https://dspace.org/

Investigating the challenges experienced by the South African construction industry in adopting lean construction principles to deliver projects

Dowra, Priyesh

2021
https://hdl.handle.net/10539/31870

Downloaded from a DSpace repository. https://dspace.org/

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Investigating the Challenges Experienced by the South African Construction Industry in Adopting Lean Construction Principles to Deliver Projects

Priyesh Dowra

(Student number: 1455094)

School of Mechanical. Industrial and Aeronautical Engineering

University of the Witwatersrand

Johannesburg, South Africa.

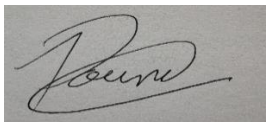
Supervisors: Dr. B. Sunjka

A Research Report submitted to the School of Mechanical. Industrial and Aeronautical Engineering in the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Engineering

December 2020

DECLARATION

I declare that this research report is my own unaided work. It is being submitted to the Master of Science to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.



……

9th day of December 2020

ABSTRACT

Lean construction is considered to be a valuable solution to the problems of declining productivity and the poor success rates of projects in the South African construction industry. This research report seeks to answer the research question: What are the challenges experienced by the South African construction industry in delivering projects when adopting lean construction principles?

Many construction projects in South Africa are completed late, and with a cost overrun and poor quality as a result of inadequate/ poor management of the programme. During the construction phase of projects, there are many opportunities to implement lean construction principles and techniques that would have a positive impact on a project.

This research explored the current challenges experienced by the South African construction industry and the challenges of implementing lean construction project management principles in South Africa and provides recommendations on how to address these challenges.

A qualitative methodology was used in the research. Semi-structured interviews were held with eight experienced individuals in the field of construction and lean construction in South Africa. Five research themes shaped the interview dialog that probed the participants' experiences and insight regarding the overall research question and the research objectives. The themes that arose prompted responses regarding the barriers that are preventing successful implementation of lean construction in South Africa. Interviewees also suggested strategies to successfully promote and implement lean construction.

The findings revealed several barriers to successfully implementing lean construction in South Africa. These challenges are further impacted by the current state of the South African construction industry, the challenges relating to the role of senior management, the level of education and technical training and expertise in the industry, financial constraints and issues, government related challenges, and human attitudes that negatively influence the adoption of a lean culture and lean construction principles.

This work is dedicated to

my family

ACKNOWLEDGEMENTS

I wish to sincerely thank the following people for their help and support during the period of my research:

- My wife (R. Dowra) for providing continuous motivation, love and support during this journey. I love and thank you dearly.

- My parents (S.S. Dowra & C. Dowra) and brother (T. Dowra) for the continuous motivation, support, belief and love throughout this research study.

- Dr Bernadette Sunjka, for the supervision, support and understanding during the preparation of this research report.

- And last, but not least, to my beloved Shri Hanuman, for always showering his protection, blessings, love and guidance upon me.

TABLE OF CONTENTS

DECLARATION i
ABSTRACT ii
ACKNOWLEDGEMENTS iv
LIST OF FIGURES ix
LIST OF TABLES x
LIST OF ABBREVIATIONS xii
1. CHAPTER 1: INTRODUCTION 1
1.1 Research background 1
1.1.1 Motivation for lean construction 3
1.2 Problem statement 4
1.3 Research question 5
1.4 Objectives 5
1.5 Summary of research method 5
1.6 Research delimitations 6
1.7 Structure of the report 6
2. CHAPTER 2: LITERATURE REVIEW 8
2.1 Lean manufacturing 8
2.1.1 History of lean and the Toyota Production System 8
2.1.2 The lean enterprise house 9
2.1.3 The five lean principles 9
2.1.4 The seven wastes (mudas) 11
2.2 Lean construction 14
2.2.1 Three steps towards lean construction 15
2.2.2 Lean construction in South Africa 15
2.2.3 Lean construction practices 17
2.2.4 Categories of LCPs 18
2.2.5 Benefits of LCP application in the construction industry 22

2.2.6 Challenges facing the implementation of lean construction 24
2.3 Construction project management 27
2.4 Construction project management in South Africa..... 29
2.4.1 Traditional project management vs lean construction principles..... 30
2.5 Conceptual framework 33
3. CHAPTER 3: RESEARCH METHODOLOGY 35
3.1 Research design 35
3.2 Study design 36
3.3 Sampling..... 37
3.3.1 Selection criteria for respondents..... 37
3.3.2 Selected respondents 39
3.4 Instrumentation 41
3.4.1 Developing the interview questions..... 41
3.4.2 Developing themes 42
3.5 Data collection 44
3.6 Interview process 45
3.7 Data analysis 46
3.8 Quality standards 48
3.9 Interview assumptions 50
3.10 Ethical considerations 51
4. CHAPTER 4: DATA ANALYSIS AND RESULTS 52
4.1 Overview of data collected 52
4.2 Thematic analysis 54
Each theme is analysed in the sections that follow. 54
4.2.1 Knowledge of lean construction 54
4.3 Data analysis for research objective 1: identifying the challenges experienced by the South African construction industry..... 60
4.3.1 Current state of the South African construction industry..... 60
4.4 Data analysis for research objective 2: identifying the challenges of implementing lean construction project management principles in South Africa 67

