea or ideas as injections will change reality from undesirable outcomes of the present to desirable outcomes of the future. Maybe we need several different injections to achieve this.

The future reality tree is the tool of choice in gaining understanding and agreement that the solution we have decided upon will account for all of the undesirable effects that we currently experience and built into our current reality tree. A prerequisite tree describes the implementation of the injection(s) and is composed of an obstacle and an intermediate objective. This diagram breaks the implementation tasks into smaller increments, noting expected obstacles and intermediate objectives whose accomplishments will overcome the obstacles. The intermediate objectives are sequenced, displaying the necessary order of accomplishment and determining which ones can be achieved in parallel. This tool is powerful in that it does not ignore the obstacles. It uses them, rather, as the main vehicle for this phase.

Finally, a transition tree or implementation plan is constructed. This element presents a detailed description of the gradually evolving change envisioned. This task forces one to carefully examine which actions are really needed and if they are sufficient to guarantee the required change.

#### **4.5.2 Performance measures**

According to Goldratt (2000:22), there are three key performance measurements to evaluate: throughput, inventory and operating expense. TOC emphasises the use of these three global operational measures rather than local measures (e.g. efficiency and utilisation). Goldratt places the greatest importance on increasing throughput. Throughput is defined as the rate at which the system generates money through sales, not through production. Goods are not considered an asset until sold. This contradicts the common accounting practice of listing inventory as an asset even if it may never be sold. Goldratt has advocated a new accounting model as an alternative to traditional cost accounting procedures and measures.

The concept of value-added and overhead are not considered. Operating expense includes all the money the firm spends converting inventory into throughput. The objective of the firm, therefore, is to increase throughput and/or decrease inventory and operating expense in such a way as to increase profit, return on investment and cash flow (more global measures). In *The Goal*, Alex explains to Jonah that his plant's use of a robot has resulted in a thirty six percent improvement in one area. Jonah then asks if Alex is now able to ship more products and if he has fired any employees or reduced inventory as a result (in other words, whether increased throughput, reduced operating expense, or reduced inventory resulted). When the reply was no, Jonah questions how there can be any real improvement; and of course, there can't.

Increasing throughput and/or decreasing inventory or operating expense should lead to the accomplishment of the firm's goal: to make money now as well as in the future. Anything that prevents a firm from reaching this goal is labelled as a constraint. Constraints may appear in the form of capacity, material, logistics, the market (demand), behaviour, or even management policy. TOC thinking regards all progress toward the goal of making money as relating directly to management attention toward the constraint(s). The marginal value of time at a constraint resource is said to be equal to the throughput rate of the product processed at the constraint, while the marginal value of time at a non-constraint resource is said to be negligible.

Therefore, the key to fully understanding TOC is that it is not just a system of eliminating constraints (bottlenecks) but more a system of managing constraints. A truly enlightened organisation will know exactly where it wants the constraints to be. Constraints are a reality, the question is whether you want them to be internal, where you can control them or external (i.e. the market). A company that is in control of its own destiny can use its constraints like a valve to control and continually promote the flow of value.

#### **4.5.3 Sector specific application of the Theory of Constraints**

The TOC has also been applied to a wide range of business areas. Blackstone (2011:1032) reported the application of the TOC in business areas that included Operations, Finance and Measures, Projects, Distribution and Supply Chains, Marketing, Strategy and Tactics, Sales and People Management. An analysis by Kim *et al.* (2008:155) of the Theory of Constraints literature in the public domain peer-reviewed publications spanning a period from 1994 to early 2006 revealed a plethora of applications of the TOC. Mabin and Balderstone (2013:568) in a meta-analysis of over 80 successful TOC applications found over 100 descriptions of the TOC applications, spanning such areas as manufacturing, re-manufacturing, administration, service, military and education. Interestingly though, despite extensive searches, this review found only one paper, Chaudhari and Mukhopadhyay (2013:13) report on the application of the Theory of Constraints in agriculture (integrated poultry industry).

Some authors today have made attempts to demonstrate the relevance and application of the TOC in various sectors (Castaño *et al.*, 2013:9). Within the banking sector, the authors studied the characterisation for banking and analysis of the factors involved in its adoption. The authors identify that the four elements of the TOC theory, throughput, inventory, operating expenses and constraints, correspond to, respectively, the money coming from financial services rendered, the money required to generate this profit, the money to fund the expenses and the limitations to the

normal activity. Regarding the constraints, Castaño *et al.* (2011:9) view that the most common are mainly administrative (regulations and policies) and the lack of technological resources associated with the scarcity of capital flow and the environment imposed by the state of the economy at a specific time.

Within the banking industry, Castaño *et al.* (2013:14) summarise that the main factors that influenced the decision to adopt the TOC by the banking sector reside, first, in the tool's current level of development; second, in the nature and the characteristics of the banking service that are very far from the original industrial reality and, finally, in organisational factors such as the attitude towards change, the leadership of the administration and the commitment of the entire institution.

Some authors have pointed out a new concept called as synchronised production created five main steps of constraint theory (Watson & Patti, 2011:18; Mabin & Balderstone, 2013:22). The authors emphasise the view that the goal of synchronised production is to exploit from the constraint ideally after determining the bottleneck through proper production planning. Furthermore, they assert that the firms which use the constraint theory in their processes and synchronised production will attain an advantage in competitive market conditions.

Literature (Inman *et al.*, 2009:21; Lin & Mills, 2001:29; Mabin & Balderstone, 2013:23; Watson *et al.*, 2007:11) indicate that the application of the TOC results in significant improvement in organisational performance. Sale and Inman (2013:12) affirm through a survey that firms that employ the TOC techniques perform significantly better than those using traditional manufacturing methods. Rigorous academic testing confirmed that manufacturing systems that employ the Theory of Constraints techniques perform better than those using well known alternatives, such as Manufacturing Resource Planning (MRP), Just-in-Time (JIT), Lean Manufacturing and Agile Manufacturing (Mabin & Baldestone, 2000). Studies have demonstrated that the use of the TOC reduces inventory, work in process inventory, lead times and improves due date delivery performance. (Darlington 2013:21) argue that the adoption of the TOC techniques yields observable outcomes, which lead to improved business unit performance. A meta-analysis of over 80 successful TOC applications by Mabin and Baldestone (2013:11) provides the following results; a 70% mean reduction in lead time, a 65% mean reduction in cycle time, a 49% mean reduction in inventory, a 83% mean increase in revenue, a 65% mean increase in throughput, a 116% mean increase in profitability and a 44% mean improvement in due date

performance. The burgeoning uptake of the TOC can thus be attributed to its impressive success rate.

Considering the success stories of the Theory of Constraints, it is likely that its application for improving the performance of the South African Construction supply chains will be a success. Cases have been reported in the literature of the successful application of the TOC in areas bearing some resemblance to integrated Construction supply and processing systems. For example, Chaudhari and Mukhopadhyay (2003:19) used the TOC to improve the performance of an integrated poultry firm in India. They identified and resolved the policy constraints that were adversely affecting the profitability of the firm. The application of the TOC resulted in an overwhelming improvement in the firm's profit without any major investment being made.

With respect to the relevant literature, as seen in Table 4.3 the first countries to publish studies on the application of TOC in various areas within the services sector were the United States, England, Australia and Israel, demonstrating the effectiveness of this philosophy in other areas besides the industrial. Although in recent years the literature related to the topic has significantly increased, the approaches are still too incipient to match the large number of studies on TOC developed for industry.

**Table 4.2: Previous research and application of the Theory of Constraints in different sectors**

<b>Author(s)</b>	<b>Country</b>	<b>Sector</b>	<b>Description</b>
Motwani, J., Klein, D., Harowitz, R.: (1996)	USA	Health	Application of TOC for optimisation and increased productivity of non-profit organisations.
Siha, S (1999)	Australia	Public Services	To consider using TOC TP in a public service organisation for service and optimisation of the processes.
Goldratt, R., Weiss, N:(2005)	Israel	Education	To applying TOC to improve the quality of school education and productivity.
Davies, J., Mabin, V.J., Balderstone, S.J.: (2005)	USA	Unspecified	Study the impact of TOC concepts in administrative functions, applying performance indicators.
Davies, J., Mabin, V.J., Balderstone, S.J.: (2007)	Australia	Operational Research OR/MS	To study TOC TP tools in relation to traditional methodologies OR / MS for building multi methodological tools.
Taylor III, L.J., Thomas, E.E.(2008)	USA	Consultancy	Improving the performance of billing system for increased business productivity.
Gupta, M., Kline, J.: (2008)	USA	Health	Improving performance indicators identified in the system TOC.
Reid, R.A.: (2009)	USA	Banking	To improve credit approval processes and overcome the constraints of the system.
Motwani, J., Vogelsang, K.: (2009)	USA	Construction	Support improved performance and productivity of the delivery of the service provided by the company.
Ritson, N., N. Waterfield.: (2010)	UK	Health - Consulting	To modernise mental health services of the UK population through the merger of the only two service providers.

#### **4.6 CRITICISM OF THE THEORY OF CONSTRAINTS**

The TOC is, however, not without criticism. Reid and Koljonen (2011:2) single out the inability of the Theory of Constraints to capture the dynamic nature of the modern manufacturing environment as one major drawback. They argued that the relationships among systems’

components depicted in the TOCs' logic trees often appear to be linear and relatively static and hence fail to fully represent the dynamic complexity in modern business organisations. They therefore proposed the coupling of the Theory of Constraints' logic trees with System Dynamics modelling techniques as a way of strengthening the Theory of Constraints process. Watson, Gardner and Patti (2010:1869) also state that top-level management support and commitment have more often been insufficient to sustain the success of the Theory of Constraints. They argued that many top-level managers delegate the implementation of the Theory of Constraints to mid-level managers because of the considerable length of training time that is required to master the subject matter.

Furthermore, Goldratt (2005:5) states that the Theory of Constraints process cannot succeed in an organisation unless all its members develop as much enthusiasm for the Theory of Constraints as the expert facilitating the process. He argued that such levels of enthusiasm among organisation members can only be achieved if the members come to the same conclusion and regard the conclusions as their own. One of the weaknesses of the TOC, according to this author, is that it treats many items, such as production technology, capacity, constrained resources, product mix, demand and prices, as fixed and inflexible. Although these items may be fixed in the short run, TOC fails to recognise the fact that in the long run each of these items is flexible. This explains why organisation engagement is a key component of its success.

Luther and O'Donovan (1998:14) criticise TOC because it seems to ignore operating expenses and simply accept them as a part of the cost. The authors assert that "if the traditional method of overhead allocation has been accused of treating overhead as a big blob, the TOC approach defines operating expenses as an even bigger blob ..." (it is not concerned with tracing operating expenses to products or doing anything about it." Kaplan (2009:82) believes that ABC (define) provides better information and allows managers to make more informed decisions. Another critic of TOC, Shank (2010:13), believes that the short-run focus of TOC can cause serious problems with very serious consequences, such as causing managers to always favour making component parts instead of outsourcing and to favour adding new products.

Even advocates of TOC are forced to recognise the inherent weaknesses in the TOC system because of its short-term focus. For long-run strategic decisions, other techniques including full product cost and ABC are probably more effective. Although these advocates see the limitations of the TOC mind-set, they also see its strengths. Shank (2010:13) mentions that that the word

"cost" is a dangerous and confusing multi-meaning word and; that the word "product cost" is "an artificial, mathematical phantom".

According to Hall *et al.*, (2007:12) the business world today has changed and some fields like cost accounting has been slow to react. They have not re-examined the fundamentals, the financial statement logic, to create new solutions. Instead, they have formulated ineffective answers like "cost drivers" and "activity-based costing." We can no longer allocate based on direct labour. So allocating expenses at the unit level, batch level, group level and company level is meaningless. These cannot be aggregated at their respective levels nor at the top.

Goldratt's (2005:12) TOC glorified the importance of identifying bottlenecks in a process and changing the process to work with and around these bottlenecks. The point that Goldratt (2000:12) draws is that the system or process is only as good as its worst performing component. But a larger point was the inefficient practice of focusing only on components in isolation as opposed to looking at the entire system. This is the *sine qua non* of Systems Thinking. Goldratt (2005:9) himself acknowledges the ideas from system dynamics, statistical process control and the Japanese Just-in-time process among others, which helped him shape TOC.

#### **4.7 THE FUTURE OF THE THEORY OF CONSTRAINTS**

Goldratt (2005:91) discusses the evolution of TOC by how the identification of major system problems leads to the development of solutions and significant system improvement only to surface the next system problem. Thus the evolution of TOC follows the natural scientific approach to system improvement. As the developer of TOC, the author has brought the mind of a scientist to the problems and needs of business, private sector organisations and individuals. The authors' scientific approach has led to the breaking of several business paradigms and the development of new simplified approaches to managing systems.

Goldratt (2005:9) warns that there isn't a more grave mistake than to equate non-constraint with non-important. On the contrary, due to the dependencies, ignoring a non-constraint can impact the constraint to the extent that the performance of the entire system severely deteriorates.

What is important to notice is that the prevailing notion that "more is better" is correct only for the constraints, but it is not correct for the vast majority of the system elements—the non-constraints. For the non-constraints, "more is better" is correct only up to a threshold, but above this threshold, more is worse. This threshold is dictated by the interdependencies with the



constraints and therefore cannot be determined by examining the non-constraint in isolation. For the non-constraints, local optimum is not equal to the global optima; more on the non-constraints does not necessarily translate to better performance of the system.

#### **4.8 CONCLUSION**

Historical and current thinking around the TOC is logical and bounty. Since its inception, it can be said that the TOC's concept of on-going improvement by focusing on and managing constraints may not be as inspiring as the Lean goal of seeking perfection. However, the complexity of modern organisations and particularly supply chain management systems leaves managers with an almost unlimited number of things to improve. Literature has shown that the magnitude of the constraints in many tasks is sufficient to paralyze even the most conscientious manager. Meanwhile, in reality, only a handful of those hundreds of potential improvements will make a real difference in achieving an organisation's goal. TOC's constraint-focused approach is both logical and pragmatic. Identifying and addressing the constraints provides the fastest and lowest cost means for increasing the throughput of any organisation.

The literature in previous sections has also shown that the use of the TOC performance measurement system results in improved performance of systems. The South African construction industry may therefore benefit if it adopts the performance measurement system for use in its Construction supply chains. More so, the South African Construction supply chains consist of multiple and independently owned business units. It is therefore likely that several performance measurement systems could be in use within the supply chains at any given time. Those performance measurement systems may not be compatible with each other.

The next chapter discusses the research methodology and the approach used to collect data. It also indicates how the data was analysed.

# CHAPTER 5

## RESEARCH METHODOLOGY

### 5.1 INTRODUCTION

Research involves an attempt to understand various aspects of the world. Research involves an explicit, systematic approach to finding things out, often through a process of testing out preconceptions (Berg, 2007:12). This process begins with deciding on a research question. It is necessary to conduct a literature review and to decide on a research design which addresses the research question. Decisions were made at this point to include the kind of data that would be collected, how the data would be collected, who would be invited to participate and how the data would be analysed.

This chapter discusses the research methodology and sequential guidelines to this study. The selection and profile of the participants, access to institutions and individuals are also discussed. The ethical and confidentiality undertakings provided to the participants during induction also form part of the chapter. The methods of data collection, data interpretation and analysis, as well as measures of trustworthiness used, are also highlighted.

### 5.2 QUALITATIVE RESEARCH PARADIGM

Saunders *et al.*, (2003:389) mention that Naturalistic-phenomenological philosophy is the basis of *qualitative* research. According to Saunders *et al.*, (2003:389) this approach assumes that there are many ways in which reality can be interpreted and experienced by individuals. Additionally, the authors stress that rather than using the scientific method, as in *quantitative* research, *qualitative* research relies on the researcher to carefully observe and describe a phenomenon and to interpret the phenomenon within a social (cultural) context. For these reasons, *qualitative* research allows one to examine phenomena that *quantitative* research cannot explore.

Though the list below is not exhaustive (Creswell, 2009:175-6), it offers a sense of well-known qualitative research methods that was followed and used for this study.

- Research was conducted in the field, allowing direct interaction with the people being studied in their context.

- Researchers collected data themselves by examining documents, observing behaviour or interviewing participants.
- Multiple sources of data were preferred over a single source; this requires the researcher to review all data, make sense of it and organise it into categories or themes that cut across all sources.
- Researchers often built their patterns, categories and themes from the bottom up (inductive analysis).

This study embraced a qualitative research design as it offers understandings which are drawn from the research in a natural situation and aims to gain an in-depth understanding of a situation (Zikmund, 2008:302). Qualitative research was selected for use in this study because it allowed probing which gave participants the opportunity to respond in their own words, rather than forcing them to choose from fixed responses, as quantitative methods do. This approach had the ability to evoke responses that are meaningful and culturally salient to the participant and rich and explanatory in nature. Furthermore, the choice of qualitative methods is that they allowed the researcher the flexibility to probe initial participant responses that is, to ask why or how (Willis, 2007:8). In this study the research design involved the review of related literature followed by the empirical study.

The research process reflects the methodological approach which the researcher decided to adopt. Many methodological approaches are described in terms of the type of analysis they imply. Different approaches also involve different sets of assumptions about what sorts of information (or knowledge) are important. This diversity often gives rise to lively discussion among qualitative (and other) researchers.

Various research methods and techniques are available for interpretive studies. They draw from phenomenology, hermeneutics, feminism, deconstructivism and may take the form of ethnographies, interviews, psychoanalysis, cultural studies, participant observation, grounded theory, just to name a few. The researcher selects the best method(s) based on his/her research question: will the researcher study individuals (narrative, phenomenology); explore processes, activities and events (case study, grounded theory); or learn about the broad cultural-sharing behaviour of individuals or groups (ethnography) (Creswell, 2009:177).

Phenomenology, the design approach used in this study literally means the study of phenomena. (Creswell, 2009:177). It is a way of describing something that exists as part of the world in which we live. Phenomena may be events, situations, experiences or concepts and in this study, to a

large extent, refers to constraints within the construction supply chains. It also assumed that the construction sector is surrounded by many phenomena, which we are aware of but not fully understand. The lack of understanding of these phenomena may exist because the phenomenon has not been overtly described and explained or our understanding of the impact it makes may be unclear. Therefore, a phenomenological study might explore, for example, the supply chain constraints within the construction sector in South Africa. According to Lee and Lings (2008:12) research begins with the acknowledgement that there is a gap in our understanding and that clarification or illumination will be of benefit. Phenomenological research does not necessarily provide definitive explanations but it does raise awareness and increases insight.

Using the phenomenological approach, the research attempted to interpret data from the perspective of the participants (this is known as a phenomenological approach), at the same time as acknowledging that it is difficult to know just how far it is possible to give a “true” account of a perspective other than one’s own. This meant that the researcher attempted to interpret data from the perspective of the population under study. The results are expressed as though they were being expressed by the participants themselves, using language and terminology to describe phenomena.

To support the phenomenological approach, Positivism that belongs to epistemology often classified and specified as philosophy of knowing (Saunders *et al.*, 2003:389) was used. As a philosophy, positivism follows the view that only “accurate” knowledge gained through observation (the senses), including measurement, is trustworthy (Saunders *et al.*, 2003:389). In positivism the role of the researcher is limited to data collection and interpretation through objective approach and the research findings are usually observable and quantifiable (Cooper & Schindler, 2008:26).

The principles of positivism depends on quantifiable observations that lead themselves to statistical analysis. It has been noted that “as a philosophy, positivism is in accordance with the empiricist view that knowledge stems from human experience. It has an atomistic, ontological view of the world as comprising discrete, observable elements and events that interact in an observable, determined and regular manner” (Collins, 2010:38).

Furthermore, in positivism the researcher is independent from the study and there are no provisions for human interests within the study. Crowther and Lancaster (2008:21) inform that as a general rule, positivist studies usually adopt the deductive approach, whereas inductive research approach is usually associated with a phenomenological philosophy. Moreover, positivism relates

to the viewpoint that researcher needs to concentrate on facts, whereas phenomenology concentrates on the meaning and has provision for human interest.

Researchers warn that “if you assume a positivist approach to your study, then it is your belief that you are independent of your research and your research can be purely objective. Independent means that you maintain minimal interaction with your research participants when carrying out your research” (Wilson, 2010:10). In other words, studies with positivist paradigm are based purely on facts and consider the world to be external and objective.

Thus, the methodology employed for this study matches the particular phenomenon of interest. In a particular way, constraints have been a cornerstone of many construction companies in South Africa, yet extremely neglected. This variation allows for capturing of varied findings as well. Different phenomena may require the use of different methodologies. By focusing on the phenomenon under examination, the research selected appropriate methodologies for this particular inquiry (Falconer & Mackay, 1999:21).