4.4.1 Government 68
4.4.2 Management 72
4.4.3 Education/ Technical 77
4.4.4 Financial 85
4.4.5 Human attitude 88
4.5 Data analysis for research objective 3: to make recommendations on how to address the challenges identified 91
5. CHAPTER 5: DISCUSSION 95
5.1 Knowledge and understanding of lean construction 95
5.2 The challenges experienced by the South African construction industry (Objective 1) 97
5.3 The challenges of implementing lean construction project management principles in South Africa (Objective 2) 99
5.3.1 Government 99
5.3.2 Management 100
5.3.3 Education/ Technical 101
5.3.4 Financial 102
5.3.5 Human attitude 103
5.4 Recommendations on how to address the challenges identified (Objective 3) 105
5.5 Research limitations 106
6. CHAPTER 6: CONCLUSION 107
6.1 Research objective 1 108
6.2 Research objective 2 109
6.2.1 Government 109
6.2.2 Management 109
6.2.3 Education/ Technical 110
6.2.4 Financial 110
6.2.5 Human attitude 111
6.3 Research objective 3 112
6.4 Further research 113

7. REFERENCES 114
8. APPENDICES 120
8.1 Appendix A: Participant information sheet 120
8.2 Appendix B: Letter of consent 122
8.3 Appendix C: Interview questions 123
8.4 Appendix D: Coding of data 125
8.5 Appendix E: Ethics clearance certificate 127
8.6 Appendix F: Interview transcripts 128
8.6.1 Interviewee A 128
8.6.2 Interviewee B 145
8.6.3 Interviewee C 163
8.6.4 Interviewee D 180
8.6.5 Interviewee E 202
8.6.6 Interviewee F 219
8.6.7 Interviewee G 223
8.7 Appendix G: Analysis 227

LIST OF FIGURES

Figure 2-1: Lean enterprise house 9
Figure 2-2: Relationship between the five lean principles 11
Figure 2-3: Pathway for lean thinking to drive change in the South African construction industry 16
Figure 2-4: LCP identified in the literature 17
Figure 2-5: Conceptual framework 34
Figure 3-1: Development of interview questions using the pyramid model 42
Figure 3-2: Streamlined codes-to-theory model for qualitative research 46
Figure 4-1: Interviewees' level of lean construction knowledge 56
Figure 4-2: Interviewees' colleagues and clients' knowledge of lean construction 58
Figure 4-3: Frequent codes relating to the SA government 69
Figure 4-4: Frequent codes relating to management 73
Figure 4-5: Frequent codes relating to education/ technical 78
Figure 4-6: Lean construction training completed by interviewees 81
Figure 4-7: Lean construction training done by managers at the interviewees' organisation 82
Figure 4-8: Frequent codes relating to human attitudes 89

LIST OF TABLES

Table 2-1: Design and Engineering Practices 18
Table 2-2: Planning and Control Practices 19
Table 2-3: Construction and Site Management Practices 20
Table 2-4: Health and Safety Management Practices 22
Table 2-5: Benefits of lean construction that have been reported 22
Table 2-6: Nature of challenges facing lean practice in organisations in the UK 26
Table 2-7: Project management's nine areas of knowledge expertise 27
Table 2-8: Differences between the traditional project management approach and the lean construction approach 31
Table 4-1: List of interviewees 53
Table 4-2: Commonly used LCPs 55
Table 4-3: Interviewee responses to question 5 56
Table 4-4: Interviewee responses to question 6 59
Table 4-5: Interviewee responses to question 7 60
Table 4-6: Interviewee responses to question 8 62
Table 4-7: Interviewee responses to question 9 64
Table 4-8: Interviewee responses to question 10 65
Table 4-9: Elements that result in poor productivity of the industry identified by the interviewees 66
Table 4-10: Top seven codes generated from the government theme 68
Table 4-11: Interviewee responses to question 11 69
Table 4-12: Interviewee responses to question 12 71
Table 4-13: Top seven codes generated from the management theme 72
Table 4-14: Interviewee responses to question 13 74
Table 4-15: Interviewee responses to question 14 75
Table 4-16: Interviewee responses to question 15 76
Table 4-17: Top seven codes generated from the education theme 77
Table 4-18: Interviewee responses to question 16 79
Table 4-19: Interviewee responses to question 17 80
Table 4-20: Interviewee and interviewee management training on lean construction 83
Table 4-21: Interviewee responses to question 20 84
Table 4-22: Interviewee responses to question 21 85
Table 4-23: Interviewee responses to question 22 and 23 87
Table 4-24: Top seven codes generated from the human attitude theme 88
Table 4-25: Interviewee responses to questions 24 and 25 90

Table 4-26: Overcoming barriers to implementation of lean construction principles 92
Table 8-1: Coding of data..... 125

LIST OF ABBREVIATIONS

BEE	Black Economic Empowerment
CAD	Computer Aided Design
CE	Construction Excellence
CLIP	Construction Lean Implementation Program
CM	Conference Management
CPM	Critical Path Method
CPMan	Construction Project Manager
CSMP	Construction and Site Management Practice
DEP	Design and Engineering Practice
ETQA	Education and Training Quality Assurance
GDP	Gross Domestic Product
HREC	Human Research Ethics Clearance
HSMP	Health and Safety Management Practice
IGLC	International Group for Lean Construction
JIT	Just-in-Time
JSE	Johannesburg Stock Exchange
LCI	Lean Construction Institute
LCP	Lean Construction Practice
LPDS	Lean Project Delivery System
LPS	Last Planner System
PCP	Planning and Control Practices
PMI	Project Management Institute
PMSA	Project Management South Africa

PPP	Public Private Partnership
NPO	Non-Profit Organisation
SACPCMP	South African Council for Project and Construction Management Profession
SGB	Standards Generating Body
SOE	State Owned Enterprise
TPM	Total Production Maintenance
TPS	Toyota Production System
TQM	Total Quality Management
UK	United Kingdom
USA	United States of America
WWP	Weekly Work Plan
VM	Visualisation Management
VSM	Value Stream Mapping

CHAPTER 1: INTRODUCTION

1.1 Research background

The South African construction industry comprises the building and civil sectors. It plays an integral role in the national economy of South Africa, by providing infrastructure that is fundamental to the continuous development of the country (South African Government News Agency, 2019).