### **5.2.1 Exploratory and descriptive research approach**

The centre of this study, however, was the intention to link both informative and exploratory examination. While descriptive studies watch specific conditions, explanatory exploration addresses the topic of why a specific result is observed. This kind of exploration tests a premise by applying it to particular perceptions. Its fundamental aim is to discover connections between variables (Yin, 2009:7). The findings of such a study will either bolster or challenge particular theorised connections in the middle of subordinate and autonomous variables. In the exploratory examination, the research tries to set up a more profound comprehension of the management situation and conceptualises methods for tackling them.

This is done by looking at the background information that could answer the research questions (Cooper & Schindler, 2008:704). This study sought to explore the supply chain constraints in the South African construction sector with a view to providing a model which would enable the industry to minimise and treat such identified constraints. In this study, participants were made to relate to key stories and incidents which relate to the research topic. Their experience, feelings, observations and opinions provide insight into the topics related to construction constraints as linked to the supply chain management and TOC.

Exploratory research on the other hand is typical when a researcher is examining a new interest or when the subject of study is itself relatively new and unstudied (Creswell, 2010:84). Furthermore, exploratory research lean towards tackling new problems on which little or no previous research has been done (Brown, 2006). Moreover, it has to be noted that “exploratory research is the initial research, which forms the basis of more conclusive research. It can even help in determining the research design, sampling methodology and data collection method” (Singh, 2007:13).

Exploratory research was also utilised in explaining the deep understanding of a situation linked to the construction sector in South Africa, its constraints as well as tapping into participants’ objectives so as to portray an accurate profile of persons, events or situations from their work. The exploration and such approaches during data collection helped the researcher’s need for better understanding. For these reasons, exploratory research was broad in focus and provided definite answers to specific research issues. Subsequently this research is within a qualitative paradigm, it strived to provide an in-depth understanding of the supply-chain constraints in the construction industry.

### **5.2.3 Inductive**

Inductive approach starts with the observations and theories are formulated towards the end of the research as a result of observations (Goddard & Melville, 2004:12). During data collection, the researcher searched for patterns from observations and the development of explanations during the FGDs. In other words, efforts were made to eliminate theory at all times so as to simplify the key concepts and aspects that arose during the discussions..

Neuman (2003:51) affirms inductive research to begin with detailed observations of the world, which moves towards more abstract generalisations and ideas. In other words, when following the inductive approach, the research developed empirical generalisations and identified preliminary relationships as it progressed through interaction with participants.

It is noted that inductive reasoning is often referred to as a “bottom-up” approach to knowing, in which the researcher uses observations to build an abstraction or to describe a picture of the phenomenon that is being studied” (Creswell, 2010:94). In other words, in inductive studies no known theories or patterns need to be tested during the research process. Inductive reasoning is based on learning from experience. To relate to this aspect, patterns, resemblances and regularities in experience (premises) were observed in order to reach conclusions (or to generate theory). In

agreement with Saunders *et al.* (2003:389), the process involved collecting data and then exploring them to see which themes or issues to follow up and concentrate on.

The approach involved moving from specific observations within the individual construction company to broader generalisations of the entire sector in South Africa. Informally, this bottom - up approach ensured that data was captured from the level where supply constraints tend to have a massive impact due to the project nature of the construction industry. The research began with specific observations and measures, to detect patterns and regularities, formulate some tentative hypotheses that were then explored later to develop some general conclusions or theories.

### **5.3 THE INTERPRETIVE QUALITATIVE RESEARCH**

The focus of interpretivism in relation to ontology and epistemology is that interpretivists believe the reality is multiple and relative (Hudson & Ozanne, 2008:44). Lincoln and Guba (2005:45) explain that these multiple realities also depend on other systems for meanings, which make it even more difficult to interpret in terms of fixed realities (Neuman, 2013:54). The knowledge acquired in this discipline is socially constructed rather than objectively determined (Creswell, 2010:94) and perceived (Hirschman, 2014:46)

Intersubjectives that are based on meanings and understandings on social and experiential classes at different levels within the supply chains, related to the inquest into what some people think and do, what kind of problems they are confronted with and how they deal with them. By positing their reality that could not be separated from the knowledge of it, the interpretivist paradigm posited that researchers' values were inherent in all phases of the research process. In addition, the facts and truth are negotiated through dialogue.

Through this approach, the findings emerged through dialogue in which conflicting interpretations were negotiated among participants. While the researcher recognised the need for fostering a dialogue between researchers and participants as critical, it was through this dialectical process that a more informed and sophisticated understanding of supply chain management and construction constraints was gained. Occasionally, the participants' curiosity of a particular context or situation helped to drive re-interpretation and negotiation through conversation.

Therefore, the goal of interpretivist research was to understand and interpret the meanings in human behaviour rather than to generalise and predict causes and effects as linked to the construction constraints as well as supply chain management. With regards to data collection

during the group discussions, it was important to understand motives, meanings, reasons and other subjective experiences which were time and context bound as discussions around the topics proceeded. In essence, this is the result of the interview and focus group participants and what transpired after in qualitative research. In using qualitative methodology to collect research data the researcher must not direct the respondent's answer through his/her tone of voice or rephrase the research question (Goddard & Melville, 2005:59). The unstructured interviews enabled the research to follow the unfolding events coming out of the interview and the participants are able to narrate the true picture of the situation being studied (Greef, 2005:290).

The research was systematically conducted as it commenced by introducing the research project. Details of the methodology used requires to be noted and thorough consultation of the relevant literature on the research subject needs to be undertaken. The other most critical issue for research includes being very careful to pay attention to particulars (rigour), truthfulness and ethical considerations in the construction sector (Bowen *et al.*, (2007:631). The methodology used in this research involved use of the relevant literature, construction managers and supply chain experts. This study considered ethical deliberations while conducting this research.

#### **5.4 RESEARCH DESIGN**

According to Yin (2007:92), the research design refers to the overall strategy that you choose to integrate the different components of the study in a coherent and logical way, thereby ensuring that the research problem will effectively be addressed; it constitutes the blueprint for the collection, measurement and analysis of data. Research design involves planning, preparations and execution of a research project. The design process covers all the issues from theoretical reading, methodology, empirical data gathering, analysis and the writing process. 'The research processes progresses mostly through a circular process which involves revising and revisiting the original ideas and thoughts, revising plans, reading lists and rewriting the chapters'. (Eriksson & Kovalainen, 2008:35). The research design also involves activities of 'collecting and analysing data, developing and modifying theory, elaborating or refocusing the research questions, identifying and addressing validity threats' (Maxwell, 2005:2).

In order to perform empirical studies in an appropriate way researchers should be familiar with quantitative research designs, appropriate research methods, common performance criteria of empirical studies and also with statistical modelling of data and documenting and presenting the results. The typical schedule of a qualitative empirical study include the following steps in chronological order (Ostermann, 2005:21)



- Determination of the research topic / issues of interest
- Determination of target group (population)
- Design and development of research instruments
- Data collection / study design
- Design of questionnaire
- Application of research instruments
- Evaluation / Analysis of information
- Documentation / Presentation of results

While not far off from the above recommended structure by Ostermann (2005:21), within this study the research design included the selection of participants and inducting them into the research processes, introducing the participants to the interviews, undertaking the interview and attaining responses on the interviews for validity and facilitating data collection in a recorded form using an audio-digital data recorder. The recorded transcripts were transcribed and the data interpreted, evaluated and analysed by the researcher.

Over and above this, the standard of design is that different kinds of issues logically demand different kinds of data-gathering to guarantee that the data were relevant to the study, valid and reliable and capable of providing results that can be generalised to conditions other than those of one's immediate organisation.

However, the interpretations of Ostermann (2005:21) have been combined into a conceptual framework of decision steps in the research process. This framework (Fig 5.1) forms the groundwork on which the research design for this research study has been based. As indicated in Figure 5.1, selecting a research topic and preparing the research question is the first step to consider. Once the research topic has been decided upon and the research question formulated, the researcher decided on the research methodology that was adopted.

**Figure 5.1: A conceptual framework for research design**



#### **5.4.1 Selection of participants**

In this study, the non-probability sampling procedure was adopted. In non-probability sampling, there is an assumption that there is an even distribution of characteristics within the population, which is what makes the researcher to have confidence that the sample is sufficiently representative (Yin, 2007:192). In non-probability sampling, elements are chosen arbitrarily and there is no way to estimate the probability of any one element being included in the sample. In addition, no assurance was given that each item has a chance of being included, making it impossible either to estimate sampling variability or to identify possible bias (Yin, 2007:192).

Non-probability sampling was deemed as suitable for use in this study because there is no sampling frame that can be used in the selection of participants.

The non-probability sampling technique used was purposive sampling. According to Welman, Kruger and Mitchel (2007:59), purposive sampling is based on the researcher's knowledge of the research area and the important opinion makers within that research area. It involves the selection of participants based on their experience and knowledge of the particular research field (Zikmund, 2008:400). The participants in this research were senior managers drawn from organisations that participate in the construction industry supply chain. The researcher's knowledge and experience of the South African construction industry enabled and easily facilitated accessibility to any senior and high profile people, including chief procurement officers, to participate in the study.

For the purpose of this study, participants sampled had a long and credible construction industry experience particularly in supply chain management as well as some newcomers to the industry from other sectors. There was a composition of participants from operation segments of the supply chain, yet not directly part of the supply chain structures. Furthermore, the choice of participants had been spread widely across to include the both qualified and un-qualified staff.

In this study, the researcher was very careful in the choice of participants as some senior members of the organisations/institutions, who may have been conversant with not only the supply chains in the construction, but presumably had some understanding of constraints as seen from the TOC were used. Therefore, the selection of participants was important so as more information would be captured from such participants.

#### **5.4.2 Data collection methods**

Common qualitative data-gathering techniques include interviews, focus groups, ethnography, sociometrist, unobtrusive measures, historiography and case studies, among others. Each approach has advantages and limitations such as level of intrusiveness, opportunity to review during collection process, proximity to natural field setting and amount of bias based on the presence of the researcher (Yin, 2007:192). The resulting pieces of data may take the form of text, audio or video files, photographs or field notes.

For the purposes of this study, data was collected using two main avenues of inquiry; namely, focus group discussions and in-depth interviews. The choice for using the interview technique was based on the need to access people that have practical experiences with the investigated

problem. Focus groups discussions were selected because they direct arguments of the reality with the use of inductive logic; deep analysis of the object (case) and interaction between researcher and the object of research (Yin, 2007:212).

#### **5.4.2.1 *Focus group discussions***

Focus group discussions were held as one way of bringing comprehensive construction specific voices into the research. According to Yin (2007:212) focus group discussion is a form of group interviewing in which a small group usually 10 to 15 people is led by a moderator (interviewer) in a loosely structured discussion of various topics of interest. Focus group discussions were deemed as applicable as they enabled different groups that are identical in demographic and characteristics to have different thoughts on the same subject. What is said in one group or qualitative interview might never be repeated in a second group. This reflected on the exploratory nature of qualitative investigations and the diverse nature of populations as mentioned by Yin (2007:212). The researcher facilitated these meetings. Altogether 30 delegates from across the nine companies attended these meetings and each meeting comprised of 10-15 participants.

As noted earlier, it is common that attitudes and opinions may have differed from group to group, regardless of their apparent homogeneity. Due to the very subjective nature of focus groups, two focused discussions were held with each key stakeholder segment, to confirm any findings. Thus, junior and senior project and SC managers were seen as distinct and important segments, thus two groups were assembled. The course of the discussion were planned in advance and tailored to address the empirical objectives of the study. As recommended by Lee & Lings (2008: 228), a digital voice recorder was used to record the focus group discussions.

#### **5.4.2.2 *In-depth interviews***

Purposive sampling was used in order to select 15 senior managers from selected construction companies. Upon selection, semi-structured interviews were conducted with each respondent. Semi structured interviewing according to by Lee and Lings (2008:228) describes a range of different forms of interviewing whose defining characteristic is that they have a flexible and fluid structure, unlike structured interviews, which contain a structured sequence of questions to be asked in the same way of all interviewees. The structure of a semi-structured interview was organised around an interview guide. This contained topics, themes, or areas to be covered during the course of the interview, rather than a sequenced script of standardised questions. The aim was usually to ensure flexibility in how and in what sequence questions are asked and in whether and

how particular areas might be followed up and developed with different interviewees. This enables the interview to be shaped by the interviewee's own understandings as well as the researcher's interests and unexpected.

The interviews were held at designated sites after an informed consent and permission from the key stakeholders is obtained. It was envisaged that each interview would run for 20-30 minutes. The in-depth interviews were recorded using a digital voice recorder, in line with the prescription by Lee and Lings (2008:228).

#### **5.4.2.3 *Recording the focus group and interview data***

There are different methods for recording information in a subjective research that may be utilised: taking notes; and utilising electronic gadgets, for example, a recording device, feature recorder or advanced voice recorder. The utilisation of an advanced voice recorder is perfect for information stockpiling and recovery in the computer. Craswell (2004:22) asserts that there are three specific methods for note-taking in meetings. These include (1) mental notes, (2) brief notes in the scientist's field record book that is carried out prudently to abstain from diverting the audience and (3) a full field report to be carried out not long after the meetings. 'Analysts may utilise cameras, sound tape or feature gear to record the meetings and perceptions.

Subsequently, the recorded materials are deciphered from varying media position into composed content configuration. The first recordings are held as reference material that could be counselled, if fundamental, for confirmation of the precision of the transcripts' (Ehigie & Ehigie, 2005: 622).

The use of a digital recorder was undoubtedly the most convenient method of recording GDS and interview data because of the obvious advantage of preserving the entire verbal part of the interview that were later transcribed for analysis. Although some respondents were nervous to talk while being recorded, this uneasiness disappears in a short time as discussions went on.

To facilitate this process, the study also developed scenarios, in the form of descriptions of situations that were acted out for participants to observe. The participant then gave their own interpretation of what is going on in the scenario. The participant's responses provided perceptions, interpretations and awareness of the total situation and of the interplay of the actors in the scenario.

#### 5.4.2.4 *Capturing and transcriptions*

Transcribing is the procedure for producing a written version of an interview (e.g. in narrative, or grounded theory-based research) or conversation (e.g. if using conversation analysis). It is a full “script” of the interview or conversation (Myers, 2008:38).

According to Myers (2008:38), transcribing is an interpretive act rather than simply a technical procedure and the close observation that transcribing entails can lead to noticing unanticipated phenomena. It is impossible to represent the full complexity of human interaction on a transcript and so listening to and/or watching the ‘original’ recorded data brings data alive through appreciating the way that things have been said as well as what has been said.

It also believed that transcribing is a time consuming process and the estimated ratio of time required for transcribing interviews is about 6:1. However, for this study, it took two to four hours to transcribe one interview. The transcription also produces plenty of written text and for some conversation analysis or discourse analysis, very specialised transcription was required which included precise notation of lengths of pauses and inflections, among other features. According to Collins (2010:88) the researcher should at an early stage consider the question “who should do the transcribing?” There was also need to pay for the service of a professional transcriber who was aware of the need for confidentiality. All transcripts were carefully checked by the researcher (the interviewer) in conjunction with the recording. When people are in conversation only a small proportion of the message is communicated in the actual words used. A larger proportion is transmitted in the way people speak (Collins, 2010:88) and tone and inflection are good indicators of a whole range of feelings and meanings and the researcher often took note of that and used it in the interpretation of findings. When transcribing, consideration was given to whether and how these feelings and meanings can be communicated on paper by using punctuation marks (full stops and commas will be essential for meaning, for instance).

Transcribing appears to be a straightforward technical task, but in fact involves judgements about what level of detail to choose (e.g. omitting non-verbal dimensions of interaction), data interpretation (e.g. distinguishing ‘I don't, no’ from ‘I don't know’) and data representation (e.g. representing the verbalisation as ‘How are you?’). However, ‘transcripts are quiet and static in that recording of the tone and emotive content of the verbal statement and the non-verbal communication (motions, facial expressions and carriage) are non-attendant’ (Barbour, 2008:193).

The transcription process involved the close observation of data through repeated careful listening (and watching), and formed an important first step in data analysis. The study ensured familiarity with data and attention to what was actually there rather than what was expected and this facilitated the realisations or ideas which emerged during analysis. Transcribing took some time (between 2 hours per hour of talk and up to 10 hours per hour with a fine level of detail) and this was allowed for project time plans and budgets.

#### **5.4.2.5 *Data analysis and interpretation of results***

As a researcher selects strategies of inquiry, it is important to realise these will have a dramatic influence on the analysis and interpretation. Data collection in the field can take a long time; however, the researcher can continually reflect, analyse and then adjust the research during this time. Pieces of data ought to be carefully labelled and organised in such a way that eases ongoing analysis. This process of analysis involves making sense out of data recorded in text, image, audio and/or video formats (Creswell, 2003:32).

Analysis of data in a research project involves summarising the mass of data collected and presenting the results in a way that communicates the most important features. In this research, the researcher was interested in discovering the big picture but used different techniques to find it. For the most part, the data was used to describe a phenomenon, to articulate what it means and to understand it. Different approaches require different types of analysis: in this introductory text we shall focus on constant comparison.

According to Creswell (2003:32), most types of analysis involve the categorisation of verbal or behavioural data, for purposes of classification, summarisation and tabulation. The content can be analysed on two levels. The basic level of analysis is a descriptive account of the data: this is what was actually said, documented or observed with nothing read into it and nothing assumed about it. Some texts refer to this as the manifest level of analysis. The higher level of analysis is interpretative: it is concerned with what was meant by the response; what was inferred or implied.

Qualitative interviews and their transcripts produced a large volume of material and is thus condensed, categorised or otherwise interpreted and made meaningful and this turned out to be one of the most costly and time-saving aspects of the study.

The choice of software for this study was Atlas.ti version eleven. As emphasised by Smit (2002:3) it is a workbench for qualitative data analysis, particularly for large sections of text, visual and

audio data that is largely relevant to this form of study. Atlas ti, a computer programme that aids in the sorting and management of data, was used to manage the data and hence facilitate analysis. In the analysis of data, the following steps were followed:

- Step 1: Creation of many codes using open coding and code.
- Step 2: Narrowing down by merging codes (“paradigm” merged with “widespread,” and it is automatically documented in the definition window of code manager), used comments or memo in addition to codes for future write-ups (“grounded” in the code manager window tells you the frequency of code as you code).
- Step 3: Producing a coding scheme graph in a network view and labelling the codes as well as the links.
- Step 4: Producing a table of code counts (a quick “quotation count report” from the code manager window, saved as a document or Excel file).

Coding was done through the hybrid coding strategy, fusing codes from earlier open coding into codes from documents of expert reports. With the codes produced from the preliminary round of open coding, the researcher coded data collected from the field and the detailed transcripts had generated lengthy and credible information to refine codes. Second, was to code according to the key constraints articulated in the research questions, while in some cases, a more of a theory-testing manner as a complementary triangulation study to the quantitative analysis was adopted as referred to by Saldanha (2013:14). The coding scheme was discussed with an additional coder to refine definitions and it has been revisited with multiple rounds of feedback from two coders. Each coder conducted coding separately with the developed coding scheme and then convened to discuss the results after each round.

Coding involved the attachment of labels to sections in the data on the basis of meanings that the researcher deduced from the data (Braun & Clarke, 2014:23). Themes emerging from the coding were documented by the interviewer. A sample of transcripts was given to another researcher to cross-code for validity purposes. In order to reach a consensus in the coding, a process was developed to negotiate or reconcile coding differences between the researchers.

Furthermore, the researcher read data transcripts a number of times until a point of saturation was reached, where themes begin to appear repeatedly. Thereafter, the themes were then grouped into more manageable groups of sub-themes, before, a summary table of the main themes emanating



from the participants' story is drawn up. It is from these themes that conclusions and recommendations are drawn.

## 5.5 MEASURES OF TRUSTWORTHINESS

Trustworthiness entails validity and credibility of information provided to an enquirer (Maxwell, 2005:106). Maxwell (2005:106) stated that 'trustworthiness consists of four elements: credibility, conformability, transferability and dependability.

- Credibility is perceived as a quality that emerges on evaluation of information or research work by experts (Donaldson *et al.*, 2009:52-53). In the current study, credibility was ascertained through the triangulation method. Triangulation entailed the use of different data collection methods within one study in order to ensure that the data is authentic (Saunders *et al.*, 2003:99). Triangulation is also a way of trying to enhance validity by looking at the issue from different angles for instance types of method or different analysis techniques. It can also be used to enhance richness of the data set (Lee & Lings, 2008:239). In this study, triangulation was established by comparing the data collected from interviews with participants, field notes and those obtained from sources stated above.
- Confirmability refers to whether or not one can convince readers that, as a researcher, you were not influenced by biases either from one's own personal values or theoretical background' (Lee & Lings, 2008:210). To ensure conformability in this study, an audit trail was completed throughout the study to demonstrate how each decision was made.
- Transferability is about whether one can justifiably transfer the findings to any other context (Lee & Lings, 2008:228). Transferability was ascertained through noting the specific details of the research situation and methods and comparing them to a similar situation that they are more familiar with within the construction supply chains. If the specifics are comparable, the original research would be deemed more credible. The researcher ensured a highly detailed description of their situation and methods.
- Dependability or reliability is about how well a researcher can assure readers of his/her findings and the way he/she arrived at them from the raw social context (Corbin & Strauss, 2008:292). In this study, dependability was ascertained through measuring and was reported in detail to enable an external researcher to repeat the inquiry and achieve similar results. This also enabled the researcher to understand the methods and their effectiveness.

A second way which was used to ensure the trustworthiness is member-checking (Corbin & Strauss, 2008:292). This was applied when the researcher interacted with the participants during the interview planning stage and after interviews in order to gather any additional material from written feedback and compliments.

## **5.6 CONCLUSION**

The study adopted the qualitative research paradigm methodology that has been discussed in this chapter. The fields of exploratory, descriptive, inductive research and purposive sampling were elaborated. The ethical considerations for the study, research design were covered. The data collection methods used as well as data analysis and interpretation using the content analysis method were stated. The validity and reliability (measure of trustworthiness) were articulated through tests for credibility, dependability and triangulation. The theory benchmarking was undertaken which yielded a supply-chain view that would alleviate constraints customary in the South African construction supply chains. The next chapter discusses the data presentation, analysis and interpretation emanating from the empirical study.

## **CHAPTER 6**

### **DATA PRESENTATION, ANALYSIS AND INTERPRETATION**

#### **6.1 INTRODUCTION**

This chapter encompasses data presentation, analysis and interpretation of the interviews for the study. The summary of the participants and participating companies has been provided with anonymity observed, as articulated at the outset of the study due to ethical grounds. Second, their participants' comments have not been edited in order to preserve their authenticity. The data were transcribed and content analysis used for the interpretation. The interpreted data were then analysed from key issues and themes stemming from the input of primary data derived from Atlas ti version seven tool of qualitative data analysis. The details and summaries of the key data outputs are given in the appendices attached at the end of this document.

#### **6.2 DESCRIPTION OF PARTICIPANTS**

Seven companies in total that wished to remain anonymous, participated in the study including participants whose positions at the time included quantity surveyor, buyers, senior buyer, estimating manager, operations manager, commodity managers, head of procurement, head of sourcing, chief procurement officer, regional buyer, estimating buyer, estimating clerk, procurement analyst, plant and assets executive, a technical manager and a logistics manager. Included in the background were persons with long construction industry experience in supply chain, newcomers to the industry from other sectors, operation staff impacting the supply chain but not part of the supply chain structures, qualified versus un-qualified staff, Site / operations based as well as office based procurement was tested (same problems) and one commodity manager with Human Resource (HR) management experience provided insight into resistance to change in the organisation.

The classification of participants was necessary to capture a range of diverse and segmented views on the supply chain as well as the TOC. In essence, the relationship between HR, especially the scope of employees and supply chain management is metaphorical. Senior managers /executives as well as all level employees in both fields should compare, contrast and enhance collaboration to better understand how personnel interact with supply networks. By contrast, the success of the supply chain will indirectly affect management of personnel and the level of demand for new

talent. In many ways, human capital involves the management of inventories, reducing surpluses and preventing losses much the same way as supply chain management.

### **6.2.1 Thematic analysis of responses**

According to Saldanha (2013:14), most of the data collected in open-ended responses are qualitative, that is, are in a nonnumeric form. Thus, in order to analyse and make sense of this data, one has to conduct Qualitative Data Analysis (QDA). QDA involves a range of processes and procedures that aim to provide an explanation, understanding and interpretation of the collected data, which in this case was Atlas ti version seven as mentioned earlier.

Buoyed by Wiedemann (2013:5), the two of the most popular approaches to analyse answers to open-ended questions are the content analysis and thematic analysis. For the authors, the first approach employs a more systematic and mechanical process and is usually used with a purpose of classifying and quantifying data. The second approach employs a more flexible and reflective process and is usually used to capture the richness and in-depth nature of qualitative data.

For a more realistic and valid content analysis, the researcher involved a rigorous and systematic classification process of coding and identifying themes or patterns that emphasise the reliability and replicability of observations and subsequent interpretations as suggested by Sinkovics and Alfoldi (2012:8). For the authors, such content analysis is a particularly useful approach when the purpose is to classify, summarise, quantify and tabulate qualitative data.

To create a clearer perspective, the structuring process of content analysis followed a three step process involving:

#### ***6.2.1.1 Identification of the categories of analysis and development of the coding system***

This involved determining the appropriate unit or level of analysis (this was all answer, sentences, or words that had been captured during data collection) and identifying the recurrent categories that gave meaning to the data. The purpose was to develop a coding system that enabled the conversion of the data into meaningful and specific units of information (codes or categories).

The researcher had in mind the view that the development of the coding system can be data-driven or theory-driven as emphasised by Leech and Onwuegbuzie (2007:9). In a data-driven approach, the categories (codes) were selected based on a detailed analysis of all data. This approach was

particularly suited where there was little knowledge about the TOC and themes that come up in the answers or when the goal was to make an in-depth exploration of the data.

Furthermore, referring to Leech and Onwuegbuzie (2007:9), the reference to the theory-driven approach, was used only when the categories (codes) selected were predetermined by an existing theory. Thus, in this approach it was not strictly necessary to go through all data in order to select the categories, making it less time-consuming than the data-driven approach. The theory-driven approach was particularly suited to already knowledge and a conceptual organisation of the themes that should have been analysed in the answers or when the goal is to test a theory.

To identify and consider thematic analysis, the researcher used deductive thematic analysis, a structure or predetermined framework used to analyse data (Saldanha, 2013:14). Essentially, the researcher imposed his own structure or theories on the data and then used these to analyse it. This approach was particularly useful as specific research questions that already identify the main themes or categories to be used to group the data so as to look for similarities and differences had been crafted beforehand. Given that this approach was relatively quicker and easier to perform, it was particularly useful where time and resources are limited. However, by using a predetermined thematic framework, one loses in flexibility of analysis which can bias and limit the interpretation of the data. At the end of the process, a checklist that identified all the relevant categories, providing clear definitions and concrete examples in the data of each category was produced. This checklist was accompanied with rigorous instructions of how the data should be coded.

#### **6.2.1.2 *Coding of the data into the categories of analysis***

This step involved the organisation and coding of all data in a way that ensured reliability and meaningfulness, i.e., the previously defined categories (codes) were used to classify the content into explicative categories. Thus, this step required the execution of an explicit set of recording instructions about the rules for coding the data into categories. For Wiedemann (2013:5), recording should involve more than one judge so that the coding of each content/unit can be examined for reliability and sources of disagreement can be identified and corrected. Reliability of the coding system was then evaluated through computation of coefficients of agreement between two or more different judges/coders.

A more comprehensive approach was to follow the Atlas ti approach to coding and thematic development and included the following phases: familiarisation with data; generation of initial

codes; searching for themes among codes; reviewing themes; defining and naming themes; and producing the final report

### 6.2.1.3 *Analysis and interpretation*

Once all data had been organised and coded, the qualitative analysis was performed and followed by an interpretation of the results. To analyse the structured themes, (thematic analysis), which is often implicitly and explicitly a part of other approaches of data analysis including grounded theory and narrative analysis according to Saldanha (2013:14), the first step was to look for broader patterns in order to then conduct a more fine grained analysis using alternative approaches. The main goal was to provide a description and understanding of answers. This helped the study to move the analysis from a broad reading of the data towards discovering patterns and developing themes.

**Table 6.1: Qualitative data analysis process**

<b>Phase</b>	<b>Description of the process</b>
Familiarisation with the data	Read and re-read data in order to become familiar with what the data entails, paying specific attention to patterns that occur and noting down initial ideas/patterns.
Generation of initial codes	Generated the initial codes by identifying where and how patterns occur. This happened through data reduction where the researcher collapsed data into labels in order to create categories for more efficient analysis. Data compilation was also completed here by making inferences about what the codes mean.
Searching for themes	Collated codes into themes that accurately depicted the data. It was important in developing themes that the researcher described exactly what the themes meant, what they included and excluded.
Reviewing themes	Checked if the themes made sense and account for all the coded extracts and the entire data set. When analysis seemed incomplete, the researcher went back and found what was missing. Generated a thematic “map” of the analysis.
Defining and naming categories	Generated clear definitions and names for each theme. Described which aspects of data being captured in each theme and what was interesting about the themes.
Producing final report	Decided which themes made meaningful contributions to understanding what was going on within the data. Researcher also conducted verification of the data to check if their description was an accurate representation.

Adapted from Braun and Clarke (2006:6)

For the purpose of presentation and analysis, the following key themes were identified and subsequently presented in this study:

- The South African construction industry
- Description of organisations supply chain
- Internal organisational supply chain constraints
- Organisation management and people skill constraints
- Supply chain system constraints
- Supply chain process constraints
- Supply chain knowledge management constraints
- Supply Chain Change Management

As data analysis proceeded, the following sub-themes also emerged;

- Procurement practices and capacity
- Construction supply chain management structure
- Supply chain Integration
- Relationships and coordination in supply chains
- Supply chain collaborations
- Supply chain leadership management
- Logistic management

In this chapter, P is specifically used to refer the companies that took part in the study in terms of numbers and the number (P 1) is related to the different participants.

### **6.2.2 The South African construction industry environment**

In this study, it was observed that the nature of the South African construction industry as well as various developments in that industry were the first constraint to supply chain management. The construction industry is often involved in large and expansive projects which often become too complex to understand in order to reduce long lead times. Inaccurate forecasts and unreliable suppliers can conspire to make it difficult to supply the right materials to the right place at the right time. Literature has also demonstrated that supply chain complexity is dynamic. It is determined by the unique nature of the items required and the complexity created by the number of components, many of which are orderly designed and engineered. Added to this is the sequence in which the multiple items need to be combined and the multi-layered approach to planning, controlling and contracting across the parties involved.

For this, participants were asked to share their opinions on the present South African Construction industry and the following were some of their responses:

- “The industry is fragmented and most companies experience difficulties with internal silos – this is no different in my company. It is an industry steeped in a specific mind-set and with people constantly moving within the same industry but to different companies, the same entrenched cultures moves from one company to the next. They also have a tendency to headhunt from within the same major players, which means that outsiders from construction find it difficult to enter this sector, which creates an almost incestuous relationship within the industry”. P 1: docx - 1:1 -11:11)
- “I think our mind-sets have changed in the last year whereby if a supplier is giving us his best prices then we need to start using them and if we have not used that supplier before we need to change our mind-set and start using them”. P 1: docx - 1:13 -51:51)
- “There is no real strategic approach to supply chain that I can see. It’s AD HOC and driven by a programme which in itself could be a plan I suppose – which is good. I’m not aware of any supply chain professionals in this company who are applying their minds to the supply chain. (P 1: docx - 1:16 -121:121)
- “My view is that this industry is trapped in a time warp, that have not adopted world class business practices and principles and that they continue to do the same thing over and over and expect different results. I joined at the height of the collusion drama. It was clear that the ‘free lunches and high margins were over’ yet the company failed to tighten its belt and focus on the core cost drivers to allow the company to effectively compete”. P 2: docx - 2:1:9:9)
- “In a collusive environment, there was no need to focus on inefficiencies as margins were huge and because of anti-competitive and collusive behaviour, the company was still making money. After the huge fines and with a level playing field, companies needed to become competitive, but refused to adopt new business practices as anything new was not given a chance to be implemented”. P 2: docx - 2:2 - (9:9)
- “The industry is characterised by the same key staff moving from one company to the next- new blood, hence new thinking is not happening on a regular basis. My view is that they need to bring people from outside of the sector in order to effectively fix it”, P 2: docx - 2:3 - (9:9)
- “It is all the same- they all do the same things. I have worked in many construction companies and when I interviewed for a job here I was told this was a world class company



- clearly they did not know what world class is. My previous company was much better and they had a better procurement structure. Here I am like a clerk”. P 3: docx - 3:4 - (82:82)
- “I cannot see anything changing, especially with regards to the sectors attitude towards supply chain and the benefits that it can bring to the company. This element of the business continues to be ignored and whilst some strategic interventions are agreed at a corporate level, implementation at a business level is usually met with resistance and a lack of understanding”. P 4: docx - 4:1 - (13:13)
- “I would describe the sector as disorganised, haphazard and constantly trying to relive the past when they made huge profits with no attention being paid to structure, strategy, policy etc. Now that the world cup is over, margins and work has shrunk and they have not been able to effectively become competitive. Possibly because they have worked in an uncompetitive and collusive environment before”. P 4: docx - 4:11 - (55:55)
- “I found construction to be very different in the sense that it appears to have its very own culture which focusses on the technical aspects of building and the financial aspects of ensuring that they make profit. However, in this process, the spending of money with suppliers, whilst important has not moved to a strategic level and is therefore ad-hoc and operational, which means that the company is missing opportunities to save costs”. P 4: docx - 4:15 - (88:88)
- “Unstructured and lagging behind in terms of strategic thinking and direction when compared to other industries- run as if this were a small family owned business”. P 4: docx - 4:24 - (163:163)
- “Full of challenges between people within the company for a long time and the new guys coming in from different industries or sectors. However the company has entrenched procurement practices in most areas of the business. Sub- contractors however continue to form part of the operational decision making”. P 5: docx - 5:1 (9:9)
- “Nothing has fundamentally changed over the past 10 odd years of my experience. They keep doing the same things over and over”. P 5: docx - 5:9- (85:85)

From the above responses, it can be said that the present condition of the construction industry of South Africa is by and large un-impressive from the inside and quite different from the outside. The nature of the industry presents dichotomy of issues, ranging from no system that are meant to run projects to an institution which the outlook is seemingly haphazardly run. It is associated with very unclear and inadequate systems and policies towards culture shift and organisation change and transformation, high inter-company labour mobility and well as stagnation for a long time. Furthermore, the responses view the construction sector as very lucrative, very competitive

(cut-throat competition), there is a lot of money, cash, to make and this concurs with the PWC (2015) report. The responses portray a picture that most of the organisations care more about the balance sheet and not how it got there.

Subcontracting has always been important in the construction industry, particularly in building construction where the production process is divided into a number of discrete activities. These tasks or activities are often carried out sequentially and may require specialised labour. Hence, it often makes sense, in technical and economic terms, for general contractors to subcontract some tasks to independent, specialised units. However, there is evidence (Modares & Sepehri, 2009:15; Rust & Koen, 2013:11) to indicate that subcontracting has increased significantly in the past two to three decades. It is no longer restricted to specialised tasks. In some instances, participants noted that the bulk of the construction workforce is now recruited through subcontractors and other intermediaries as the “outsourcing” of labour requirements has become the norm.

There is also evidence of the traditional practices of labour recruitment through subcontractors and intermediaries that is common in the construction industry in many developing countries. Evidence (Weirauch, 2010:22) is then presented to demonstrate a further increase in labour subcontracting in South Africa and a very significant shift in this direction in the industrialised countries.

The findings also point to the opportunity to cut costs, while always attractive to employers, becomes imperative during periods of intense competition for work, such as that which occur during economic downturns. Many companies seem to experience a severe drop in demand which leads to both excess supply in construction markets as well as increased competition for contracts. This is in agreement with Jain and Benyoucef (2008:22) who noted that contractors cut costs by managerial innovation (project management), by outsourcing labour and in the construction industry by undermining collective agreements.

The constraints for the development of the construction industry in South Africa identified by the respondents range from increasing costs of building materials to the lack of human skills. The question that needs to be addressed, however, is why the respondents perceive the increasing costs of building materials to be a key challenge to and constraint on the performance, development and growth of the South African construction industry. This perception arises from largely unexamined assumptions that an increase in the cost of building materials results in the low-cost performance of construction projects. It also introduces uncertainty into project pricing and bidding, and may cause future cash flow problems for contractors. The failure of projects that

are not adequately priced to absorb price increases in building material may result in an unsustainable contractor/construction industry.

The findings tend to agree with the OECD Competition Committee's (2008) Policy Roundtable on the Construction Industry notes that the South African construction industry is characterised by a small number of large firms that are active in all or many construction markets. Furthermore, there is significant vertical integration in the industry, with the few large construction firms controlling input suppliers of bricks, cement and aggregates. The large firms often form joint ventures to bid for the larger construction projects. There are also a number of barriers to entry, including meeting the financial and capacity requirements of the CIDB (2014) in order to be awarded certain tenders and being able to attract and retain engineers, technologists and technicians who are in short supply.

The South African construction industry has performed poorly in recent times. PricewaterhouseCoopers (2014) report that in 2014, financial results of listed heavy construction and construction materials companies were mixed. The aggregate market capitalisation of these firms declined throughout 2014. The cyclical nature of construction activity might explain the decline in 2014. However, it may also reflect a sustained downward trend in the industry and companies have therefore adopted cost cutting measures against systems and compliances. First, the South African economy was not immune to the 2008 global economic crisis and its growth since then has been sluggish. Second, despite the government's stated commitment to public infrastructure investment, public institutions such as Eskom (power), Transnet (ports, rail, pipelines and logistics) and SANRAL (roads) are spending less on capital projects. Third, the mining industry has significantly reduced its capital expenditure as a result of reduced margins arising from volatile commodity prices and labour unrest. Other reasons mentioned included volatile and violent industrial unrest, loss of skills and expertise, the investments needed in new projects and delays in their commercial close-out.

### **6.2.3 The description of organisations' supply chain**

Theme two related to the organisation of supply chains. Literature shows that supply chain should be an entrenched system for project driven organisations of which the construction sector is a part of.