A key stimulator of economic growth in South Africa is the construction industry (National Treasury, 2018). This is accomplished by increasing the productive capacity of the economy through the provision of infrastructure. The National Treasury, the Department of Public Works, the Presidential Infrastructure Coordinating Commission and the Department of Planning, Monitoring and Evaluation are implementing reforms to improve spending efficiency through better planning, financing, procurement and implementation of infrastructure projects (National Treasury, 2018).

One of the fundamental challenges of the South African government is service delivery in the construction sector (South African Government News Agency, 2019). While it is evident that there are challenges, the government's contribution to the industry plays a vital role in meeting the demands for infrastructure such as housing, clinics, hospitals and schools in under-developed areas of the country. Kaul (1998) supports this view, by indicating that since the transformation of the South African government in 1994, government has implemented numerous turn-around strategies in its attempts to improve service delivery in the country. These strategies include collaboration or partnerships (also known as Public Private Partnerships (PPPs), Black Economic Empowerment (BEE), the Accelerated and Shared Growth Initiative of South Africa (ASGISA), the National Skills Development Strategy, the Employment Equity Programme and the Affirmative Action Programme.

In light of this, the South African construction industry is struggling and many large construction companies have filed for business rescue since 2018 (Rumsey, 2018). The 2018 year in construction saw several companies being liquated or filing for business rescue (Rumsey, 2018). In June 2018, Basil Read was placed under business rescue and Liviero Group (Pty) Ltd. - South Africa's largest privately black-owned construction group, was also placed under voluntary business rescue (Rumsey, 2018). Esor Construction (Pty) Ltd. filed for business rescue in August 2018 and the Aveng Group struggled to survive (Rumsey, 2018). Group Five's stock was suspended in March 2019, after 45 years of trading on the Johannesburg Stock Exchange (JSE), as it had filed for bankruptcy protection (Rumsey, 2018). Group Five had a market value of R8.2 billion in 2007 and is now worth less than a

R100 million (Kew, 2019). These construction companies, along with many others, have been struggling to survive in an industry that is squeezed by stagnant growth and slow infrastructure spending by the South African government (Kew, 2019). Therefore, it is crucial for the industry to manage the challenging conditions it faces and deliver successful projects.

The challenging economic environment is exemplified by the declining Gross Domestic Product (GDP) figures. According to (StatsSA, 2019), South Africa has seen its GDP shrink from 2.5% in 2013 to approximately 1.0% in 2018. The construction industry recorded negative growth in the first quarter of 2018 on from the fourth quarter of 2017. In addition, the industry has experienced consecutive quarters of decline since December 2016 and has seen a loss of R1.7 billion in value since the fourth quarter of 2016 (Trading Economics, 2019).

Part of the reason for this situation in the construction industry, is the lack of new infrastructure projects being initiated by government (Rumsey, 2018). Slow economic growth in South Africa has a ripple effect on the construction industry and the industry is seeing increasingly fewer infrastructure projects (Rumsey, 2018). Because of this, as well as various other factors, construction companies are struggling to remain profitable and to keep their door open in the challenging economy (Rumsey, 2018).

One of the additional problems is that the construction industry has also fallen victim to poor project performance and poor project execution (PWC, 2016). With the increased pressure on corporations to deliver successful projects, there is a call for the implementation and monitoring of project management procedures and policies over the life cycle of projects, and for the assignment of accountability in mitigating the risks that hinder successful project execution (PWC, 2016). PWC (2016) emphasised that various specialist skills and knowledge are required to deliver successful construction projects, but the skills gap in South Africa makes it extremely difficult for companies to complete contracts successfully and this ultimately undermines growth and expansion of the industry (PWC, 2016).

Some of the reasons why construction companies in South Africa are struggling to deliver projects successfully (PWC, 2016) include poor project execution, poor quality control of the management teams, poor service delivery, lack of innovation, poor policy implementation, and lack of involvement and support from government. Poor execution of projects results in profit margins diminishing and eventual losses (PWC, 2016). Poor quality control on site results in re-work, increased cost and, ultimately, a delay in the delivery of projects (PWC, 2016). Poor service delivery in the construction sector is a fundamental challenge to the South African government. The key factors that result in poor service delivery in the construction industry are delays and disruption during construction, poor site management,

time and cost variations, lack of skills and competence issues, lack of quality improvement processes and a lack of worker participation (South African Government News Agency, 2019).

1.1.1 Motivation for lean construction

The South African construction industry is not unique in terms of the problems it is facing. The productivity of the global construction industry has been in decline for the past 40 years. This is due to poor quality control, reduced value add, poor execution and a lack of involvement by major role players, which has led to delays and cost over-runs (Aziz & Hafez, 2013). For example, up to 30% of construction work done in the United Kingdom (UK) is re-work. The cost of re-work in Australian construction projects has been reported as being up to 35% of total project costs, and it contributes as much as 50% of a project's total over-run cost. Re-work is one of the primary reasons for the Australian construction industry's poor performance and productivity (Aziz & Hafez, 2013).