The following responses were captured from the participants in the various companies:

- “With 4 specific organisations made up of 16 separate businesses, the impact of organisation as well as business unit Managing directors invariably leads to silos, with different management styles”. P 1: docx - 1:2 - (15:15)
- “Buyers are relegated to securing the smaller, low value items from suppliers, however, they usually tend to return to those suppliers that provided pricing on the tender process to negotiate pricing with the sole purpose of beating the allowable. Given that this norm has existed in the sector for decades, suppliers usually inflate their prices, knowing that the buyers, quantity surveyors and contracts managers will return to negotiate. This therefore implies that the company did not necessarily submit its most competitive tender to secure the work and therefore increases the probability of securing new contracts. Buyers are administrative in that their ability to make procurement decisions is restricted and on average they make decisions on possibly only 20% of all procurement spend”. P 1: docx - 1:3 - (15:15)
- “Management, however, chose to move the responsibilities of the buying function back to the respective MD’s of the business unit. This is counterproductive, as it now makes it impossible as the CPO to control procurement activities”. P 2: docx - 2:5 (10:10)
- “Efforts to implement a logistics strategy, warehousing structure and inventory control is simply ignored. Notwithstanding the site based operations of construction, large quantities and value of inventory is held in various stages of operations and is neither controlled nor properly accounted for”. P 2: docx - 2:7 - (10:10)
- “They estimate and send tenders, once they win the contract, buyers gets the small items to order and the site does the rest. Or if they are lazy, they send us the documents to capture the orders. I did not come here to capture orders and phone order numbers to suppliers”. P 3: docx - 3:5 - (83:83)
- “It is unstructured, unsupported and ad hoc. I have spent years identifying suitable sub-contractors, reducing rates etc., but they are never used. The company still has a mental block against strategic sourcing. This is either due to a lack of understanding, or defending their patch with regards to appointing sub-contractors- further we are constantly told that we don’t understand the industry”. P 4: docx - 4:2 (14:14)
- “The resistance also appears to be more associated with historical practices and an unwillingness to change, possibly again caused by ‘I don’t understand, therefore I won’t change’. The supply chain is not managed, stock held at sites, stock held in workshops etc. is not managed and further transportation is ad hoc, unplanned and not taking into account logistics principles including load planning, road planning”. P 4: docx - 4:3 (14:14)

- “The cost of strategic sourcing is borne by the various business units, which they are clearly not happy about. Then there are operational buyers that report directly to the business. Logistics, warehouse staff etc. report to their respective operations. So it is disjointed and not accountable to one person. When people refer to supply chain in this company, they are mostly referring to the buying function. In saying this, it must be noted that the company carries R2.8bn of stock, spends close to R100m on logistics, freight forwarding etc., has a procurement spend exceeding R15bn and still does not believe it has a ‘supply chain’ which requires high level management and control”. P 4: docx - 4:7 (36:36)
- “Highly erratic, with a vast majority of suppliers being engaged by operations without any processes being followed. In the IT space, we discovered some fraud and corruption and further spend most of the time placing orders when we should be focussing on sourcing strategies”. P 4: docx - 4:12 (56:56)
- “There is no structured plan regarding operational planning, leveraging spend across the group, no transport/ logistics planning”. P 4: docx - 4:16 (89:89)
- “Problematic as there is a constant war between operations, buyers and strategic sourcing. Without a firm structure anything we do is hitting a brick wall. I think half of strategic sourcing’s efforts are wasted as buyers ignore recommendations”. P 4: docx - 4:25 (164:164)
- “We brought in commodity managers and supply chain managers about 8 years ago as part of the corporate structure. The business did not subscribe to this change. We then decentralised these managers into the various business units in order for them to influence decision making at the operational level. We placed supply chain managers into our Housing, Building, Civil Engineering, Plant and Projects divisions. Only Civils accepted the transition and benefited substantially from the input of a qualified supply chain manager. All other business units deliberately excluded supply chain management from ops meetings, excos, estimating and planning meetings to the point that most of them left the company and the previous status quo was restored. This was a sad indictment on the Group and whilst I remain Supply Chain Director, I no longer have the clout to influence the day to day procurement or supply chain across the group. We do however have a structured policy and any non-compliance is dealt with accordingly”. P 5: docx - 5:2- (10:10)
- “Strange would be the best way- I was part of the group’s overall strategic sourcing initiative- this did not work as the business refused to pay for us. We were then deployed to the business itself which caused even more problems when they found that we earned more than some of their directors and senior staff. I was lucky that I was given the opportunity to

add value and stay, however, I now manage a buying team and my position has remained static for almost 8 years. My colleagues that moved to other business units all left the company after being refused access to any decision making in the organisation. They still however operate in silos in that estimating sometimes talks to buying, sites make most decisions and sub-contractors are appointed by quantity surveyors on site”. P 5: docx - 5:5 (41:41)

- “Not too bad- we are allowed to impact most aspects of the supply chain, but it tends to focus on cost savings and efficiency savings is not understood or accepted”. P 5: docx - 5:10- (86:86)
- “I’m really not involved, I just do research for my commodity manager who is more involved operationally. But people sometimes think I am still a buyer and send me silly queries”. P 5: docx - 5:13 - (107:107)
- “I get quotes in from a lot of the suppliers. Those quotes, should we then become successful in the job, form the resource schedule that I have priced with the prices I have used I then pass on to the buyer. That is my first involvement with the procurement chain. She now has a list of resources that are required for the job. She then uses this as an allowable of how much can be spent on the job. My involvement to a certain degree will end there unless there are problems with the allowables then we would have to see what was used at the tender stage. If my allowables are too high and we make money on the job I never hear about that but what I do hear about is when my allowables are too low”. P 6: docx - 6:2 (11:11)
- “We need to differentiate between the different types of people that go about doing procurement in the organisation so typically in organisation split between subcontractors and suppliers and there is different bodies or different personal carrying out that procurement”. P 7: docx - 7:2 - (12:12)
- “The organisation as a whole is not really mature in terms of the procurement practices. Yes there is some absence in the buying department, there is also some areas of improvement to be add but there is generally never been a strategic sourcing element to the organisation”. P 7: docx - 7:3 - (13:13)
- “I don’t think strategic sourcing in this organisation should be signing contractors up but we need to differentiate again there between the commercial operations and maybe the tender stage, so the strategic sourcing guys don’t have to be ex QS’s or so on, they can be ex lawyers, ex whatever, ex specialists in their field, they are able to go out into the market

place and source the correct vendors for the commercial teams. So this is a bit different work, it is sourcing and doing a bit of supplier management”. P 7: docx - 7:4 - (13:13)

- “So I think from an operations point of view it is important for us to be involved in the process because we need to take ownership of the project. That is important to be involved in the procurement process as well, subcontractors generally has more risk attached to suppliers so there is a management function involved in that as well”. P 7: docx - 7:11-(65:65)
- “I believe when you start doing procurement you must be on the ground where that work needs to be executed, in that area where the work needs to be executed. Because some people do not operate in other areas”. P 7: docx - 7:15 (91:91)

Most participants seem to suggest a supply chain that is dichotomous and hugely disjointed within their organisations. Also important was the number of respondents who were unable to effectively describe the elements of a supply chain and were clearly not aware of what a traditional supply chain entails. This was common for most of the participants.

The supply chain in the South African construction industry is a network formed by a vast number of heterogeneous firms cooperating on the same task. The majority of these organisations associate with one another at specific stages but this in the findings has been associated with collusion practices instead which has been emphasised by Kujawa and Prinsloo (2013:12). Presently construction firms have no capacity to deal with the increasing number of firms and subsidiaries in different location and the lack of synergies is clearly visible. Therefore, successful correspondence and communication should become pivotal with a specific end goal to accomplish a visible and integrated supply chain.

#### **6.2.4 Internal supply chain constraints**

The third theme related to internal of supply chain constraints. The question posed here was a result of the extensive literature that was conducted around the TOC as well as the construction supply chain management within South Africa. Participants were not told but guided to sufficiently answer the question from understanding what a constraint is. Not surprising, many participants could not comprehend it and guidance was given to use as anything that may deter an organisation from attaining specific goals as expected. The following were the key aspect from participants as regard to the critical constraints to the organisation supply chain;

- “Lack of strategic decision making and supplier selection at the tender stage. This is further compounded by short timelines associated with preparing and submitting a tender to a client”. P 1: docx - 1:4 - (18:18)
- “It is clear that the best prices are not used in the tender and that a lack of competitive behaviour exists amongst suppliers at this early stage. Further, suppliers escalate their prices, knowing that the buyers and operational staff will return to renegotiate the final price in order to ‘beat the allowable’”. P 1: docx - 1:5 - (18:18)
- “The company further does not have a consolidated view of its supply chain activities and current systems do not support strategic decision making. A lack of item masters as well as a consolidated vendor master further detract from the ability to conduct strategic sourcing initiatives”. P 1: docx - 1:6 - (19:19)

The responses above indicate that participants’ companies have not kept pace with the view that CSM is meant to offer new ways to reduce costs and drive efficiencies aimed at improving strategic decision making and control. In this regard, reference is made to Mattsson (2008:9) who discusses overlap and overlapping processes with focus on actors and relationships that overlap between different supply chain networks. He states that, “*the actor based overlap influences the strategic actions and network processes in both of the overlapping networks.*” His definition of an actor based network overlap is that “*some actors of one network are related to other actors in another network*”. This would perhaps help to explain that the lack of strategic decision making in the appointment of suppliers and subcontractors will continue to impact project delivery in both quality and cost as disjointed supply chain networks continue to surface. The subcontractor and supplier appointments on large projects encompass the largest spend, inventory base and present the single biggest opportunity for cost savings and control. By the same token, it creates the area with the most risk and therefore reinforces the need for greater strategic control.

- “Change management is non-existent and at least 5 projects, initiated by the company and using external consultants has failed to be implemented at a high cost, mainly due to the company not being able to proceed beyond the resistant culture in the organisation”. P 1: docx - 1:7 - (19:19)
- “Some of these projects were aimed at making the entire supply chain report to a centre led structure, implementing new systems (contracts cancelled) and further implementing world class processes through all operational functions. This also failed as it required system and process changes and whilst the company spent money to determine the problems that



existed in its current processes, it refused to spend money to correct same”. P 1: docx - 1:8-(19:19)

Some change within CSC is inexorable. By comparing different commercial enterprises, it can be contended that construction accommodates change too promptly for the purpose of progress. Moreover, it can be contended that most partners: customers, creators and builders all have a common enthusiasm for change. Nonetheless, this study confirms that the pace of progress is too slow. This originates from many participants and can be very unfavourable to project performance.

The study unmistakably demonstrates that the incapacity to change is the norm in the sector. It appears that change disrupts advancement, presents a cost and lessens industry profitability.

- “There are three distinct supply chain/ procurement structure in our company- the first is the strategic sourcing division made up of highly qualified strategic sourcing specialists and commodity managers and reporting to corporate as a support function to the entire group. The second is the operational buyers reporting to each business unit and that are more administrative in nature. They are made up of poorly qualified or trained individuals with an average of 10 to 20 years of service. They are generally clerks that ‘became buyers’. The third are the engineers, quantity surveyors, site agents, commercial and contracts managers that appoint sub-contractors and decide the suppliers for high value bulk items. This tends to cloud the supply chain as policies, processes, actions, orders as well as suppliers are not visible due to poor systems”. P 1: docx - 1:9 - (20:20)
- “As a large volume of decisions and large value of spend takes place between the buyers and operations, it is clear that world class practices are not taken into account and large spend is not subjected to expert scrutiny. There is a tendency to revert to previous suppliers, or using favoured suppliers and this creates complacency within the supplier base”. P 1: docx - 1:10 (20:20)
- “We still use a manual requisition system and not an electronic system. That matter was brought up last year and at that stage it was decided that the manual system works well and we don’t have a problem with manual requisitions but if it is going to make our lives a bit easier in procurement I am all for going the electronic route”. P 1: docx - 1:14 (83:83)
- “There is no real strategic approach to supply chain that I can see. It’s ADHOC and driven by a programme which in itself could be a plan I suppose – which is good. I’m not aware

of any supply chain professionals in this company who are applying their minds to the supply chain”. P 1: docx - 1:16 - (121:121)

This section shows that the role of strategic supply management is underestimated. The idea that people in different organisation do not know and understand the underlying principle of procurement, due to their lack of training and competence in supply chain suggest that proper procedures may not be followed. Strategic approaches should endeavour to align all resources in an organisation, most importantly, people and systems with the focus on issues that may impact supply chain activities. The goal is to reduce costs and duration of site activities. In this case, the primary thought is to ensure dependable material acquisitions and labour flows to the site to avoid disruption to the workflow. This may be achieved by simply focusing on the strategic relationship with key stakeholders especially between the site and direct suppliers. If everyone in the project thinks and works independently then the operation of the organisation is affected negatively.

- “I really do think that a lot of people in senior roles in this business don’t understand the benefit they can extract from supply chain; they see it as almost a necessary evil and not a real value add. I don’t think it’s through any fault of their own, more a matter of it how it’s always been”. P 1: docx - 1:17 - (124:124)
- “Procurement is very immature in this business but we are starting to see some good examples where procurement is starting to add value as it should but we need to educate our internal customer and sell the benefits of procurement to them. Only then I think, once we have done that, will we start to see more buy in to the procurement philosophies”. P 1: docx - 1:18 - (124:124)
- “It’s a constant battle to convince people that they are going down the right route. I believe it is the resistance to change that causes this. Inevitably this work does involve looking at options they may have considered in the past and opted not to pursue and are as a result reluctant to go down that road again”. P 1: docx - 1:19 - (124:124)
- “People have fixed ideas on their preferred supplier solutions and it’s a matter of challenging the status quo which does ruffle a few feathers in the process. – the first thing in procurement is really to unpack and understand spend and as in many large corporates there are many different source systems in use”. P 1: docx - 1:20 - (124:124)
- “Buyers are administrative in that their ability to make procurement decisions is restricted and on average they make decisions on possibly only 20% of all procurement spend”. P 1: docx - 1:21 - (15:15)

- “Beginning with a lack of strategic decision making and supplier selection at the tender stage”. P 1: docx - 1:22 - (18:18)
- “I get pushed around by the people on sites and get told to stop asking questions and just place orders. I normally like to get 3 quotes, but there is usually not enough time these days. But I don’t really know much about supply chain, just buying”. P 3: docx - 3:2 - (68:68)
- “No one follows policy and nothing happens. The people that are not in buying make the decisions and again I cannot say anything. This culture has always been QS and Project managers call the shots and they are more senior so what can we say. There is no planning so everything is urgent and we have to jump. Even if the site does not plan, it then becomes our fault if the stuff does not get to site on time. No one takes buying seriously and I am sure it is worse in stores and transport. I would prefer to work with the sourcing guys as I always learn from them, but my boss does not like them, so we are actually afraid to go and see the guys in sourcing. It is so silly”. P 3: docx - 3:6- (84:84)
- “no training, no development, no KPI and no performance management but we then get average increases although no one can tell us what they measured us on”. P 3: docx - 3:7- (87:87)
- “I want to make decisions by no one wants to teach me what to do. They tell me I should not be there if I don’t know the job”. P 3: docx - 3:8 - (141:141)
- “can do paperwork and capture orders, but I don’t talk to suppliers as they say they don’t know what I want and then the managers do it themselves”. P 3: docx - 3:9 - (143:143)
- “Construction is immature in terms of business skills, business processes, business experience outside of construction and the ability to embrace new concepts”. P 4: docx - 4:8- (37:37)
- “The sector is almost incestuous, in that the same people constantly rotate from one company to the next, continuing to perpetuate the same processes and culture. It is therefore not surprising that similar problems exist in the sector. The company will spend money on systems aimed at project management and to a large extent HR, but will ignore the large spend happening in procurement in a system that most probably was outdated 25 years ago”. P 4: docx - 4:9 (37:37)
- “I understand constraints to be hurdles that we need to overcome or that influence the way we do business. If I were to be honest, the processes are flawed, there is no segregation of duty, no structured approval process and people constantly commit the company to spend without a purchase order. I am almost certain that the company is losing vast sums of money

simply because too many 'buyers' exist in this company with the ability to spend money".

P 4: docx - 4:13 (57:57)

- "We have different levels of skills- all the new people in the past three years were highly qualified. Most of the historical buyers are clerks with no qualifications and whilst they may argue that they have 20-30 years of buying experience, I would not hesitate to claim that they are admin clerks who don't understand buying at all". P 4: docx - 4:14 - (59:59)
- "Lack of planning is a huge constraint and a lack of visibility of supply chain activities further contributes to losses". 4: docx - 4:17 - (90:90)
- "Lack of structures, lack of skills, definitely a lack of communication, but these are changing with the new MD who is implementing a strategic sourcing structure to ensure that 90% of spend is managed via supplier contracts". P 4: docx - 4:19 - (129:129)
- "We battle to differentiate between buyers versus strategic sourcing roles and responsibilities. Because buyers tend to do as operations tell them to do, the strategic sourcing teams find it difficult to actually do their jobs". P 4: docx - 4:22 - (147:147)
- "The sourcing guys are trained, qualified and skilled- the buyers are not and the company has not figured this out as yet. In essence, poorly qualified and or incompetent buyers are spending billions in this sector". P 4: docx - 4:23- (149:149)
- "Problematic as there is a constant war between operations, buyers and strategic sourcing. Without a firm structure anything we do is hitting a brick wall. I think half of strategic sourcing's efforts are wasted as buyers ignore recommendations". P 4: docx - 4:25 - (164:164)
- "leadership and providing visible support for supply chain initiatives and also visibly dealing with non-compliance". P 4: docx - 4:26 - (165:165)
- "We have spent data, but cannot do spend analysis in the absence of an item master. Communication and acceptance of supply chain principles is still problematic, so even though we are sometimes included, it could change the next day if someone else takes over". P 5: docx - 5:7 - (42:42)
- "The only problems I encounter is with regards to involvement consistently- it sometimes feels as if I am included only when they run into trouble. It also feels as if operations are king in this company". P 5: docx - 5:11 - (87:87)
- "A lack of buy in and management understanding of what we do. Irrespective of how qualified or experienced an individual is in this company- we are considered second class citizens in that only contracts managers, QS's, Engineers etc. are respected. Titles mean a lot in this company". P 5: docx - 5:14 - (108:108)

- “We get a price from various suppliers and in most cases they cannot fix them for longer than 30 days. By the time the job gets started you could be looking as much as 6 months to a year later that the materials have to be ordered. We have two ways of dealing with that. If it is a contract that is subject to escalation we would look at potential recovery by looking at escalation indices. Alternatively if it’s a fixed cost then I have to make an allowance for that when I do the pricing. It’s a difficult thing to bring to a science because you are never quite sure where the costing is going to go. We do put pressure on the supplier to meet the price he quoted us but there is no contract obligating him to do so. As an estimator I would like to get more feedback from the buyer placing the order especially in cases where I have to make allowances to see if the allowances I have made are realistic or not”. P 6: docx - 6:3 - (15:15)
- “organisation unfortunately there are no good tools, world class tools that we have available to us at the moment to enhance what we are doing, a lot of what we do is done manually and I think the size of the team within procurement is indicative of that as well”. P 7: docx - 7:5 - (16:16)
- “We cannot have too many people do stuff manually, the cost is exorbitant so the route that I see that the company has gone is that to say yes is reduced to a few key people that will keep things going but really we need better tools to provide a better service” .P 7: docx - 7:6 - (16:16)
- “Time is an issue that’s not always there because as soon as you get a project there is a lot of things that needs to happen before you actually do the start-up. So time is an issue but if you have your processes and your data in place already then there is no reason for it to not work better”. P 7: docx - 7:8 - (36:36)
- “There is not enough time for the estimators or estimating team to put the tender enquiry documents together properly. So when you eventually as the QS receive the subcontractor documentation, you have to have discussions with the subcontractors or engage with them in order to conclude a contract”. P 7: docx - 7:12 - (68:68)
- “So I think the time required to put a proper bid or RFQ together is usually too short. So that is from handover from tender to execution? See I think from an execution point of view we generally get led by who is the cheapest”. P 7: docx - 7:13 - (68:68)
- “Guys at tender stage to put the bid together, what you also often find is that the subcontractor would produce a tender, submit a tender, with a 1-5 page set of conditions attached to it. Those conditions aren’t analysed, read, priced and included in the price, due to time constraints so they take the price and it is left up to the post tender team, whoever

that may be, to then you find out the issues or conflicts that you may have between standard conditions and our standard conditions, contract conditions and subcontractor conditions but on the other hand if you price all those risks at the tender stage you might not win work, so you have to balance the two, that is definitely another thing where a lot of time is spend post tender, working with those things and ironing them out”. P 7: docx - 7:14 (68:68)

- “I haven’t specified this one as this is more than a risk, if you take the time constraints into account when we require other subcontractors the full contract conditions and obligations, is not made aware to the subcontractor, so that applies to normal things such as doing the drawings and or the final points of the contractual requirements and then after the award of the contract, then you find guys we need more of this or not enough. I find this as a short coming and a risk”. P 7: docx - 7:16 - (93:93)

The responses above demonstrate the severity of the constraints within the construction sector in South Africa. The research response and actual assessment analyses show that most systems are ineffective and many problems exist. Analysis of these problems has shown that a major part of them are supply chain problems, manifesting at the interfaces of different parties or functions (Vrijhoef *et al.*, 2001:9).

In summary, the following common constraints arose from the responses:

- Lack of coordination, collaboration and commitment between suppliers and clients within the supply chain.
- Poor leadership in key areas of systems.
- Design problems (many changes and inconsistent information).
- Deficient internal and external communication and information transfer.
- Inadequate management within the supply chain, mainly poor planning and control.
- Poor training of contractor’s suppliers, subcontractors and workers.
- Lack of effective methods for measuring the performance of the different parties within the supply chain.
- Lack of guidance for creating alliances with supply chain partners.
- Failure to develop measures for monitoring alliances.
- Inability to broaden the supply chain vision beyond the procurement or product distribution to encompass larger business processes.
- Inability to integrate the company’s internal procedures.
- Lack of trust inside and outside a company.

- Organisational resistance to the concept
- Lack of integrated information systems and electronic commerce linking firms
- Lack of suitable organisational setup

It can also be deduced that the responses, as regards the constraints, can be bundled in the thematic category as was suggested by the three arms of TOC as follows:

**Table 6.2: Thematic summary of the key constraints derived from the study**

Category	Key constraints Observed
<p><b>Capacity Constraint:</b> a resource which cannot provide timely capacity the systems demands for it, also referred to as a CCR (capacity constrained resource).</p>	<p>Leadership and poor decision making                      Inconsistent business rules management system.                      Supply chain management software and incompatibilities.                      Incapable and incompatible planning systems.                      Non-standardisation of operations.                      Lack of training lacking for key staff/ skills shortage.                      Rigidity to change.                      Labour mobility and turnover.</p>
<p><b>Market Constraint:</b> the quantity of construction supply chain revenue is not sufficient to sustain the required growth of the system.</p>	<p>Market pressure and changing customer requirements.                      Supply chain integration non-existent.                      Poor collaboration with suppliers, customers and service providers.                      Supply chain visibility (end to end, supplier, retailer) / visibility into operations                      Poor Synchronisation of key data                      No market Information sharing                      Lack of proper planning on a daily basis                      Process improvement and redesign disjointed</p>
<p><b>Time Constraint:</b> The response time of the construction supply chain, to the requirement of the construction markets is too long and to the extent that it jeopardises the construction supply chain's ability to meet its current commitment to its customers as well as the ability of winning new business.</p>	<p>Lack of a well-defined procurement system                      Outsourcing and operations inexperience                      Changing requirements of the industry                      Redesigning the supply chain                      Reorganising the distribution network                      Poor collaboration with suppliers</p>



The study findings concurs with Steyn (2015:12) who indicates that most organisations agree on the importance and potential benefits of supply chain management but they struggle when they seek to evolve from theory to implementation.