Koskela (1992) indicated that poor implementation and use of traditional project management was the common cause for the delays and issues in construction. Traditional project management practice is based on an inappropriate model, because it tries to manage projects according to a central scheduling program while the amount of control is dependent on the results or current situation (Banki & Orumchi, 2007). Traditional project management models offer a limited set of measures, as most of them limit their analysis to a defined number of measures, such as time, cost and productivity in the form of labour (Aziz & Hafez, 2013). The shortcomings of traditional project management is that this model is very rigid and inappropriate for measuring new items and performance measures (Aziz & Hafez, 2013). The downfall of this approach is that workflow and value-adding for the client and the project are ignored, while activities that are non-value-adding are not omitted, which means that handling all related activities is impossible (Banki & Orumchi, 2007).

Koskela (1992) mentioned that the introduction of new management philosophies requires new measures that focus on waste, value, time, innovation, productivity and variability. The way the industry manages and delivers its projects requires questioning and in- depth analysis, so that a possible solution that provides an alternative method of management is developed. With the ever-growing complexity of the built environment and the difficulties being experienced with government, attempting to maintain the traditional management method is not viable, hence further investigation into other methods is required. One of the new management philosophies that have been considered, in order to address these problems in the UK construction industry, is the lean construction approach (Green, 1999).

Lean construction is a new and transformational method for construction design, management and building construction projects (Lean Construction Institute, 2016). Lean thinking has already been applied in many other industries and service areas, and the construction industry has recognised its need to implement lean thinking, given the objectives of a lean production system, which is to maximise value and minimise waste by using specific techniques and applying them to a new way of project management (Lean Construction Institute, 2016).

Lean construction follows a different strategy from that of traditional project management. The lean construction approach follows a collection of precise purposes that are directed at maximising delivery at all stages of the project (Howell, 1999). Lean construction's main goals are to better meet the customer's strategic goals while using less of everything (time, cost, labour, etc.) (Gleeson & Townsend, 2007). There are a number of benefits that derive from the implementation of lean construction and the success achieved by various construction projects has also been documented. These are detailed in Table 2-5.

The lean construction philosophy is based on two variables that are evident in all production systems: transformation and flow. All activities in the production and construction environment require cost and time. It is only the transformation activities - material and instructions - that add value when the product is developed (Barboza, 2012). Any improvement to the flow of activities that is not linked to transformation inherently reduces the value-add aspect. In construction, both variables (transformation and flow) must be considered in all procedures, as there is a relationship between management of flow (by the contractor) and transformation of materials into the desired product (Barboza, 2012). Lean construction ensures that an activity is tracked regarding execution, value stream and perfection (continuous improvement) (Banki & Orumchi, 2007), which ensures that every activity is value-adding and continuously improved until its completion, and even after completion.

1.2 Problem statement

As mentioned, the South African construction industry is facing several challenges, such as poor performance of construction projects due to a lack of the required skills, poor motivation and leadership, and under-performance by staff. This leads to waste and poor performance (low productivity, re-work, defects and low profitability) of the industry (Fidelis & Heinrich, 2014).

Lean construction is a new concept in the South African construction industry, and its implementation and successful delivery of projects utilising lean construction principles is

facing challenges. In light of the issues pointed out above, as per Fidelis & Heinrich (2014), there is scope to explore the challenges experienced by the South African construction industry in delivering projects when adopting lean construction principles. This research therefore builds on the research of Fidelis & Heinrich (2014), in order to create a more contemporary and complementary picture of these challenges.

1.3 Research question

The critical research question for this research project is:

What are the challenges experienced by the South African construction industry in delivering projects when adopting lean construction principles?

1.4 Objectives

The research question assisted in defining the research aim, which is to: “Investigate the challenges experienced by the South African construction industry in adopting lean construction principles to deliver projects”.

To realise the aim, the objectives of this research were defined as follows:

1. To identify the challenges experienced by the South African construction industry.
2. To identify the challenges of implementing lean construction project management principles in South Africa.
3. To make recommendations on how to address the challenges of lean construction implementation that could assist in improving the state of the industry.

1.5 Summary of research method

In order to achieve the research objectives, a qualitative research approach was adopted. The information was obtained using two sources of evidence, namely documentation and semi-structured interviews. The participants chosen for the semi-structured interviews were selected using a purposive/ expert choice sampling method. Eight semi-structured interviews were conducted with participants who are experts in the area of lean construction as well experienced engineers, project managers or researchers in the field of lean construction. The data obtained from the semi-structured interviews was analysed using thematic content analysis and coding.

The ethics clearance number for this research study is MIAEC 177/19. (See Appendix E: Ethics clearance certificate.)

1.6 Research delimitations

The delimitations of the research were as follows:

- The research was conducted in a timeframe of one calendar year.
- The semi-structured interviews were limited to people in Gauteng Province, South Africa, due to resource and financial constraints, including the limited research timeframe.
- The research conducted was based on the construction industry in South Africa, with reference to construction industries in other countries.

1.7 Structure of the report

The research report is divided into six chapters, which will provide a comprehensive understanding of the research conducted.

Chapter 1 (Introduction): It provides an introduction and the background to the research project. The background summarising the situation in the South African construction industry and indicates key matters relating to lean construction principles in the industry. The chapter provides a motivation as to why the research was carried out, and details the research problem, the research question and the objectives of the study.

Chapter 2 (Literature Review): It provides a foundation for the research project by reviewing relevant information from different sources with respect to lean construction in South Africa and internationally. This information was used as a method of checking the credibility of the results presented in Chapter 5.

Chapter 3 (Research Design and Methodology): The methods and approaches used to undertake the research are described in this chapter. Sources of data, instrumentation, data collection and the analysis procedures that were followed are elaborated on.

Chapter 4 (Data Analysis and Results): Full details are provided of the results obtained, i.e. the qualitative data, which was analysed comprehensively. The chapter also provides an overview of the sample selection process and its composition, as well as information on the data collection process.

Chapter 5 (Discussion): The results and analysis detailed in Chapter 4 are discussed in this chapter.