According to the author, *"Managing cross-organisational processes, as required by the modern supply chain approach, is a serious challenge, particularly as most organisations still struggle with internal process management, Consequently, organisations need to manage their internal processes properly before venturing into the cross-organisational level,"*

He further emphasises that the extended functions of the supply chain stretch the processes at either end, representing a virtual network of partners. Demand and supply collaboration between partners necessitates that the whole supply chain reacts quickly to any changes and capitalises on its ability to fulfil demand optimally.

The findings are not exceptional since current practice of supply chain management, as observed from the participants' reflections, does not consider supply chain as an integrated value-generating course, but rather a series of individual activities. It is therefore not organised. Organisation refers to the phases through which CSM proceeds before it becomes a crucial part of the industry. The categorisation of constraints simplifies the way in which they ought to be understood. However, problem diagnosis within the construction industry is largely disjointed.

### **6.2.5 Organisation management and people skill constraints**

This section presents the key response from the participants regarding how their organisations deal with people skills, supply chain system, supply chain processes, supply chain knowledge management and change management with supply chain and the greater organisation.

As seen from the study objective, one way of identifying the extent to which the TOC could be implemented in the organisation, was to establish how much knowledge there was about construction supply chain management. It is considered important to acknowledge that the vital driver of the construction supply chain remains its employees. Improved management is a prerequisite to further understand the skills and competencies required as well as to increase learning and development at a pace which is consistent with the progress of a specific discipline, within construction, it was evident that this has not happened.

Secondly, it was also important to assess how an organisation's Supply Chain Systems were structured and implemented and whether they were capable of attaining pre-determined

objectives. The goal of such systems is to synchronise tasks and strategies, throughout a company and across businesses structures and to improve the performance of all parties involved. Since supply chain management systems link several different branches of an organisation, each of these systems is different and requires fine tuning to work.

Thirdly, supply chain processes are key components to an organisation's performance. As seen earlier, participants came from very large organisations and so the management of relationships in the network of organisations, from end customers through original suppliers, using key cross-functional business processes to create value for customers and other stakeholders, was always a challenge. Fourthly, supply chain knowledge management may be summed up as the cornerstone of properly managing supply chain systems and therefore, identifying how well participants knew the details of supply chain within their organisations, was important. The literature points to the view that there is evidence of relationships between knowledge and an organisation's performance.

Finally, with the current volatile economic conditions and the ever changing market dynamics, the change management process in supply chain is necessary to reduce costs and increase revenue and profit. Thus, the study sought to assess the responses relating to how well this is done.

Below are the responses arising from the people skill constraints:

- “Buyers have traditionally been regarded or order capturers and or enquiry clerks for low value, non-critical purchases. The majority if not all existing buyers were not subjected to further training and development, which means they do not have the ability to realise how the supply chain discipline has changed. Further, given the lower level at which buyers operate, they are unable to challenge decisions from operations as in most cases it is being made by more senior staff” P 1: docx - 1:11 (23:23)
- “I'm in the same boat as my colleague. I moved up in this company by going through all levels, starting as an administrator and working my way up from there with no formal training except the in-house courses we go through”. P 1: docx - 1:15 - (86:86)
- “Buyers in the organisation are mainly historic and therefore do not have the right qualifications and competencies. I had all the buyers undergo a competency test two years ago and results were shocking. Most of the buyers would fail a basic buying course”. P 2: docx - 2:9 - (13:13)

- “No training and development. Most of the supply chain staff are poorly educated, so do not qualify for higher education unless they are able to secure entrance by virtue of age or experience. Most do not request further training” P 4: docx - 4:20- (131:131)
- “Two distinct groups- historical and new- historical being basic buyers with little or no qualifications and formal training. New being highly qualified and experienced in world class best practices- two distinct groups at war with each other- with the historical group protecting its ‘turf’ by excluding the strategic team from all operational issues and the strategic group trying desperately to entrench its principles on the organisation”. P 4: docx - 4:4 - (17:17)
- “There are no pro-active steps to up skill supply chain people and for as long as I have been in the company, there has been no visible training of existing buyers- most people that handle buying logistics and stores learnt on the job from people that had done the work before. The commodity managers get very frustrated when buyers constantly complain about the time it takes to decide a commodity strategy as they don’t understand the work that we do...”P 4: docx - 4:10 - (39:39)
- “No one in supply chain receives training, but more importantly I don’t believe that the existing operational buyers realise that they require training as they believe they are world class”. P 4: docx - 4:18 - (92:92)
- “The buyers are mostly old traditional buyers that are dictated to by site, estimating and operations. There are pockets of excellence within the company with some of the new more recent appointments”. P 5: docx - 5:3-(13:13)
- “Little or no training and development- the senior guys tend to pay for their own training”. P 5: docx - 5:8 - (44:44)
- “there is focus on training and development in most areas of the company, however, supply chain appears to be ignored”. P 5: docx - 5:12 - (89:89)
- “I have never seen the buyers receive any form of training in the 20 years I have been here”. P 5: docx - 5:15 - (110:110)
- “I believe there are still a lot of buyers in the company that do need more training especially when it comes to negotiating skills and not just phoning around or sending out a RFQ then using the first price that comes back”. P 6: docx - 6:4 - (18:18)
- “Very little attention paid to existing supply chain skills, however, new criteria now in place for new recruits”. P 7: docx - 7:7 - (18:18)
- “We have different levels of skills- all the new people in the past three years were highly qualified. Most of the historical buyers are clerks with no qualifications and whilst they

- may argue that they have 20-30 years of buying experience, I would not hesitate to claim that they are admin clerks who don't understand buying at all". P 4: docx - 4:29 - (92:92)
- "from what I have seen, no one in supply chain receives training, but more importantly I don't believe that the existing operational buyers realise that they require training as they believe they are world class". P 4: docx - 4:30 - (131:131)
  - "No training and development. Most of the supply chain staff are poorly educated, so do not qualify for higher education unless they are able to secure entrance by virtue of age or experience. Most do not request further training". P 4: docx - 4:31 (149:149)
  - "The sourcing guys are trained, qualified and skilled- the buyers are not and the company has not figured this out as yet. In essence, poorly qualified and or incompetent buyers are spending billions in this sector". P 4: Company 4.docx - 4:32 - (167:167)
  - "buyers are not competent in the context of world class buying practices". P 1: docx - 1:24 - (23:23)
  - "The majority if not all existing buyers were not subjected to further training and development, which means they do not have the ability to realise how the supply chain discipline has changed". P 1: docx - 1:25 - (55:55)
  - "I joined the company in 1984 as a site clerk, I worked myself up to an office situation in administration firstly as an accounts clerk. Thereafter I was promoted to accounts supervisor, then to book keeper. About 10 years ago when the merged I had to move on. There was a vacancy in procurement and I have been involved there ever since. In terms of training, I have a purchasing Diploma. I also obtained my Accounting Diploma when I was involved in finance. Perhaps the company could look at giving me additional training in procurement". P 1: docx - 1:26 (86:86)

Some senior respondents who have been in the industry for some time reiterated that buyers in the organisation are mainly historic and therefore do not have the right qualifications and competencies. The experience of all the buyers was gained through undertaking a competency test two years ago. The results of were shared with the researcher and included the following:

- The vast majority of buyers did not make decisions and simply captured orders as instructed by site.
- Buyers did not understand the basic fundamentals of cost.
- They simply accepted price increases from suppliers, sometimes twice a year without understanding how to decompose pricing to determine if price increases were justified.

- Open orders were not maintained and the financial implications of open orders pertaining to accruals was not known.
- Expediting was not done.
- No segregation of duties existed and buyers could create requisitions, create and approve orders and in some cases, they were able to receive goods and approve for payment.
- 400 individuals had authority to create orders, however, the business only had 80 designated buyers across the country.
- Buyers did not know or had not heard of the pareto principle.
- No supplier evaluations or performance management was ever done.
- Buyers did not have KPI's (Key Performance Indicators).
- Profit leverage was no known.
- In fact they were asked around 48 questions and on average only got two right- they were not even buyers in the professional sense.
- Cost reduction was not measured or monitored.
- New suppliers were prevented from entering the supply chain as sites did not allow this, resulting in no competitive quotes being obtained and suppliers becoming arrogant and complacent.

When it gets to skills, the study as quoted earlier shows that buyers have “traditionally been regarded as order capturers and/or enquiry clerks for low value, non-critical purchases. The majority of all the buyers were not subjected to further training and development. This means they do not have the ability to realise how the supply chain discipline has changed. Further, given the lower employee levels at which buyers operate, they are unable to challenge decisions from operations as in most cases it is being made by more senior staff”.

These findings demonstrate the criticality of the constraints within the construction industry in South Africa. It is important to note that the demand for supply chain professionals is ever increasing. While industries look to guarantee stability and watching the bottom line, an upward trend is fuelling demand for supply chain professionals.

The challenge emerging in the construction market is the availability of candidates with the desired skill sets, as shortages are prevalent throughout in all areas. Unfortunately, the employers, however, are not investing in recruiting and training candidates with the appropriate backgrounds. This is generating competition within the market for the same skilled employees. In procurement, indirect spend is highly sought after, as financial services continue to hire and the public sector

places increased emphasis on the supply chain management profession (Gewer, 2009:12). Construction and facilities-based commodity experience is also in high demand, creating a need for strong skills in managing complex contracts for large builds and engagement with third-party construction businesses.

The findings above must be an area of concern, as the present skills and abilities deficiency, are not addressed by most companies. This speaks to a potential limitation on the execution of the key supply chain and construction based issues in general (De Louw, 2009:19). In the event that administration is not keen on learning and development as a key lever, it is important to view the information manager's position as focal in the organisation. Analysis has demonstrated that most directors have small comprehension of how individuals identify with data and relate to supply chain based information. As a result, tendencies to concentrate on useless system arrangements may grow, neglecting to perceive the significance of the better knowledge Management arrangement.

The observations made in this study also seem to agree with Bendix (2009:21) that the construction companies appear to have ignored the development in supply chain, resulting in poor overall knowledge and skills within their organisations. Most major players have only commenced with the process of introducing strategic sourcing into their organisations in the past decade. This has, however, not had the desired impact, mainly due to resistance from within. Their structures have remained one in which operational staff including quantity surveyors, estimators, contracts managers, engineers and site managers have greater influence over procurement activities than do traditional buyers, who remain administrative in nature (Branch, 2010:9; Cosser, 2010:16). Without a management paradigm shift, strategic sourcing will continue to fail. They have, however, not as yet realised the implications of having a visible, functional and stream lined supply chain which controls inbound and outbound logistics as well as inventory and procurement. This implies that the existing systems remain disparate and open to fraud and corruption and or practices which are not adding value to the organisation. Traditional buyer skills remain poor, with higher skilled individuals being side lined and therefore unable to add value.

The continued focus by construction companies on operations, without realising the full impact of a supportive supply chain remains a mystery and overall, the sector requires a culture shift. Current practices remain archaic and non-value adding. In order to effectively understand the short comings of present supply chains, both buyers and line managers need to be able to understand the role of a supply chain within an organisation and must be able to buy into the

concept. Given the historical practices, the inherent culture, the incestuous nature of movements from one company to the next and the inability of new blood from outside of construction to influence or impact thinking, there will never be a view within operation that supply chains can add value or are necessary. Given this backdrop, normal change management strategies will not apply- these are changes which need to be forced onto the organisation from top management in order to succeed. Traditional consultative change management methods have clearly failed in some organisations.

Not surprising the findings relate to talent management and the skills shortage in PwC's latest Annual Global CEO Survey (2014). It indicates that more than two-thirds of CEOs, senior and middle managers in the construction industry expressed extreme concern about their access to key skills. Additionally, 70% show apprehension about increasing workforce costs in high-growth markets and about 62% have not even attempted to make up-skilling the workforce an internal business priority.

Shortage of staff know-how not only affects a company's capability to compete for and complete contracts, but also adds to the growth risk it faces in the management of key tasks whose success is system aligned. Similarly, staff retention should be critical to the sustainability of a company; yet the study shows massive movement of staff across the top ten construction companies.

#### **6.2.6 Supply chains systems constraints**

The seventh theme emerging from the study was labelled 'supply chain systems'. The following were the responses from participants regarding supply chain systems:

- "Our Company has none. They did contract for a world class supply chain system, implemented it partially and then cancelled the contract before realising any of the benefits of the systems". P 1: docx - 1:27 (24:24)
- "I'm sorry to be sarcastic, but they believe that all they need is a system to capture orders and pay suppliers. Vendor maintenance is not a priority, no items master exist- can you believe that we are a construction company, but cannot even determine how much we spend on cement and concrete? Strange way of doing business". P 2: docx - 2:10 (28:28)
- "We use Buildsmart which I am told is a world class system. I saw a report from head office which says it is a project management tool and not for procurement. I just use the system as it is and I don't know who does what to the system". P 3: docx - 3:11 - (52:52)

- “We just use the same systems everywhere. I don’t know how good or bad it is as I am not in IT. We wish that we had something that remotely resembles a supply chain system”. P 4:.docx - 4:33- (18:18)
- “I am not allowed to use the systems- I only have email and can place an order- I can’t look or go anywhere else on the system as I am blocked”. P 3:docx - 3:13 (165:165)
- “We have a buying system and across the company, we have about 8 systems. We tend to pull procurement data into one central reporting system but it is problematic as all we have is supplier spend, not item spend”. P 4: docx - 4:34- (40:40)
- “we pull information from various systems for sourcing purposes, however, there is not standardised system that can be used”. P 4: docx - 4:35- (60:60)
- “Very disjointed, does not support supply chain activities and there is no attention being paid to implement a system which truly and effectively controls and manages supply chain activities”. P 4:docx - 4:36 - (93:93)
- “4 stand-alone systems within this organisation and so no central visibility”. P 4: docx - 4:37 - (132:132)
- “We have a standardised ERP across the group, but spend analysis is still impossible as we tried for 5 years to implement an item master and this was never accepted by the business”. P 5: docx - 5:17 - (14:14)
- “We have a proper ERP system across the group, but it is a not geared towards supply chain excellence”. P 5: docx - 5:18 (45:45)
- “The company has changed some systems, but they still do not address supply chain effectively”. P 5:docx - 5:19 - (111:111)
- “From an estimating side I would probably be happier to be able to have more feedback. Possibly a live tracking system I could have access to as well would be important. I deal a lot in theory and don’t often know if that theory becomes reality or not. We were talking about suppliers and choosing suppliers and if a price is theoretically the cheapest I could be overlooking other factors that could possibly discount a supplier like poor quality materials, poor delivery times, poor workmanship. The kind of information, that if I had a data base I could refer to as well. This is important because it’s no good if I’m constantly pricing the same supplier at the cheapest rate then when it gets to site level they never use that supplier because of factors that I am not aware of”. P 6:.docx - 6:4 (20:20)

Without a sense of how supply chain strategies can positively affect a company’s performance and profitability, the sector will not invest in expensive supply chain systems. Until such time that construction realises that supply chains encompasses more than just the buying function, they



will not migrate to world class best practice. Given that even the buying function does not enjoy a strategic presence within some organisations, procurement systems remain substandard. The need for supply chain systems will therefore present an even greater challenge as reiterated by Vrijhoef *et al.*, (2000:24). Given the comments from some participants regarding the manner in which inventory, logistics and distribution is handled, it is clear that construction appear to view these as disparate functions with no need to create an integrated supply chain. Without an effective item and vendor master, spend segmentation will always present challenges, therefore strategic sourcing becomes impossible and buying will remain an ad-hoc administrative function which is costing the sector billions each year, mainly due to the inability to effectively leverage its spend and/or manage its supply chain.

The study shows that most construction companies have been reluctant to invest in system that would streamline processes to save time and cost. The relationship here has indeed been captured in the section of constraints as one major setback. They lack a world class supply chain system, and if any has been implemented, it was done partially and then cancelled before realising any of the benefits of the systems.

### **6.2.7 Supply chain process constraints**

Systems are vital to the support of processes and it is clear that in the absence of an integrated supply chain system within construction companies, most goods? Policies and processes will collapse. Most organisations mention and agree that with the exception of a procurement policy, no other policies or processes exist. This means that most activities are *ad hoc* and not properly controlled or governed. The available procurement policy is not unilaterally communicated or implemented and there are usually no repercussions for non-compliance to policy. There is an inherent belief that policies are guidelines within the company and are therefore breached. Furthermore, in the absence of proper systems and processes, the availability of decision making data is non-existent. In responding to this, the interview opined that supply chain management processes are not formalised and is erratic in construction. However, the interviewee suggests that supply chain management can be viewed as organised bodies that endeavour to be efficient in their collective undertakings. One respondent notes that “*that the firm perceive a supply chain to be an organised group of suppliers that are committed to providing products and services*”.

A number of participants espoused the view that whilst some policies and processes existed, they were not followed, nor were there repercussions for any transgressions. This is indeed true for my own company where policy serves as ‘guidelines’ and not as the ‘law’ of the company. There is

a train of thought that the lack of repercussions may be symptomatic of a greater problem within the organisation. That management 'cover up' for each other and further that most line managers are not equipped to deal with disciplinary issues. This again highlights the need that successful industries have progressive line managers that are experienced and/or knowledgeable in all aspects of the business, including people management. Construction does not appear to have moved to the well-rounded manager concept and focusses on specific technical skills, which is detrimental to overall company performance.

The industry is known to be maverick in nature, with the concept that management will do whatever it takes to deliver a project on time and within budget. This creates an environment not conducive to operating within structured policies and processes. An environment of this nature will result in a lack of control and effectiveness and governance is lost. Policies and process are necessary in any company and compliance is instrumental in ensuring on-going effectiveness and success. This is, however, an issue for top management to address and to instil discipline into the organisation.

When asked how relationships between project parties affect the supply chain processes, most participants held the opinion that relationships between the client and the entire supply often improve project delivery; relationships between suppliers and the entire supply chain may foster collusions which is on the rise in the industry; and the effect of the relationship between a given project and project consultants on one hand and the entire supply chain on the other hand could improve project delivery. It is, however, notable that the participants were unable to mention the interdependencies that are evident in supply chains, although they suggest that reliable database constitute a tool that is synonymous with supply chain management in the firm. Based on the perceptions of the participants, having a reliable database of professional suppliers is a significant benefit of supply chain management. The participants, however, noted that the benefit can be marginalised by price fixing.

A shoddy Supply Chain process usually leads to increased inventory costs allocated to such projects according to a number of participants. In addition, the participants affirm that they are able to keep track of material delivery and related activities because each site has a dedicated store man who is mandated to check materials upon delivery. Some cited several cases where materials were returned to suppliers because they fail to comply with specifications. The companies often encounter either late delivery of material or the delivery of sub-standard materials. To this end, the construction companies make it a point to check the work of

subcontractors and suppliers thoroughly and quality sheets are always used to evaluate the performance of such subcontractors and suppliers. This must be done as poor quality and late delivery or completion constitute major issues that are related to the work done by subcontractors on some of their project sites. The participants illustrated how the firm ensures that subcontractors and suppliers deliver project related commitments, so that client satisfaction can be assured. In essence, long-term relationships are developed with suppliers and subcontractors that are able to perform to the satisfaction of the companies. Improved products and services as well as preferential rates are some of the benefits of such relationships mentioned by the participants.

### **6.2.8 Supply chain knowledge management**

With regards to Knowledge Management, any organisations that pays no attention to systems and process will likely lack the necessary acumen for skills audit to improve performance. Yet most participants seem to realise that it is becoming increasingly important for organisations across a wide spectrum of industrial sectors, especially for the logically fragmented construction industry. There is also an indication that it is very important for each project participant to effectively capture, share and utilise strategic knowledge and project knowledge, as well as process knowledge within the construction supply chain for better performance.

Confirming the observations made by Harrison and Van Hoek, (2011:12), knowledge and information management drives supply chain performance and its lack will mean that decisions will be operational, reactive and prevent the organisation from achieving a supply chain which is integrated and visible. This allows inefficiencies to enter the organisation and remain invisible from management. The lack of an item master means that spending will remain uncontrolled and the true competitive position of any company cannot be exploited within a competitive supplier environment. Competitive tendering becomes non-existent and spending remains uncontrolled and therefore at risk. Further, inventory control remains a vital component of any supply chain. But, inventory control requires an item master and a warehousing system to track and control. In this disparate structure, movement of goods becomes *ad hoc*, uncontrolled and therefore a high risk area for the sector. Notwithstanding the short term duration of projects, institutionalised knowledge is lost and high value procurement activities can be easily concealed according to Jackson and Low (2013:5). Effective knowledge management, however, requires effective systems which do not exist in some companies.

## 6.2.9 Supply chain change management

In the construction industry, changes are very common and likely to occur at any stage of the project. However, there is a lot of resistance to change, as players hold on to what they know best.

To critically pick out one sentiment that virtually is representative of all through “*this company won't change- every time I try to implement something; I get told that I don't understand the business or 'their' industry. I am still seen as an outsider. If I were to be honest, I think that they are protecting their turf, especially the 'benefits' associated with being the key decision makers. For too long, I have been told that I will never control sub-contractors and that I should not interfere. Implementing anything is like hitting a brick wall- it kicks off, management support it on the surface and a few weeks later everything reverts to the way it used to be even if I dropped the prices of every item my team works on, the business will never acknowledge our input- we are mostly seen as an admin costs on their books and not being able to influence their profits positively.*”

Change management within the sector is clearly a problem area and resistance to change is rife in some organisations. This stems from historical practices and management practices which the sector refuses to change. Again, given the lack of exposure by entrenched and long serving managers to world class management principles and practices, including advancements in supply chain over the past decades, these new practices will remain foreign to most long serving personnel. Therefore any attempt to entrench new thinking and or concepts will face resistance. It is not possible to change what they do not know or do not understand. This is against the participants comments about the need to recruit new supply chain professionals in the sector. Although new graduates enter the sector yearly, they are usually indoctrinated into the existing culture and thinking from the outset, thereby preventing them from learning anything other than what they are taught on site. Those employees that join the sector from other industries or sectors are either frustrated and leave, or face challenges if they wish to change the industry. Traditional change management methodologies have been deliberately set up to fail or resisted until they are dropped. Therefore a more stringent manner to enforce change is required in the sector and in some organisations. However, it also important to note that while change is good, given the magnitude of the constraints observed, if not managed properly through a formalised change management process, it will have considerable impact as it disrupts work and affect its orderly sequence, adversely impacting on productivity and causing schedule delays and cost overruns.

Hence, change management remains ineffective because most of these process are seemingly absent. ,

An observation from this study revealed that long serving or recent buyers that were under-qualified and had a poor grasp of supply chain practices, systems and they further did not grasp the concept of constraints. Once the discussion was terminated, most participants felt a sense of relief, but wanted to talk even further and the researcher allowed this to happen. It was clear that some construction companies had at some point brought in consultants to review processes and practices and recommend changes in the organisation. This created a sense of fear and concern for the participants as they believed they would be fired as the consultants had asked for their CV's and checked their qualifications and experience. When they met with the consultants, they could not answer most of the questions so fear of change became entrenched and the business almost collectively decided not to co-operate with the consultants. In fear of their jobs, the participants followed suit. They did, however, state that if they were informed that they would be trained to work differently they would have happily obliged. However, they did not like the attitude of the consultants and that their companies did not tell them why the consultants had been hired.

Further they informed the researcher that the systems were supposed to change, but the cost of buying a new system was not approved by their management. Even if the constraint was identified, exploiting and or elevating it above everything else would have been impossible, due to financial constraints. This would indicate that the company was possibly aware of challenges that it faced, but that it cut short its own initiatives without any resolution. This concurs with the views of Jurgens (2010).

## **6.3 OTHER SUB THEMES FROM THE STUDY**

### **6.3.1 Procurement practices and capacity**

The responses of the participants seem to suggest that there are serious constraints within the organisation what organisation are you referring to? With regards proper streamlining of procurement practices. The lack of proper processes creates risk and could lead to opportunities for fraud and corruption. The convoluted nature of construction supply chains, the lack of an integrated system, aggravated by lack of governance policies and processes all combine to suggest that the sector has not established control over its supply chains and is therefore at a high risk.

Given the extent of current constraints, capacity within construction supply chains is at a fairly low level when compared to other industries and will require a huge paradigm shift in both management support, systems, skills and processes to begin the long journey towards best practice. From a supply chain perspective it was clear that they did not have a structured supply chain, but mainly focussed on its buying activities. However, it was further confirmed that buying was reactive, administrative and that most decisions were made operationally. This was further corroborated by respondent one.

### **6.3.2 Construction supply chain management structure**

The construction industry has been described as multifaceted in nature, alluding to the demography of the business and the organisation of construction, including the design and coordination of development supply chains. The participants commented that conditions in the South African construction industry remain difficult and less prosperous. Although several companies have reported improved margins, it is mainly as a result of forced restructuring in order to improve internal efficiencies. Understanding the prospects for the industry is extremely difficult, as many of the indicators show that there are many challenges. Responses show that it is associated with the high cost of materials, fraudulent practices and kickbacks and fluctuations in material prices that elevate the costs of construction.

According to the findings, most of the constraints within the industry seem to affect all departments and project processes and is very much dependent on both group as well as individual efforts. This results in complications emanating upstream in the supply chain which increase as they cascade downstream if not addressed quickly.

### **6.3.3 Supply chain integration**

The findings also seem to concur with the literature that the construction industry is different from manufacturing since most contractors are not producers of assimilated end products. Most products are also sub-standard and construction processes are regularly not repetitive and often result in high levels of waste (Vrijhoef & Ridder, 2007:5). Vrijhoef and Ridder (2007:6) further propose that low levels of coordination and monotony in development lead to various challenges and underperformance of the construction supply chain. A method for resolving this is to apply ideas that expand coordination and redundancy inside and between task supply chains. This study does point to the requirement for better arrangements and more organised methods for working in the construction supply chain. Enhancing the supply network by supply chain integration can

help organisations to respond to market conditions and reduce cost levels. All organisations in supply chain ought to be linked, working in unison. While it is basically difficult to completely coordinate a whole network due to the temporary nature of construction, a genuine exertion ought to be made to invoke better results from the construction process.

It is essential to note that the supply chain integration can be made operational. Supply chain management is regularly seen from two points of view, which are the strategic perspective and the operational perspective (Ferne & Thorpe, 2007: 323). The operational perspective is concerned with an efficient focus on the developments occurring inside a supply chain. The operational perspective draws upon the utilisation of connections and social structures as needed in accomplishing and encouraging the goal of proficiency gains in transactions (Ferne & Thorpe, 2007: 323). On the other hand, the operational efficiency might fall apart if not supported with incisive organisational approach to develop collaborative relationships in the marketplace to support, sustain and consolidate the firm's position in the industry.

### **6.3.3 Relationships and coordination in supply chains**

The study findings seem to agree that the construction management system and process is essentially project-based and in most cases such a project can be regarded as a transitory multi-firm. It is also in conformity with the findings that the application of supply chain management to construction has been related primarily to the construction industry as a whole, or to its companies' supply chains. The nature of supply chains within construction has very rarely been the focus of attention and when this happens they are in general analysed from the point of view of the client or the most powerful company in the supply chain. But because of the temporary nature of construction projects and the existence of project-specific transactions, its supply chain differs from the company supply chain in that it arises, develops and finally dissolves. Furthermore, due to the concentration of the effort and the division of the general process between supply chain members, it is not conceivable to assume that a single firm or subsidiary would have the power or the capacity to independently coordinate and harmonise the whole supply chain. Every member can influence-and be influenced by- the whole supply chain as was suggested by Isatto and Formoso (2006:294).

Grounded on this key observation, a construction supply chain can be considered as a precise kind of human structure made of several firms that are interrelated through economic linkages and conceived with the aim of delivering a construction project.

According to the above-mentioned, the firm is an essential block that shapes a project supply chain, stressing that the organisational properties are the main factors to be taken into consideration for describing and understanding inter-firm coordination (Isatto & Formoso, 2006: 294).

As observed in the literature, construction supply chain management considers the flow of value as one of the most important along with the flow of products, the flow of information and the flow of money. While findings suggest that the absence of proper system would usher in flow challenges, coordination and relationship would counter it as the flow of value in particular would consider the process dimension which is the key aim of the supply chain (to create value). It encompasses the flow of objects of the work: products or, in managerial processes, the share of the information flow that carries value and the social dimension. According to Barratt (2010:33), the main tenacity of the supply chain particularly in the construction sector is to coordinate actions of people and organisations which includes essentially the flow of the information that is intended to coordinate the work among people or to create a common context among people for mutual understanding and provide the economic stimulus for the firms to take part in the exchanges that are essential for conveying value to the client.

Considering the temporary nature of construction related projects, there was a call in the findings that material flows must be simultaneously coordinated to anticipate the breakdown of the supply chain. This prevents the lack of proper cooperation or poor coordination or even due to loss of competitiveness of the supply chain. One senior manager who was among the few to presumably have commanding knowledge of supply chain management raised a debate on coordination and that it would take into account managers to occasionally ask themselves or others the following questions; (i) How to organise the work among supply chain members? (ii) How to achieve and maintain cooperation among these firms? (iii) How to coordinate process execution among people from different companies that are autonomous. Subsequently, three questions might guide this choice of how relationships between supply chain partners and coordination need to be handled (Vrijhoef *et al.*, 2000:33).

#### **6.3.4 Supply chain collaborations**

Some responses from the study tend to agree that the South African Construction industry is highly competitive and often there is a reluctance to collaborate and share information with their peers. In fact, many were cautious of the responses they shared towards some questions as they feared victimisation. They also saw the researcher as a rival, who may syphon information and



work against them, rather than a student. As mentioned in chapter two of this report, the construction sector needs to pay attention to how they accredit their supply chain as there is little or no commercial advantage to be gained through enforcing mandatory compliance and regulatory information.

One specific issues mentioned by the participants was that working collaboratively to pre-qualify existing supply chains may potentially reduce the aggregate time necessary to assess the capabilities of suppliers and sub-contractors. In doing so the procurement community will be able to focus most of their efforts on the formal tendering process and procuring the best value. Notably within South Africa, as the construction industry gains significant growth, there should ideally be more time available to spend on advanced supply chain management, developing long-term relationships, sharing risk and opportunity and unlocking innovation to provide the best solutions for clients and stakeholders.

### **6.3.5 Supply chain leadership management**

The study showed that there is evidence of very poor leadership from top to bottom regarding management of supply chains. In this aspect, the CIDB (2014:9) report emphasises that the construction industry would benefit greatly by creating a leadership environment that has the potential to minimise management pitfalls and risk at the same time. It decreases the number of decision makers. It reduces overhead and creates a very efficient system. Further, it allows the party with the risk (the contractor) to make the decision. Findings suggest that with lessened decision making and control, it is easy to identify who is responsible, the level of risk, the decision maker, etcetera. These are characteristics of an information environment.

One manager made interesting remarks that if leadership within the supply chain was good, everyone would know who is responsible and become accountable.

*‘Everyone would know who can do the job and who cannot and seek alternatives and when someone fails, everyone knows and solutions would be sought. No one makes decisions for anyone else because decision making brings risk and intrigue in big organisations. Finally, everyone would be motivated to self-assess their performance, to continually improve and add value to such organisation.’*

Furthermore, participants observe that top management of firms involved in a project rarely commit themselves to mutual objectives. Thus, mutual objectives are not always achieved at

project completion and profit sharing tends to be unfair. While long-term relationships have been promoted with its advantages, the interviewee opined that supply chains are not always focus on such relationships. Information sharing within the chain is not also open or free. It was observed that that problems are not constantly resolved at their level of occurrence and open book costing is not used by project parties. The participants noted that ‘reinventing’ the wheel of past mistakes is not avoided and lessons learnt are not implemented. Performance measures on projects are not consistent, while performance reviews are not conducted, either formally or informally.

It is also clear from the findings that the implementation of management based solutions has not had a justifiable positive impact on the construction industry and may not be an efficient solution when dealing with supply chains. Mabin *et al.* (2010:169) indicated that management based thinking may even be repelling the transformation into a performance based environment. The research also conjectures that leadership based solutions may be more successful. Leadership based solutions also include information based solutions where decision making, management and external control are lessened but supervision, independence and support increases.

#### **6.3.6 Logistic management**

The findings also shows that Logistics knowledge and management are generally poor within the construction industry. Competition and consequently customer orientation and cost consciousness has for a long time been weak. This partly explains the lack of developed applied logistical concepts amidst the poor systems and process. The companies in the construction industry are unaccustomed to flow models or supply chain models.

The absence of logisticians within the supply chains reduces the possibilities to handle logistical problems. By normally not seeing the possibilities to pro-actively manage material flows, flow-related problems are frequent, yet often not considered to be problems; it is a part of the normal production conditions on site. So far, flow-oriented companies do not seem to exist in the construction industry yet and flow approaches are rare both among practitioners and researchers. Lambert *et al.* (2013) agree that proactive logistics can improve effectiveness and efficiency and thus reduce costs and this insight has caused a clear trend in the stationary industry towards pro-active approaches as supply chain management. A responding movement in the construction industry is not yet seen.

In relation to this, material flow in the construction site consists of many different entities that are not coordinated. The consumer is only interested in total efficiency and overall effectiveness. So

if an attempt is to be made to reduce the total costs in a construction project, a holistic approach is needed. If the material flows are not considered in a holistic view, uncontrolled flows threaten to disturb and destroy the conditions for controlling the other flows. Some of the companies are trying to reduce costs often in pilot projects. But all companies are making efforts all the time.

Mabin *et al.* (2006:169) stress that the possibilities for supply chain management is necessary, and confirm that it is clear that the industry suffers from numerous problems. These problems could to a certain extent be traced to inefficient material flow control. Yet very little effort is put into developing logistical skills. Interestingly for most companies, systematic efforts to reduce costs show results and this is clearly seen in the case study. Many of the efforts in the study are of a logistic nature and the efforts to manage the supply chain could not really be described as purely supply chain management. However, the approach used could be developed to a deliberate supply chain management approach. The supply chain management concept is hence possible to apply in the construction industry. According to Mabin *et al.*, (2010:169) the use of supply chain management is a necessity in order to be able to offer products that the vast majority of the market can afford to demand.

One respondent remarked that *“if we would have seen more of these efforts in the rest of the construction industry costs could be generally reduced”*. This offers both the possibilities for customers to reduce their costs and the companies in the construction industry to increase their revenues. By using logistical approaches such as supply chain management costs can be reduced. Additionally, the general conditions for the construction industry can also be changed for the better by structural changes in material flows.

## **6.4 CONCLUSION**

There is apparent ambivalence towards the use and / or adoption of supply chain management within the construction industry in South Africa. There is widespread use of horizontal integration for project execution, as well as the numerous constraints. With expected extensive use of subcontractors and suppliers in South Africa not slowing down in the near future, the management of CSC is deemed to be vital to performance progress and profitability in the sector. The research strategy adopted the exploratory and qualitative approach and therefore provides a vivid example of construction management in practice in South Africa in that the firm makes use of suppliers and subcontractors to fulfil most of its functions on site.

It was observed that management strategies that are synonymous with supply chain management are not yet fully assimilated in the construction firms. This is because only the possibility of a long-term relationship and the availability of a database constitute the main supply chain management approaches that are presently used by companies in the construction industry. The perception of supply chain management in the sector is also not sophisticated enough to become a means of driving performance improvement in the firm. Nevertheless, the description and level of understanding of supply chain management that were visible when interviewing the informants support the notion that there is a major need to adopt a proactive instead of a reactive approach to how subcontractors and suppliers are managed by construction firms in South Africa.

# **CHAPTER 7**

## **SUMMARY, CONCLUSION AND RECOMMENDATIONS**

### **7.1 INTRODUCTION**

This chapter provides appropriate recommendations to address the constraints in the construction supply chains. These conclusions are split into two themes; one linked to the constraints in particular and the second linked to the issues of supply chain management within the construction industry in South Africa. The classification of these conclusions into theoretic and empirical design is also presented in this chapter. Overall, it provides a summary of the interpretation of the findings, depicts and explains the supply chain constraints in the construction sector as well as the TOC in the management of these constraints and concludes by flagging areas that may require additional research. Recommendations on supply chain management within the construction industry as well as the TOC philosophy combined with a scientific orientation on construction constraints are discussed in this chapter. It further articulates the limitations, contribution to knowledge as well as brief insights into future possible research.

### **7.2 REVIEW THE STUDY**

This thesis is presented in seven chapters. Chapter one set the foundation for the study, outlined the background of the research and the research problem. The theoretical and empirical objectives plus the research question are also addressed. The chapter also attempted to define common terminologies used in the construction supply chain industry. Chapter two provided an overview of the construction industry in South Africa and looked into the nature and development of the industry as well as the challenges and opportunities facing the industry. Chapter three focused on supply chains and supply chain management and particularly looked into construction supply chain and demonstrate how the two relate to each other. Chapter four discussed the systems theory and the TOC and further explained the relevance of these two theories for the study. Chapter five outlined the research design, sampling methodology, data collection and data analysis procedures employed in this study. Chapter six provided scientifically analysed data and presented the research findings. Chapter seven presents the major conclusions and recommendations

### **7.3 CONCLUSIONS BASED ON THEORETICAL OBJECTIVES**

In order to achieve the primary objective, the following theoretical objectives were set for the study:

- to conduct a literature review on the construction industry;
- to conduct a literature review on supply chain management;
- to conduct a literature review on the TOC; and
- to conduct a literature review on constraints facing supply chain management in the construction industry.

Therefore, the following conclusion are clustered according to the above four thematic objectives as revealed from the literature and theoretical excursion.

#### **7.3.1 Conclusions based on the literature review on the construction industry**

Contrasted with numerous different industries, the construction industry assumes an indispensable role in South Africa's economy and is a noteworthy benefactor to economic development. Many scholars view the construction industry as that basic area of the economy that delivers buildings and structural designed structures and decides the degree to which investment efforts in an asset rich nation are translated into investment outcomes. The construction industry is not a solitary industry but constitutes a complex cluster of industries, including banking, materials and equipment manufacturers, contracting organisations et cetera.

The literature also shows that the construction industry assumes a critical part in the economic development of any country (Kujawa & Prinsloo, 2004:19). Development makes a huge commitment to the national economy, it creates job (particularly for the least talented persons from society), it assumes a part in the development and exchange of innovation, it creates numerous opportunities for enterprises and it contributes to improving the quality of life of the users of its products.

In several cases, literature demonstrates that several difficulties have been notable that impact the execution, improvement and development of the South African construction industry (Van Wyk, 2003:9; CIDB, 2004:16; Modares & Sepehri, 2009:25). In spite of the fact that some of the difficulties recognised have existed for quite a while, there is little proof to propose that the issues brought up in the past are no more present, because of the lack of pertinent and reliable data on

the subject. The literature likewise recommends an assortment of unexamined and unique interventions with regards to the nature of these problems.

The literature examined those aspects believed to impact the execution, improvement and development of the South African construction industry. To achieve this objective, the different problems influencing the South African construction industry are recognised. The outcomes of a study of the view of construction industry partners are then exposed. The ramifications for the future development and growth of the South African construction industry are also examined.

### **7.3.2 Conclusions based on the literature review on supply chain management**

Supply chain management has been widely researched in numerous application domains during the last decade. Despite the popularity of supply chain management research and applications, there remains considerable confusion as to its meaning. There are several attempts made by researchers and practitioners to appropriately define supply chain management. Amidst fierce competition in all industries, supply chain management has gradually been embraced as a proven managerial approach to achieving sustainable profits and growth. This is accomplished primarily by focusing on the whole supply chain management process to deliver the right products or services, in the right quantity, to the right place, at the right time and with the maximum benefits

Supply chain management is identified as a dynamic discipline because many contemporary authors writing on the subject of supply chain management refer to this trend as a “new” or “relatively new” concept in management theory. Hence a brief overview of the developments that have occurred in management since 1960 was included in this chapter. Future trends in supply chain were also addressed. Due to the intense competition, both locally and internationally, relationships in the supply chain have evolved/are evolving from adversarial to collaborative/alliance relationships.

Well executed supply chain management efficiently integrates suppliers, manufacturers, warehouses and other intermediate value-adding partners so that production and distribution are synchronised with customer demands thus reducing overall costs and satisfying service level requirements. When one activity fails or is badly performed, supply along the supply chain is interrupted and this affects the effectiveness of the whole supply chain at risk.

There is also no doubt that supply chain management can play major roles in construction and some principle roles are covered by the generic supply chain management methodology and

approaches in the literature. The supply chain management offers general guidelines that can be used to analyse, re-engineer, coordinate and constantly improve virtually the complete construction supply chain, resolving basic problems and the myopic control that has been plaguing the supply chain. This would not be possible to realise in the short term. Therefore, initially, the supply chain management methodology is deployed on a lower scale, addressing partial supply chain problems, involving a limited number of supply chain actors. Due to its complex character, the supply chain management methodology implies a continuous improvement process of which the scope can be enlarged over time by involving an increasing number of areas of application.