Chapter 6 (Conclusion and Further Research): This chapter provides the conclusions drawn from the discussion provided in Chapter 5. It also provides an indication of the level of

achievement of the research objectives and compares the results of the study with the theory studied in the literature review. Finally, the chapter provides recommendations for further research.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a review of relevant literature on the research topic, i.e. lean construction. It introduces the origins of lean manufacturing and provides succinct details, and then deals with lean construction. Thereafter, specific topics relating to lean construction in South Africa are dealt with, i.e. lean construction principles, benefits of lean construction and the implementation challenges. Construction project management and comparisons between construction project management and lean construction are discussed, as well as the conceptual framework that was developed for this research.

2.1 Lean manufacturing

Lean engineering is a methodology that focuses on minimising waste in manufacturing systems while simultaneously maximising productivity (Lean Engineering Institute, 2020). This requires continuous improvement in three dimensions: waste reduction, value enhancement and people involvement (Bischeno & Holweg, 2016).

2.1.1 History of lean and the Toyota Production System

Mr Taiichi Ohno joined the Toyota Production System (TPS) in 1943 as a mechanical engineer (Bischeno & Holweg, 2016). He had no experience in the automobile manufacturing industry, having spent 11 years at Toyoda Spinning and Weaving. Despite his inexperience, he brought a “common sense” approach to his role (Bischeno & Holweg, 2016). Ohno had studied western production systems (Ford and General Motors) and argued that they had fundamental flaws: producing components in large batches resulted in large inventories that required costly capital and warehouse space and resulted in numerous defects. Secondly, consumer preferences could not be accommodated. Ohno believed in small lot production and focussed on reducing cost by eliminating waste (Bischeno & Holweg, 2016).

Ohno and the TPS developed a system of producing a variety of automobiles in comparatively low volumes at competitive costs (Bischeno & Holweg, 2016). This method altered the conventional logic of mass production and focused on producing variety whilst keeping cost and waste down, and Toyota gradually developed ways of combining the advantages of small-lot production with economies of scale (Bischeno & Holweg, 2016). It is this dynamic learning capability that is at the heart of the success of TPS.

2.1.2 The lean enterprise house

Toyota and the TPS now use a lean enterprise house, as opposed to a lean tools house (Bischeno & Holweg, 2016). The lean enterprise house emphasises philosophy, and a wider view of lean (Bischeno & Holweg, 2016). The foundation of this approach is the ongoing challenge of continually adapting to the needs of customers, employees and the environment, which yields kaizen or continuous change for the better. Emphasis is also placed on teamwork, and Gemba - the hands-on approach of going to see for oneself rather than management going to see (Bischeno & Holweg, 2016).

Figure 2-1 shows that the lean enterprise approach is not limited to manufacturing and operations, as a lean outlook is necessary for all functions. Additionally, the enterprise house focuses on both waste elimination and value adding.

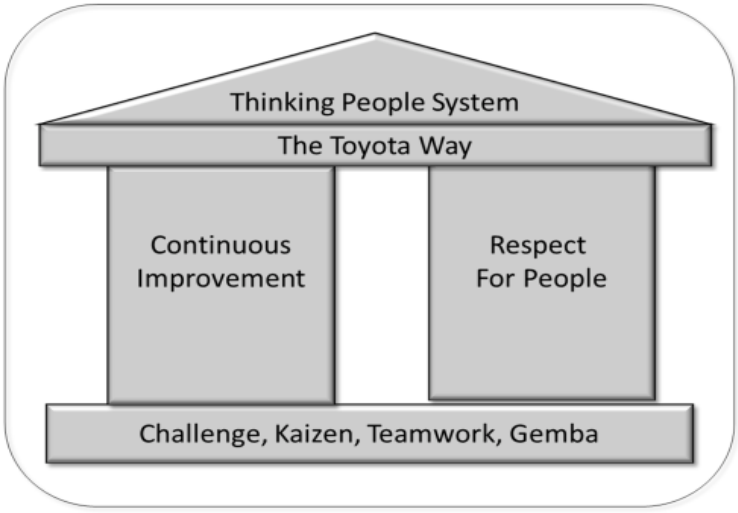


Figure 2-1: Lean enterprise house

(Bischeno & Holweg, 2016)

2.1.3 The five lean principles

According to the founders of Lean Enterprise Institute (LEI), (1997), James P. Womack and Daniel T. Jones, there are five key lean principles: value, Value Stream Mapping (VSM), flow, pull and perfection. These are explained below.

Value: This is the customer's need for a specific product. It is an established marketing idea (Crawford, 2016). Customers tend to buy results and not products (e.g. customers are really buying a clean shirt when they buy a washing machine) (Bischeno & Holweg, 2016).

VSM: After the value or end goal has been determined, mapping of the value stream is required. This is done by mapping all processes involved in creating a specific product from raw material and delivering it to the customer. VSM identifies all the actions that a product or service goes through in the production process. VSM uses a system of standard symbols to depict various work streams and information flows. Items are mapped as adding value or not adding value from the customer/ client standpoint, with the purpose of rooting out items that do not add value. The goal is to identify all steps that do not create value and then find ways to eliminate those wasteful steps. Therefore, VSM is a tool that is used to identify waste, reduce process cycle times and implement process improvement. This results in a greater understanding of the complete business operation (Crawford, 2016).

Flow: Once the waste has been removed from the value stream, the producer should ensure that the remaining process steps flow smoothly, with no interruptions, delays or bottlenecks in the process of delivering the product or service to the customer (Crawford, 2016). Reduce all non-value adding steps and introduce only value-adding steps so as to develop a strategy that will move towards simple, slim and swift customer flow (Bischeno & Holweg, 2016).