Some areas of application, which may be and to a certain extent have been subjected to supply chain management, include the reduction of costs (especially logistical costs), lead-time and inventory in the supply chain. In view of the large share of these costs in construction, this focus is often fully appropriate. Secondly, the focus may be on the impact of the supply chain on site activities. Here, the goal is to reduce site costs and duration. In this case, the primary consideration is to ensure material (and labour) flows to the site to avoid disturbances in the workflow. Thirdly, the focus may be on transferring activities from the site to upstream stages of the supply chain. The rationale may simply be to avoid the inferior conditions of site, or to achieve wider concurrency between activities, which is not possible in site construction with its many technical dependencies. Here, the goal is again to reduce the total costs and duration of the project. Although in practice, these areas are intimately interrelated, it is often difficult to improve the dependability of the deliveries of a supply chain without addressing the total supply chain. If activities are transferred from a site upstream the supply chain, it is a requisite that the resultant, more complex supply chain is orderly managed and improved in order to have the intended benefits.

In view of these roles gaps in prior initiatives to advance the supply chain can be identified. For instance, the logistics initiatives, stressing (average) costs, have often failed to address the impact of supply chain variability on site. In addition, industrialised construction, with its long and complex supply chain, has often been lacking even basic principles of supply chain management.

The generic body of knowledge accrued in the framework of supply chain management leads to improved understanding of the characteristics of construction supply chain problems and gives direction for action. However, the practical roles for supply chain management have to be



developed in construction practice itself, taking into account the characteristics of construction and the specific situation.

### **7.3.3 Conclusions based on the literature review on the Theory of Constraints**

The (TOC) has been widely known as a management philosophy coined by Goldratt (1990) that aims to initiate and implement breakthrough improvement through focusing on a constraint that prevents a system from achieving a higher level of performance. The TOC paradigm essentially states that every firm must have at least one constraint. The fundamental goal of most business entities is to make money now and in the future. Other stakeholders may develop necessary conditions that must be met to allow the system to continue operating. The TOC thus encourages managers to identify what is preventing them from moving towards their goals - as well as necessary conditions - and find solutions to overcome this limitation.

Conclusions are also drawn that TOC comprises a set of three separate but interrelated areas, namely, logistics, performance measurement and logical thinking. The TOC applications to logistics include the drum-buffer-rope scheduling method, buffer management and the VAT analysis. Measurements are required to determine whether or not the system is accomplishing its goal of making money. Performance measurement includes operating measures (i.e., throughput, inventory, operating expenses) and local performance measures (i.e., throughput-dollar-days and inventory-dollar-days). Logical thinking comprises the five-step- focusing process and the thinking processes.

Over the last decades the development of the TOC and accounts of its application have burgeoned with the publication of a considerable number of articles, proceedings and books based on the TOC approach, its reviews and application in the manufacturing firms, in different types of service organisations and beyond business firms, it has been used as the TOC thinking processes to identify core problems in public policies.

Literature on TOC supply chain solutions deals mainly with managing the supply chain from a single enterprise perspective, for instance, described how a manufacturing firm applied the TOC approach to direct the implementation of enterprise resource planning (ERP). Literature also recognises that the TOC approach can be used to guide a single firm to concentrate on exploiting resources based on different logistics cost along the supply chain (Jackson & Low, 1993; Cox & Spencer, 1998; Umble *et al.*, 2001).

The assessment of assorted literature follows up the previous research through clarifying how participating members from respective companies can benefit from applying the TOC to construction supply chain and devising strategies to improve the supply chain performance as a whole.

#### **7.3.4 Conclusions based on the literature review on constraints facing supply chain management in the construction industry**

The issues exposed by literature include the volatility of market demand and increased complexity as notable causes for fragmentation of the construction industry where subcontracting and the rental of expensive equipment has been a way of risk mitigation for construction companies. To understand constraints specific to the construction industry, a distinction between construction and manufacturing was drawn that the construction industry is project-based and of discontinuous nature, while manufacturing industries involve continuous processes and relationships. While the majority of contributions involving supply chain relationships in management and marketing literature deal with continuous exchanges in long-term buyer-supplier relationships (Claycomb & Frankwick, 2010), there is a lack of research on discontinuous exchanges in project-based industries, such as the construction industry.

Management of supply chain relationships is, however, especially problematic in project based environments due to: the discontinuity of demand for projects, the uniqueness of each project in technical, financial and socio-political terms and the complexity of each project in terms of the number of actors involved (Skaates *et al.*, 2002). In addition, the recent development of modular building systems opens new research opportunities in the application of supply chain modularity in construction (Voordijk *et al.*, 2006). This special issue therefore serves as a source of scientifically generated knowledge regarding various problems and opportunities associated with supply chain management in the project-based construction industry

A survey of the industry observed that problems with the implementation of successful supply chain management and collaboration in construction are associated with an inappropriate traditional root culture and the unique features of its organisational structure. The literature survey cited, lack of senior management commitment, lack of appropriate support structures and widespread ignorance of the supply chain philosophy, as key issues which are preventing the industry from rivalling the success seen when adopting supply chain management in other industries. These were made based on responses to a specific request to the survey participants to comment on supply chain management within the industry. Although the findings were used in

the context of the client - contractor relationship, they were, directly correlated to the nature of the tendering process and the focus on competitive bidding. The literature concludes that the fundamental objective of supply chain management is to create value for the whole supply chain and not for individual organisations. This message is not understood by the industry as yet. It is observed that the continuing reluctance or unwillingness to change the management mind-set from singular, that is to say managing individual supply chain functions, to a more integrated function with integrated activities, will continue to hamper progress within the sector.

There are further barriers presented throughout literature. These include the relationship and the many influences from other disciplines or the interdependence of supply chain management to other disciplines such as: organisational theory (governance), economics (Supply-demand), sociology (Confrontational vs trust) and management (culture, routines, history) etcetera. These influences and interdependence make it almost impossible to see how supply chain management within the construction sector can be successfully implemented. The view taken here is that, without achieving full alignment of the complex issues presented by these disciplines across the supply chain, especially when considering construction and the sheer volume of participants, a truly integrated functional supply chain cannot exist (Tennant, 2012:9).

Following research into the topic has presented a number of crucial attributes which could lead to the success of interdependence within the construction supply chain. These are trust (sociology), decision making (management), information sharing (governance) and goal congruence (economics). These views serve to support further discussion on supply chain configuration, introducing considerations related to issues such as communication, coordination, collaboration and cooperation (Lejeune & Yakova, 2005:12).

#### **7.4 CONCLUSIONS BASED ON EMPIRICAL OBJECTIVES**

From the onset, the following empirical objectives were set for the study:

- To identify supply chain constraints in the construction industry in South Africa
- To establish the factors influencing supply chain constraints in the construction industry in South Africa
- To suggest approaches for mitigating the supply chain constraints facing the construction industry in South Africa
- To develop a model for minimising the supply chain constraints in the construction industry.

The following discussion is therefore relating to the findings from the above empirical objectives set at the beginning of the study. In the study, the following supply chain constraints were identified:

#### **7.4.1 Conclusions on identifying supply chain constraints in the construction industry in South Africa**

Responses from the major role players in the construction sector affirm the importance and the role of supply chain management. A number of participants agrees that supply chain management is vital for construction project success. This conclusion is based on experiences gathered on construction projects executed over many years. The findings also show that some organisations have been involved in one form of collaborative working or the other. This form of working gave credence to their perceptions concerning supply chain management especially where unfair competition and colluding practices are presumed to be common.

Though, they agree that adversarial relationships are present in the industry, their opinion is that it is not pervasive, which would be a notable departure from the norm in the last two decades whereby traditional forms of contracting was the only one used in the industry. However, short term objectives and a price oriented approach persist in the industry. It is a problem that is uppermost in the mind of the participants and it seems to have dominance in all sub-sectors of the industry and therefore confirmation on why long-term systems and strategies to deal with bottlenecks within supply chain have been haphazard. Furthermore, the temporary nature of construction projects seem to have hampered systems integration within the sector as companies choose the shortest and safest routes which often yield conflicting results.

From all the companies from which the participants came, there is inference to the level of supply chain management irregularities for both product and contract outsourcing. This has rendered possible long term relationships difficult and necessitates short term view of project objectives. The traditionally treasured relationships between suppliers, for example, is very common in all companies regardless of the consequences involved. External and internal relationship problems in the construction process are equally on a high scale of fragmentation. Rigorous discussion with participants indicates that the construction supply chain is fragmented. There also is strict and inflexible adherence to contents of construction contract data as well as poor use of modularisation in order to reduce construction time.

In addition, management issues from individual managerial competencies to large scale cooperate senior level inadequacies exist. The issues raised in the above paragraph would usher in the impact of poor risk management competencies that seem to have had a massive impact on the revenue of many organisations (CIBD, 2014). This is together with the fact that contractual and competency suspicions in the supply chain play a marginal role among the relationship problems in construction. Inefficient and ineffective problem solving mechanisms, especially between contractors and subcontractors was also highlighted as a problem. However, the most pressing issue to deal with immediately seems to be the reduction of the prevalence of short term objectives and price oriented approaches used by supply chain members.

In the modern cooperate sector, knowledge has been said to be synonymous with power. A number of participants do not seem to have thorough knowledge of the industry in which they work and the tasks that they are employed to do. This explains why there were many issues related to people skills as well as the lack of knowledge management, sharing and transfer, make it impossible in a collaborative working environment in the South African construction industry to achieve sustainable reduction in cost and time. Knowledge management, sharing and transfer can bring about collaboration that can simplify the construction process by removing bottlenecks occasioned by individual perceptions and attitude. In addition to this, the quality of service between suppliers, subcontractors and contractors can be enhanced as well as the quality of service delivered to clients and other project stakeholders. Closer relationships have the potential to break down barriers such as organisational and individual cultures.

Given the labour intensive nature of some major construction projects whereby a personnel head count can reach a thousand at any given time, collaboration can support the flow of materials and information. Further, a consistent workload is beneficiary to long term relationships. A subcontractor that is sure of consistent work with a major contractor for a long time may align its project goals with that of its clients. This is particularly true for subcontractors dealing with formwork or earth works because their services will always be sought at the inception of new construction projects. Long term and stable relationships can, therefore, persuade subcontractors to focus on value rather than profit. Contractors can also adopt collaborative procurement methods to promote innovation and creativity on construction projects.

The procurement method may facilitate the negotiation of common project goals and objectives in an agreeable manner. Collaboration can also mitigate avoidable communication problems as well as logistics related issues. The construction industry does not lack partners with appropriate

collaborative skills, but the will and mechanism to engender a collaborative working environment is required. Contemporary management tools have sought the improvement of processes in organisations.

Similarly, supply chain management can engender a culture of continuous improvement in construction. Early involvement of supply chain partners is a key to achieve continuous improvement. Stated target objectives are formulated by the supply team with inputs from everyone. Strong leadership in coordinating interfaces and open exchange of data and information is a driver of successful supply chain management. The overall project cost can be impacted positively through collaboration based supply chain management.

#### 7.4.2 Conclusions on establishing the factors influencing supply chain constraints in the construction industry in South Africa

In summary, the following common constraints arising from the response can be segmented into two as follows:

**Table 7.1: Distribution of constraint**

People related constraint	System related constraints
<ul style="list-style-type: none"> <li>• Poor leadership in key areas of systems</li> <li>• Deficient internal and external communication and information transfer.</li> <li>• Lack of coordination, collaboration and commitment between suppliers and clients within the supply chain.</li> <li>• Poor training of contractor’s suppliers, subcontractors and workers.</li> <li>• Lack of effective methods for measuring the performance of the different parties within the supply chain</li> <li>• Lack of guidance for creating alliances with supply chain partners</li> <li>• Failure to develop measures for monitoring alliances</li> <li>• Lack of trust inside and outside a company</li> <li>• Organisational resistance to the concept</li> </ul>	<ul style="list-style-type: none"> <li>• Design problems (many changes and inconsistent information).</li> <li>• Inadequate management within the supply chain, mainly poor planning and control.</li> <li>• Inability to broaden the supply chain vision beyond the procurement or product distribution to encompass larger business processes</li> <li>• Inability to integrate the company’s internal procedures</li> <li>• Lack of integrated information systems and electronic commerce linking firms</li> <li>• Lack of suitable organisational setup</li> </ul> <p><i>NB. Depending on the organisation, some of these constraints may appear across the two categories</i></p>

### **7.4.3 Conclusions on approaches for mitigating the supply chain constraints facing the construction industry in South Africa**

Several attempts have been made to study factors influencing the performance of supply chains. These studies are generally quantitative and involve rigorous statistical analyses. But in general, one would agree that a supply chain has a key leverage point, the point where the potential output of the system is defined. And if, on the other hand, the system's leverage point (or points) are the critical factors in determining the rate of a system's return, then to maximise returns, strategy implementation must be focused around maximising the system's leverage points and their interactions with each other.

Therefore, from the conclusions above, the study generates recommendations that are clustered into thematic areas; one, recommendations linked to the supply chain constraints in the construction industry in South Africa as well as the factors influencing supply chain constraints in the construction industry in South Africa and two; recommendations through a proposed model for minimising the supply chain constraints in the construction industry

#### ***7.4.3.1 Recommendations linked to the constraint in the construction industry.***

As seen from chapter four of this study, TOC is a philosophy that implemented significant improvement in management through focusing on a constraint that prevents a system from achieving a higher level of performance. The Theory of constraints is a concept that emphasises the role of constraints in limiting the performance of an organisation (Goldratt, 2000:12). A constraint is as any element or factor that limits the system from doing more of what it was designed to accomplish (i.e., achieving its goal). A constraint can be capacity, market, or time constraint.

Constraints interrelate to decrease throughput. Moreover, the key to the TOC is to assume that any system can be presented in the form of a chain of events, or a network of chains. This study is meant to present a system approach which has been referred to earlier as the Thinking Process (TP) in order to identify constraints and critical success factors in supply construction chain management and to understand causal relationships between these factors.

Due to the project based nature of the construction industry the TOC knowledge would appeal to the industry through is popular management areas of Project Management – CCPM – Critical Chain Project Management; distribution and supply chain management (supply chain integration,

inventory management, distribution, reverse logistics, just in time deliveries, storage and end user distribution, pick and pack, track and trace); finance and measurements (Throughput Accounting); sales management; marketing (developing market offers), managing people; strategy and tactics (developing a company).

In literature one can find simple examples that explain the idea of thinking process in the TOC (Mabin & Balderstone 2003). Consider a situation where five ships enter the port at the same time. Each ship requires 5 person-days to unload the delivery. Each owner wants his ship unloaded as soon as possible. The port has five people to unload the ships. The simplest decision is to assign one worker to each ship and each ship can be unloaded on the end of the fifth day. But using TOC thinking process means putting all five resources on first ship the first day, all five resources on second ship the second day, third ship the third day etc.

Thinking process in the Theory of Constraints provides a set of holistic processes and rules, all based on a systems approach that exploits the inherent simplicity within complex systems through focusing on the few “leverage points” as a way to synchronise the parts to achieve ongoing improvement in the performance of the system as a whole. The philosophy of TOC is based on three simple assumptions, which the construction supply chain can bear in mind as mentioned by Goldratt (2000:12):

- i) Everything within a supply chain management system is connected by cause and effect relationships. Identification of the causes leads us to converge onto an apparent core problem/contradiction/conflict.
- ii) All contradictions within the supply chain management system can be resolved without compromise – the level of understanding and assumptions hold the contradiction in place. A compromise is not usually a win-win solution.
- iii) There is no resistance to improvement – people do not embrace change because we have not brought them to see the win for them.

The working principle of TOC provides a focus to ensure effective ongoing improvements of SC. The principle consists of five focusing steps as was discussed in detail in chapter four of this report.

In general terms dealing with supply chain management constraints during the implementation of the five steps, requires making three decisions:



- i) Decide what to change – identify the weakest link.
- ii) Decide what to change to – design a stronger link.
- iii) Decide how to bring about the change – operationalise this stronger link into the chain.

For each of these questions TOC thinking processes offer different tools that help to focus and reach the goal (Table 7.2).

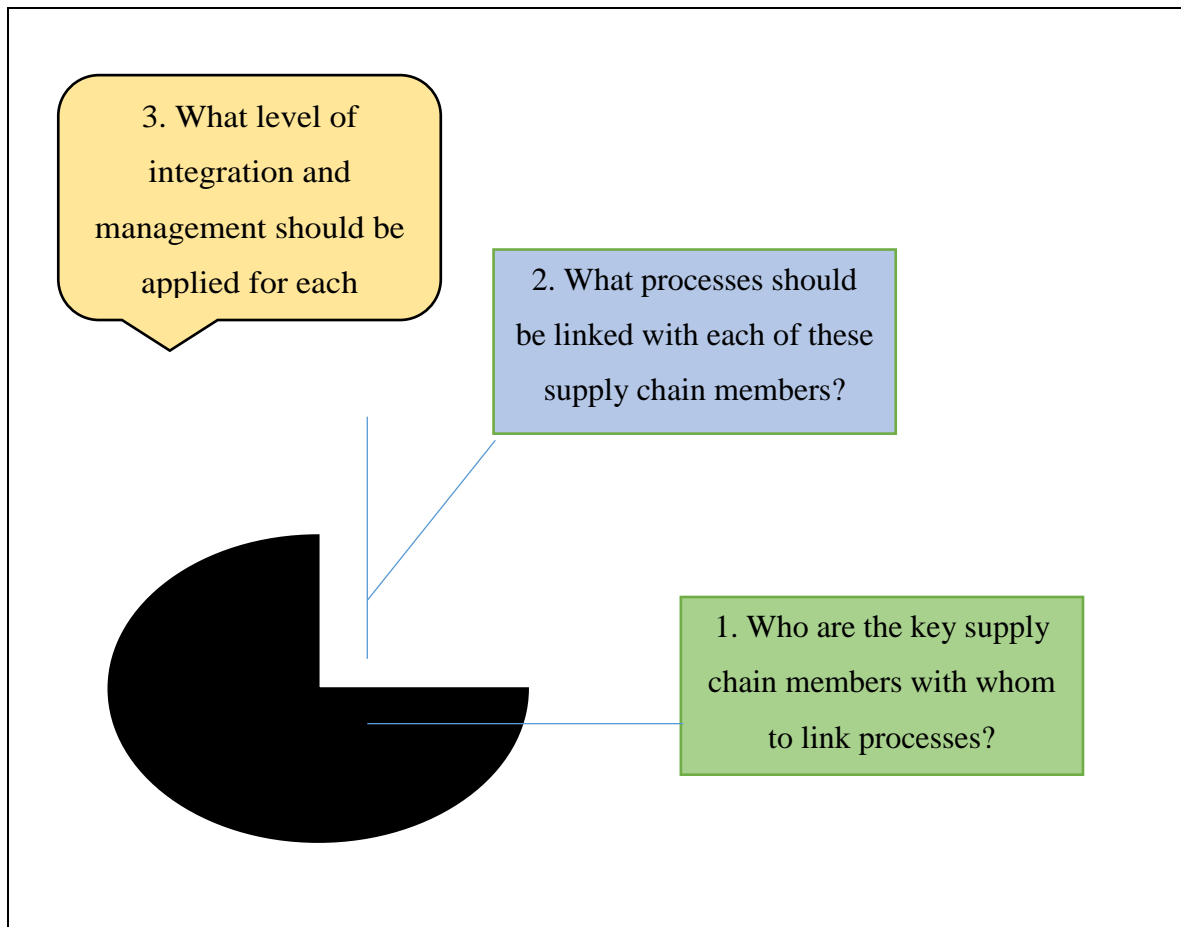
**Table 7.2: Thinking process’ tools and their roles**

<b>Generic questions</b>	<b>Purpose</b>	<b>TP tools</b>
What to change?	Identify core problems	Current reality tree
What to change to?	Develop simple, practical solutions	Evaporative cloud Future reality tree
How to cause the change?	Implement solutions	Prerequisite tree  Transition tree

Source: Goldratt (2000:12)

The TOC in supply chain management is a process to identify, exploit and manage a system through its leverage points and their interactions. The first areas to look for leverage points should be among the interactions in the supply chain management framework. The supply chain management framework consists of three closely interrelated elements: the supply chain network structure, the supply chain business processes and the supply chain management components.

**Figure 7.1: TOC and supply chain management components**



According to what was mentioned above at the heart of TOC is a five-step procedure that enables to plan the overall process and focus attention on the resources with the greatest potential to be affected by changes to the system. In supply chain management usually the first questions that should be asked in order to define constraints' areas on strategic thinking level are:

- i) Referring to supply chain network structure: who are the key supply chain members with whom to link processes?
- ii) Referring to supply chain business processes: what processes should be linked with each of these supply chain members?
- iii) Referring to supply chain management components what level of integration and management should be applied for each process link?

Use of TOC for supply chain management is a new and unique approach to tackle the issues. The problem the supply chain members face is one of irreconcilable condition –all the individual members search for their own particular efficiency to the detriment of other members. t. This can be determined by changing the technique followed by the manufacturers and the retailers. The

centre of the methodology ought to be conveyance of the item to the end client and discovering the limitation at every level.