Pull: With improved flow, time to market (or time to customer) can be dramatically improved. This makes it much easier to deliver products as needed, as in Just-in-Time (JIT) manufacturing or delivery. The customer can “pull” the product from the producer as needed. This results in products not being built in advance and materials not being stockpiled, which results in an expensive inventory that needs to be managed. The benefit is saving money for both the manufacturer/ provider and the customer (Crawford, 2016).

Perfection: This is delivering exactly what the customer wants, exactly when the customer needs it, at a fair price and with the least amount of waste (Bischeno & Holweg, 2016).

Figure 2-2 illustrates the relationship between the five lean principles described above.

Figure 2-2: Relationship between the five lean principles

(Lean Enterprise Institute, 2020)

2.1.4 The seven wastes (mudas)

Seven types of waste are identified in the lean manufacturing system: over-production, inventory, motion, defects, over-processing, waiting and transport. Waste or muda (meaning useless in Japanese) is anything that does not add value. In a business, it is something that the customer will not pay for (Henshall, 2018).

Over-production: This is the most serious of the wastes, as over-production can cause all other types of waste and results in excess inventory. Stocking too much of a product that goes unused has obvious costs: storage, wasted materials and excessive capital tied up in useless inventory (Bischeno & Holweg, 2016).

Depending on the product in question, over-production can have serious environmental effects, e.g. more raw materials than necessary are consumed, and the product may spoil or become obsolete, which requires that it be discarded. In addition, if the production process involves hazardous materials, hazardous material may be wasted, resulting in extra emissions, extra costs of waste disposal, possible worker exposure, and potential environmental problems resulting from the waste itself (Eastern Kentucky University, 2015).

Inventory waste: This refers to the waste due to unprocessed inventory. This includes the waste related to storage, capital tied up in unprocessed inventory, transporting inventory, cost of containers to hold the inventory, lighting for the storage space etc. Moreover, having excess inventory can hide the original waste involved in producing said inventory (Modi & Thakkar, 2014).

Motion: Wasteful motion is all the motion related to production, whether by a person or a machine, that could be minimized. If excess motion is used to add value than what could have been added using less motion, then that margin of motion is wasted. Motion could refer to anything from a worker bending over to pick something up off the factory floor to additional wear and tear on machines that results in capital depreciation and equipment that must be replaced (Arunagiri & Gnanavelbabu, 2014) .

Defects: This refers to a product deviating from its standard design or from the customer's expectation. Defective products must be replaced, which requires that paperwork be processed by human labour and the producer could lose customers. Furthermore, the resources put into the defective product are wasted, because the product is not used. Moreover, a defective product implies waste at other levels that may have led to the defect to begin with. Creating a more efficient production system reduces defects and increases the resources needed to address the problems in the first place (Bischeno & Holweg, 2016).

The environmental costs of defects are the raw materials consumed, the defective parts of the product that require disposal or recycling (which wastes other resources involved in repurposing the product), the extra space required for storage, and the increased energy used in dealing with the defects (Eastern Kentucky University, 2015).

Over-processing: This refers to any element of the manufacturing process that is unnecessary. Painting an area that will never be seen or adding features that will not be used are examples of over-processing. Essentially, it refers to adding more value than the customer requires (Arunagiri & Gnanavelbabu, 2014).

The environmental impact relates to excess parts, labour and raw materials consumed in production. Time, energy and emissions are wasted when they are used to produce something that is unnecessary in a product. Simplification of the process and efficiency reduce these wastes and result in benefit for the company and the environment (Eastern Kentucky University, 2015).

Waiting: This refers to wasted time because of slowed or halted production in one step of the production chain while a previous step is completed. The classic example is the

production line: if one task in the chain of production takes longer than another, then any time that the employee in charge of the next task spends waiting is wasted time. The task that takes more time must be made more efficient, additional employees must be hired to help, or the workflow must be better coordinated or scheduled, in order to compensate for this wasted time (Modi & Thakkar, 2014).

Transport: This relates to moving materials from one position to another. The transport itself adds no value to the product, so minimizing this cost is essential. This means having one plant closer to another in the production chain or minimizing the cost of transportation by using more efficient methods. Resources and time are used in handling material, employing staff to operate transportation, training the staff, implementing safety precautions and in using extra space. Transport can also cause the waste of waiting, as one part of the production chain must wait for material to arrive (Eastern Kentucky University, 2015).

2.2 Lean construction

In recent years, the manufacturing industry has made significant improvements in their performance, and especially in the automobile industry (Barboza, 2012). The automobile industry has learnt to utilise fewer resources while gaining more product development. These improvements are not only the result of technological advancements but are also due to the successful application of the theory of lean production (Barboza, 2012). The definition of lean production is related to several management principles, such as JIT, Total Quality Management (TQM), Benchmarking and Concurrent Engineering (Barboza, 2012; Aziz & Hafez, 2013).

The basis of lean production was used to create the methodologies and knowledge of the lean construction approach. The term lean construction was first mentioned by Koskela (1992). Koskela (1992) stated that, in construction, labour, material and man-power need to be utilised optimally, with the minimum amount of waste and the elimination of all non-value adding activities, in order to improve the quality and efficiency of the construction processes (Bashir, et al., 2015).