In construction supply chain management, the first step is to identify what is preventing the chain members from satisfying the desired level of performance or profitability. This step of TOC approach is known as constraint identification. The constraint can be, internal or external, physical or non-physical, dependent or independent.

The procedure of constraint identification includes examination and collaboration between the supply chain individuals (Goldratt, 2000:12). The constraints can be at an extremely individual level or at a full scale level. The requirements can likewise be an after-effect of human conduct. The "no danger approach" taken by senior generation administrator to deliver products in light of the past figures and not investigating the need to change the system because of business sector progress. This methodology followed by the manager may bring about non-accessibility of activities which thus causes inefficiencies. The constraints grown in a framework can likewise be an aftereffect of the arrangements and strategies followed by the organisation for normal operations. There are many interdependencies between a numbers of elements which at last prompt a constraint.

Identification of the constraint leads to second step of the method which is exploiting the constraint. This step is crucial for the overall implementation of TOC and requires a lot of brain storming from the chain members. This step involves augmenting the prevailing capacity at the constraint. For example- if a company manufactures three different types of products (A, B and C), and non-availability of type C product is the problem, then the supplier has to observe the constraint and replenish the constraint without delays. This change of continuous replenishment is initiated by the change of production schedule and product mix manufactured at the facility.

The third step is to subordinate all other activities to the constraint. This means that changes may be necessary to the existing rules and procedures which caused the problem. Hence all activities or procedures which caused the problems will be eliminated or changed, which in turn helps in exploiting the constraint.

The next step (fourth) is to elevate the constraint. This step involves increasing of the capacity of the constraint to a higher level. This step often involves the creation/ identification of a new constraint.

The fifth and the last step essentially deals with managing the problems which hamper the improvement process. This is the constraint based approach which can be followed to tackle the problems associated with processes and enhance the overall performance of the supply chain.

The ultimate aim of the supply chain management is to bridge the gap between demand and supply. In a supply chain of make to order type products, the constraint is the end customer, so to exploit this constraint of the supply chain one needs to have the right product in the right place at the right time. For this to happen the kind of collaboration required is huge and it involves plenty of information sharing. This step will require information sharing of overall supply chain about each and every level and finally taking decisions at the local level. This decision is dependent on the factors such as non-availability of any particular resource and other forces which may be internal or external to the system. For these types of problems the application of D-B-R (Drum buffer rope) solution can provide the desired results. .

Although there are both internal and external forces hampering the overall performance of the supply chain, the solution developed must be internal in nature. This does not mean that there should be no collaboration between the chain members; it means the desired level of performance of the supply chain will not be achieved until and unless there are policies and procedural changes at the local level. Directly looking at the big picture and ignoring the internal problems will not lead to overall supply chain effectiveness. Effective implementation of the TOC approach requires perfect integration and alignment of the business and supply chain strategies to achieve business goals and objectives which in turn will lead to overall supply chain's effectiveness and improved performance.

To sum up, TOC key principles for supply chain management, several guidelines for strategic approach are formulated in the following way:

- i) Visualise processes/organisations as chains. This is crucial to TOC, because it enables finding the weakest links that can then be strengthened. The linkages in question can be between the different steps or activities in a process or between diverse organisations within a supply chain.
- ii) Understand the conflict: local versus system optima. Due to interdependence, the optimum performance of a system as a whole is not the same as the sum of all the local optima. A chain that maximises the activities of every process will not perform as well as one that ensures optimisation of the flow and value created through its linked set of activities.

- iii) Use “cause and effect” thinking to find the constraint. It helps to focus on significant constraints, not on symptoms only. Capturing the essence of cause and effect within the system and identifying measurements that emulate these relationships are the keys to optimising system performance.
- iv) Look for policy constraints. Most of the constraints faced in systems originate from policies, not physical things. Physical constraints can be objectively identified and dealt with. Policy constraints are much more difficult to identify and deal with (e.g. behaviour patterns, attitudes, lack of information and assumptions) and are potentially more damaging.
- v) Plan total system impact. All organisations are systems made up of interdependent activities, each with its own level and type of variability. In order to optimise performance, management needs to understand and focus on the total system impact of a decision or event, not just on its local or immediate effects.
- vi) Do not forget about resistance to change. In most cases, resistance to change comes from disagreement with the initiator of the change. There are potential six layers of resistance to change: disagreement on what the problem is, disagreement with the direction of solutions, disagreement that the solution will bring the desired benefits, fear that the solution will result in negative consequences, obstacles to implementation, intention of doing nothing. To implement the TOC solution successfully, the resistance to change must be overcome by TOC thinking process tools. In the TOC approach the main focus is on constraints – finding the constraints and finally resolving the problems. This kind of approach is continual and it requires a great effort from all the members of the chain. The application of TOC for supply chain management is quite new and a unique approach to tackle the problems. The problem the supply chain members face is conflict of interest –all the members look for their own profitability at the expense of other member. This can be resolved by changing the strategy followed by the manufacturers and the retailers. The focus of the approach should be delivery of the product to the end customer and finding the constraint at each level.

#### **7.4.4 Proposed model for minimising the supply chain constraints in the construction industry.**

While the section above seems to reflect on the TOC as an ideal tool in addressing constraints within the construction sector, the TOC would fall short due to its complex nature in understanding and application, as seen from the above section. Therefore, in minimising the constraints as well as specifically addressing challenges relating to the supply chain management

within the construction industry in South Africa, a model is suggested after reflections in both the theoretic and empirical conclusions.

#### ***7.4.4.1 Recommendations linked to supply chain management and model in the construction industry.***

The study has highlighted a number of constraints and the fragmentation of the supply chain, which has long been recognised as a structural issue that needs to be accounted for to improve performance within the construction supply chain management. The findings of the study suggest that the industry will be less able to manage it unless it makes efforts to adhere to the following as derived from the proposed model:

- **Training and development within supply chains**

Construction companies appear to have ignored the development in supply chain, resulting in poor overall knowledge and skills within their organisations. Most major players have only commenced with the process of introducing strategic sourcing into their organisations in the past decade. This has, however, not had the desired impact, mainly due to resistance from within. Their structures have remained one in which operational staff including quantity surveyors, estimators, contracts managers, engineers and site managers have greater influence over procurement activities than do traditional buyers, who remain administrative in nature. Without a management paradigm shift, strategic sourcing will continue to fail.

They have, however, not as yet realised the implications of having a visible, functional and stream lined supply chain which controls inbound and outbound logistics as well as inventory and procurement. This implies that the existing systems remain disparate and open to fraud and corruption and or practices which are not adding value to the organisation. Traditional buyer skills remain poor, with higher skilled individuals being side lined and therefore unable to add value.

The continued focus by construction companies on operations, without realising the full impact of a supportive supply chain remains a mystery and overall, the sector requires a culture shift. Current practices remain archaic and non-value adding (Finch, 2008:9). In order to effectively understand the short comings of present supply chains, both buyers and line managers need to be able to understand the role of a supply chain within an organisation and must be able to buy into the concept. Given the historical practices, the inherent culture, the incestuous nature of movements from one company to the next and the inability of new blood from outside of

construction to influence or impact thinking, there will never be a view within operation that supply chains can add value or are necessary. Given this backdrop, normal change management strategies will not apply- these are changes which need to be forced onto the organisation from top management in order to succeed. Traditional consultative change management methods have clearly failed in some organisations.

- **Policies and processes**

A number of participants espoused the view that whilst some policies and processes existing, they were not followed, especially when there are repercussions for any transgressions. This is indeed true for my own company where policy serves as ‘guidelines’ and not as the ‘law’ of the company. There is a train of thought that the lack of repercussions may be symptomatic of a greater problem within the organisation. That management ‘cover up’ for each other and further that most line managers are not equipped to deal with disciplinary issues. This again highlights the need that successful industries have progressive line managers that are experienced and or knowledgeable in all aspects of the business, including people management. Construction does not appear to have moved to the well-rounded manager concept and focusses on specific technical skills, which is detrimental to overall company performance.

The industry is known to be maverick in nature, with the concept that management will do whatever it takes to deliver a project on time and within budget. This does not create an environment that is conducive to operating within structured policies and processes. An environment of this nature will result in a lack of control and effectiveness and governance is lost. Policies and process are necessary in any company and compliance is instrumental in ensuring on-going effectiveness and success. This is, however, an issue for top management to address and to instil discipline into the organisation.

- **Communication**

Generally communication to all levels of the company appear to be poor and blue collar workers are usually unaware of company strategy, company policies and how their role impacts overall company performance. Effective communication must be seen at all levels of the organisation and a structured communication strategy needs to be implemented.

- **Systems**

Without a sense of how supply chain strategies can positively affect a company's performance and profitability, the sector will not invest in expensive supply chain systems. Until such time that construction realises that supply chains encompasses more than just the buying function, they will not migrate to world class best practice. Given that even the buying function does not enjoy a strategic presence within some organisations, procurement systems remain substandard. The need for supply chain systems will therefore present an even greater challenge. Given the comments from some participants regarding the manner in which inventory, logistics and distribution is handled, it is clear that construction appear to view these as disparate functions with no need to create an integrated supply chain. Without an effective item and vendor master, spend segmentation will always present challenges, therefore strategic sourcing becomes impossible and buying will remain an *ad-hoc* administrative function which is costing the sector billions each year, mainly due to the inability to effectively leverage its spend and or manage its supply chain.

- **Knowledge management**

Knowledge (information) drives supply chain performance and the lack of it will mean that decisions will be operational, reactive and prevent the organisation from achieving a supply chain which is integrated and visible. This allows inefficiencies to enter the organisation and remain invisible from management. The lack of an item master means that spending will remain uncontrolled and the true competitive position of any company cannot be exploited within a competitive supplier environment. Competitive tendering becomes non-existent and spend remains uncontrolled and therefore at risk. Further, inventory control remains a vital component of any supply chain. But, inventory control requires an item master and a warehousing system to track and control. In this disparate structure, movement of goods becomes *ad hoc*, uncontrolled and therefore a high risk area for the sector. Notwithstanding the short term duration of projects, institutionalised knowledge is lost and high value procurement activities can be easily concealed. Effective knowledge management, however, requires effective systems which do not exist across some companies.

- **Change management**

Change management within the sector is clearly a problem area and resistance to change is rife in some organisations. This stems from historical practices and management practices which the



sector refuses to change. Again, given the lack of exposure by entrenched and long serving managers to world class management principles and practices, including advancements in supply chain over the past decades, these new practices will remain foreign to most long serving employees, and therefore any attempt to entrench new thinking and or concepts will face resistance. They will not change what they do not know or do not understand. The participants' comments about new blood being needed in the sector is true. Although new graduates enter the sector yearly, they are usually indoctrinated into the existing culture and thinking from the outset, thereby preventing them from learning anything other than what they are taught on site. Those employees that join the sector from other industries or sectors are either frustrated into leaving, or face challenges to any idea that seeks to change the entrenched ways of the industry. Furthermore, traditional change management methodologies have been deliberately set up to fail or resisted until it goes away. Therefore a more stringent manner to enforce change is required in the sector and in some organisations.

Therefore, the following model based on the above is suggested in addressing the existing constraints within the construction supply chain

**Figure 7.2: Model for construction supply chain constraints management**



From most of the narrations captured by the participants, it appears that even the senior-executive involvement, including hands-on attention from the CEOs, is pivotal in managing the cross-functional trade-offs that underpin many supply chain decisions. This is, however, largely linked to the available policies and processes that should not necessarily be drafted and shelved but rather practically demonstrating the will for compliance. While the role of CEOs at many companies surveyed is limited to balance sheet management of some kind, it appears non-existent with regards to supply chain management. Once companies attempt to bridge the functional divides that thwart collaboration as result of policy compliance, they will have no edge in creating competitive supply chains capable of fulfilling business strategy requirements, and how the relationships between the above can be practically exploited.

With linking and addressing compliance to policy and better processes, the challenges companies identified as of how the supply chain management would improve service and responding to new expectations and patterns of customer demand requires more and better information, regardless of the geographical scope or the length of supply chains and efforts that would make increase the efficiency of the chain. As the marketplace becomes increasingly fragmented and competitive, keeping better track of internal customer information and supply chain integration, which can inform and support interpersonal, cross-functional discussions and decisions, will help companies prepare for the supply chain uncertainties and constraints that lie ahead.

The main argument of the framework is that managing complexity in a supply chain requires consideration of the complex structure of the supply chain, monitoring and managing the interactions between the members that contribute to complexity in terms of flows in the supply chain and making decisions regarding the structure and flows that will ease dealing with complexity without creating adverse consequences. The framework provides a basis for understanding the concepts of supply chain complexity as well as managing the complexity in the supply chain. It is generic in the sense that it is meant to cover all types of supply chain complexity.

Along with the framework, an implementation methodology to reduce the inherent difficulty in managing complexity in the supply chain is suggested. The methodology is mainly aimed at dealing with dynamic and decision-making complexity drivers lying within the sphere of influence of the problem owner. It provides a rigorous and practical means to deal with complexity of the supply chain by leveraging the knowledge and the expertise of the people involved in the problem to facilitate change with the help of TOC TP tools. The methodology is novel in its ability to identify the complexity drivers that are the cause of most problems in the supply chain, as such it allows us to focus our efforts on the right issues and, in turn, helps to manage complexity in a more efficient and effective way.

## **7.5 CONTRIBUTION OF THE RESEARCH**

The study contributes to scientific knowledge as it generates valuable information about complex systems and supply chain management methodologies, especially with regard to their behaviour, mapping, description, analysis and diagnosis. Such information may lead to a better understanding of complex construction systems.

Since there is a lack of empirical research in this area, this study is the first to investigate the

key success factors for project success in the construction sector. It is anticipated that this study will provide a foundation on which further local research can be conducted for the improvement of supply chain management and project performance in the construction industry. This is a theoretical contribution.

The TOC tools have typically been used in dealing with physical constraints. The application of this framework leads us to the conclusion that the TOC tools provide promise as a strategy for management teams grappling with difficult organisation programmes and working towards resolution of a wide variety of issues, including managerial and interpersonal organisational dynamics. We suggest future applications of the principles of TOC to organisational analysis and to introducing TOC vocabulary to the discipline of organisational behaviour.

The extent of discourse available on the topic is still largely focused on manufacturing and production type environments and discourse on construction remains mainly theoretical. Future research on actual case studies within the construction industry with clear focus on the measured benefits would benefit the sector.

The present study contributes to the field by integrating knowledge about TOC as well as the constraints within the construction supply chain. Identification of these constraints specifically within supply chains is perceived as most significant in avoiding or preventing critical delay factors. This study can lead to better performance within construction industries. Although the research study is based in South Africa, it is anticipated that these results would be broadly applicable to other developing countries by identifying similar construction constraints and benchmarking on the solutions and the model suggested.

A unique strength of the present study, aside from being the first to investigate the relationship of supply chain management and TOC identified in the literature and delay factors identified in construction management process, is that it collected data from managers, contractors and engineers working on the same projects who are directly linked to supply chain management within their organisations

## **7.6 IMPLICATIONS FOR FURTHER RESEARCH**

This study focused on the constraints within the supply chains in South African construction industry. There are, however, other issues that have not been explored and could be done in future. These include the following:

Further research is needed to investigate potential improvements in the implementation of project management systems in the construction industry with reference to the TOC. The constraints in this study can be used to investigate this. Efficient project management would result in tangible outcomes for all aspects of planning, scheduling and monitoring control of time, cost and specification of projects. Implementing efficient management methods will overcome political, organisational and cultural obstacles.

Through the economy as a whole, innovative businesses are operating in an increasingly information-intensive manner, using knowledge and information technology to enhance the management of their core process, the way in which they use their business support capabilities and management of supply chains. The opportunity of using more advanced information technology to generate control and streamline project information in construction has remained under-exploited and could be one area to consider for future research.

Supply chain management and logistics in construction is quite profound and practical experiences do exist. However, there is need to focus on the importance of managing the supply chain outside of the immediate construction site. Future research here would provide essential guidance and expert advice for construction and logistics managers as well as researchers and students in the field. Such studies would explore a broad range of strategic and operational responses to the challenges facing the construction industry today, especially the key issues relevant to the management of supply chains within the industry

This study could be extended to other industrial sectors that are critical to the South African economy, such as transport, manufacturing and production. This provides a basis for comparisons.

Future studies could focus on correlating the supply chain constraints identified in this study and supply chain performance in the SA construction industry in order to uncover the influence of these constraints on SC performance.

A mixed method approach could be used to obtain more information that could not be covered in this study. This would help to overcome a weakness in using one method with the strengths of another or to seek information from different levels especially within the supply chain management organisation hierarchy.

## 7.7 CONCLUDING REMARKS

The research identified the critical constraints in the South African construction supply chain. Critical delay factors which were identified are lack of supply chain management systems, coupled by procurement, lack of leadership, skills shortage in supply chain management, lack of communication, slow decision making, change rigidity and inadequate contractor planning.

The aim of the research is to improve performance of supply chain management in the South African construction industry. Findings in this research proclaim that the critical constraints perceived as most influential in avoiding or preventing critical delay factors can lead to better performance within construction industries and they are likely to improve success in construction management systems as a whole.

This study also has provided the conceptual framework for using the TOC approach to assist the chain members to realise the potential benefits of supply chain within the construction sector. The inherent dilemma can be broken if the chain members manage the few constraints as their common denominator to achieve the overall goal. The goal of any collaboration is to increase throughput and at the same time reduce inventory and Operating Expense. As a prerequisite to ensuring profitability, the chain members must be able to quickly identify and remove the constraint(s) and ensure that they can continue to meet changing customer requirements accurately.

Collaborative replacement policy has been proposed. Collaborative performance metrics encourage the individual chain members to contribute to the goal of optimising supply chain profitability. These two strategies help the chain members to ensure the swift and smooth flow of products to end customers and maintain the level of trust amongst themselves. However, the application of TOC should be adopted with care due to its intensive training requirements and radical approach that requires experimental learning. Further research is recommended to refine the TOC approach in dealing with the quantification of replenishment and emergency levels, the evaluation of the self-enforcing property of collaborative metrics and the inclusion of reverse logistics.

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# ANNEXURE 1: RESEARCH INTRODUCTION LETTER



**Vaal University of Technology**  
*Your world to a better future*

## RESEARCH INTRODUCTION LETTER

02 February 2015

Dear Sir/Madam,

As the Acting Head of Department of Logistics and co-promoter in the Faculty of Management Sciences at the Vaal University of Technology I wish to introduce to you our DTech student, Mr Poobie Pillay who is currently undertaking a research project titled: "Exploring Supply Chain Constraints in the South African Construction Industry". I wish to invite you to participate in this very important study by way of an interview.

This study is important due to the important role played by the construction industry in South Africa and other countries. The study will explore supply chain constraints within the construction industry with a view to minimising those within the supply chains. The interview should take between 30-40 minutes and strict ethical guidelines will be adhered to. A digital voice recorder will be used to record the interview process in order that we can verify the recorded transcripts and facilitate data analysis.

As a condition for the qualification, the researcher has undertaken to adhere to all ethical issues pertaining to confidentiality, nondisclosure and anonymity and this letter serves to provide such undertakings. The information related to the interviews will not be accessible to anyone else except to his promoter Prof David Pooe and co-promoter, Dr Chenedzai Mafini, of the University of Johannesburg and Vaal University of Technology respectively.

The results of this study will be made available to you on request. Your participation in this study will be of benefit since it will hopefully contribute towards a model for minimising supply chain constraints in the construction industry. On acceptance, the researcher Mr Poobie Pillay will introduce you to the research process, sample questionnaire and the study time frame so that an appropriate interview date can be set.

Thanking you in anticipation for your valuable role in this project.

Yours faithfully,



Dr Chengedzai Mafini

**INTERVIEW ACCEPTED:**

Company/ institution: \_\_\_\_\_

Name of respondent: \_\_\_\_\_

Tel: \_\_\_\_\_

E-mail: \_\_\_\_\_

## **ANNEXURE 2: INTERVIEW SCHEDULE**

1. Describe the present South African Construction Industry
2. Describe your organisations' supply chain
3. What are the typical constraints that are experienced within your organisations supply chain?
4. Describe how your organisation manages people skills
5. Describe how your organisation manages supply chain systems
6. Describe how your organisation manages supply chain processes
7. Describe how your organisation manages supply chain knowledge management systems
8. Describe how your organisation is able to handle change management issues within the supply chain

### ANNEXURE 3: PROOF OF LANGUAGE EDITING

#### DECLARATION

*I, Clarina Vorster (ID: 710924 0034 084), Language editor and Translator, and member of the South African Translators' Institute (SATI member number 1003172), herewith declare that I did the language editing of the thesis of mr P Pillay (student no 213123665) from the Vaal University of Technology.*

*Title of the thesis: An empirical exploration of supply chain constraints facing the construction industry in South Africa*

*C Vorster*  
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*28/5/2016*  
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