As described in Chapter 1, lean construction is a natural development from lean production, which was developed by TPS (Howell, 1999; Koskela, 1992). The lean construction philosophy focuses on two aspects that are evident in all production systems: transformation and flow. All activities in the production and construction environment involve cost and time. It is the transformation, material and instruction activities that add value when a product is being developed (Barboza, 2012). In construction, both aspects of transformation and flow must be considered in all procedures. There is an inter-relationship between management of flow (by the contractor) and transforming the materials into the desired product (Barboza, 2012). Any improvement to the flow of activities that is not linked to transformation inherently reduces the value-add aspect. Lean construction ensures that an activity is tracked in terms of its execution, value stream and perfection (continuous improvement) (Banki & Orumchi, 2007). This ensures that every activity is value-adding and continuously improved until its completion and even after completion.

Lean construction is centred around a respect and relationship-oriented production management-based approach to project delivery. This is a new and transformational method of engineering construction design, and the management and building of construction projects (Lean Construction Institute, 2016). The construction industry has recognised its need to keep up with the ever-growing complexity of the built environment industry. Lean construction extends from the objectives of a lean production system, which are to maximise

value and minimise waste using specific techniques and applying them in a new way of project management (Lean Construction Institute, 2016).

2.2.1 Three steps towards lean construction

Green and May (2005) stated that attempting to be lean requires three steps to be executed successfully. The initial step requires efforts to be focussed on the removal of waste from all technical and operational aspects. Step one contains four critical elements, namely: cutting out pointless expenses; optimising workflows; removing all unnecessary actions; sharing benefits from improved performance (Green & May, 2005). Effective transportation and stock holding of material - often referred to as JIT - is required for waste minimisation (Jorgensen & Emmitt, 2008), and off-site pre-fabrication offers many benefits, such as decreasing material waste and decreasing building duration (Green & May, 2005).

Step two focuses on improving collaboration and executing tasks successfully (Green & May, 2005). In this step, continuous improvement will be the result of information sharing and joint learning (Green & May, 2005). Continuous improvement can be promoted by ensuring an educational environment in which staff communicate information and experiences regularly (Green & May, 2005).

Step three is the most difficult stage, as it requires a fundamental revision of project governance (Green & May, 2005). Aspects related to stage three are: IT tools; pre-fabrication; last planner; JIT; self-control; concurrent engineering; soft parameters; special interest groups; training; suggestions from staff; logical procurement decisions; large scale contracts; balanced goals. Only when striving to achieve step three, is a revolutionary change from the other kinds of project governance required (Eriksson, 2010).

2.2.2 Lean construction in South Africa

Fidelis & Heinrich (2014) point out that in order for lean construction to be successfully implemented in South African construction companies, four key concepts must be applied. These are highlighted and discussed below.

Awareness: Lean construction awareness is necessary to sensitise stakeholders in the industry to the opportunities and benefits of lean construction implementation.

Policy: An organisational policy should describe the principles that guide decisions, procedures and protocols. Policies should establish why the organisation supports lean construction principles and should illustrate how and what areas should be applied in what projects.

Training: Training is very important in the implementation of lean, as it involves teaching stakeholders and practitioners about the lean tools and techniques available.

Application: The implementation of lean techniques in organisations requires a high-level commitment and contribution from management. The participation and involvement of clients and stakeholders is required to support its practical implementation.

Fidelis & Heinrich (2014) stated that the following key points were noted in relation to the performance of the construction industry and the implementation of lean construction in the South African industry:

- There is a lack of proper performance management systems in the industry.
- There is a lack of a continuous improvement strategy to advance performance in the construction industry.
- Strategising is vital, as companies are finding it necessary to constantly change their approach to business, because of the uncertainties in the environment.
- Improved morale and empowerment of staff and stakeholders would enhance performance in the industry.
- There is a resistance to implementing lean as people generally show resistance to change and to new concepts. Lean being a new buzz word to South Africa does have a play in creating an atmosphere of job insecurity, considering that South Africa has low employment issues.
- There is a lack of lean related training. There should be a strategy to train people on lean before trying to implement the philosophy.

Fidelis and Heinrich (2014) developed a graphic showing the pathway for lean thinking to drive positive change in the South African construction industry – see Figure 2-3.

Figure 2-3: Pathway for lean thinking to drive change in the South African construction industry

(Fidelis & Heinrich, 2014)

2.2.3 Lean construction practices

Lean Construction Practices (LCPs) are used to ensure the lean philosophy is applied at the planning, design and construction stages of projects. LCPs are practices that can be used to enhance the project management process. One study has shown that lean construction practices can either be implemented as an integrated system such as the lean project delivery system (LPDS) and the last planner system (LPS), or as stand-alone practices in construction projects (Babalola, et al., 2019).

Figure 2-4 shows the LCPs identified from the literature, with evidence of their implementation at the various stages of planning, design and construction of buildings and physical infrastructure projects in different countries. Figure 2-4 was prepared by Babalola et al. (2019) after several papers related to lean construction and LCPs were analysed. It reveals that the most prevalent LCPs identified in this review is LPS, with its implementation in various countries being reported in 17 different articles studied by Babalola et al. (2019). Next is JIT, which Babalola et al. (2019) reported to have found in 10 articles. Other LCPs identified to have been implemented were: pull scheduling/ planning (identified in eight articles); concurrent engineering, visualization tools/ management and daily clustering/ huddle meeting (each with seven citations) (Babalola, et al., 2019). The two least implemented LCPs identified were detailed briefing and Integrated Project Delivery (IPD).

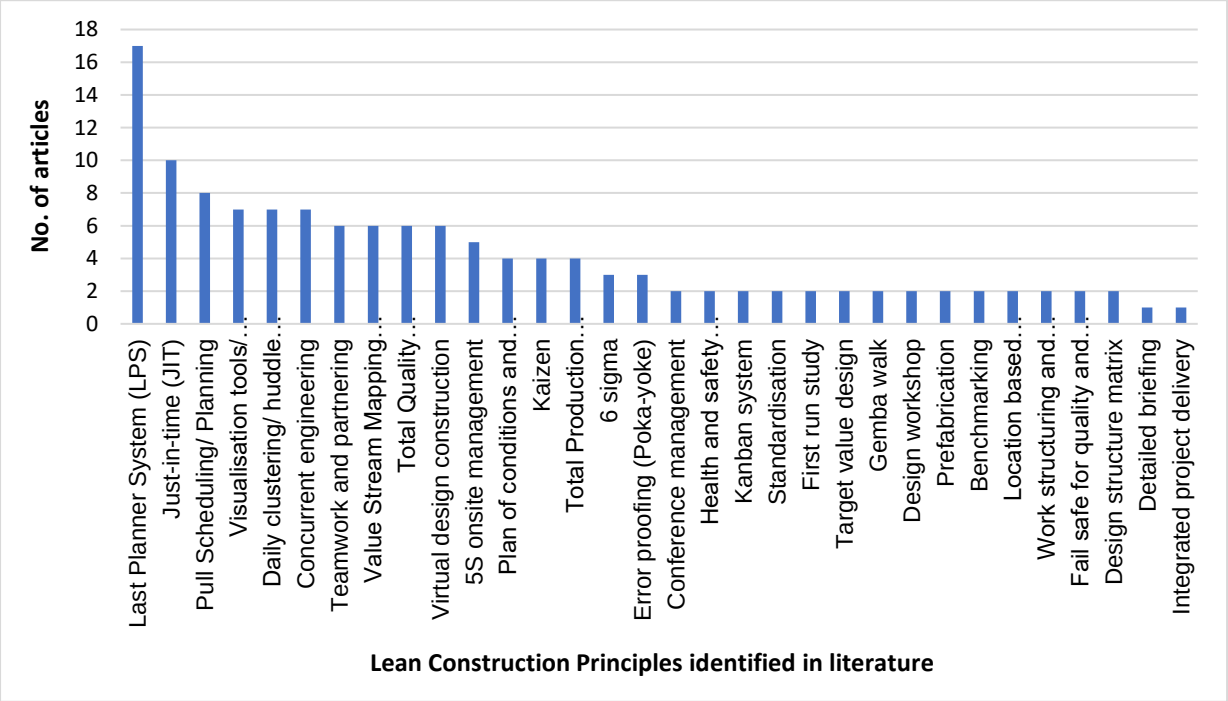


Figure 2-4: LCP identified in the literature

(Babalola, et al., 2019)

2.2.4 Categories of LCPs

The work done by Pavnaskar et al. (2003) reveals that lean manufacturing tools have been categorised based on several parameters, including: the level of abstraction; specific applications in the organisation; the capacity to address management waste or activity waste; the type of resource waste that can be addressed and whether or not the tools can identify waste, measure waste, eliminate waste or even serve these three functions simultaneously.

The key operations in terms of delivering building and infrastructure projects include design, planning, construction with management, control and monitoring. The 32 LCPs identified were categorised by Babalola et al. (2019) into four main groups, based on the areas of possible implementation in terms of design, planning and construction of building and infrastructure projects. These four groups are: Design and Engineering practices (DEPs); Planning and Control Practices (PCPs); Construction and Site Management Practices (CMPs) and Health and Safety Management Practices (HSMPs). It should be noted that the classification developed by this author is not perfect, as several of the LCPs can be put into more than one category (Babalola, et al., 2019). Tables 2-1, 2-2, 2-3 and 2-4 illustrate the distribution of the 32 LCPs among the four categories mentioned above.

Table 2-1 illustrates the Design and Engineering Practices (DEPs) classified by Babalola et al. (2019). Table 2-1 shows that the DEPs consist of nine different tools that help in achieving lean construction objectives at the design and fabrication stages of projects. One study revealed that the Virtual Design Construction (VDC) tools and the concurrent engineering appear to have been implemented in the construction industry more than the other tools in this group (Al-Aomar, 2012).

Table 2-1: Design and Engineering Practices

(Babalola, et al., 2019)

DEP	Description
Virtual Design Construction (VDC)	This is a design tool for creating Computer Aided Designs (CAD) and simulations. It can also be used to test for errors in designs and models and for direct transfer of error free design for production or pre-fabrication.
Design structure matrix	This is used in structuring the design and design process into sequential segments.
Pre-fabrication and modularisation	Pre-fabrication is used in the production of project parts at an off-site factory. These are moved to site for installation. Modularisation involves

	dividing spaces into sections or modules of equal size to aid the process of mass pre-fabrication of project components.
Detailed briefing	This is a pre-design tool that enables proper analysis of a client's brief and transfer of the brief into design.
Design workshops	This is a room on site that is used for meetings by project designers, where the entire design and its process are discussed and analysed, in order to deal with difficulties and suggest creative design solutions.
Integrated project delivery	This project delivery approach involves signing a contract between the client and key designers, contractors and other stakeholders involved in the project.
Target value design	This design tool ensures that projects are designed to meet the client's cost and time set targets.
Standardisation	This means the use of accepted dimensions, criteria and standards in the design of project components and each operation involved in the project.
Concurrent engineering	This involves collaborative sharing of information in the process of executing different tasks on a project, with the aim of ensuring functional design, a product with good quality and a productive process.

Table 2-2 shows the Planning and Control Practices (PCPs) classified by Babalola et al. (2019). Table 2-2 indicates the second category of LCPs identified in the literature as falling in the category PCPs. Nine of these LCPs support strategic decision-making at the preconstruction, construction planning and control process stages, one of which is 6 Sigma, which is a quality control tool. From the number of articles that identified the tools in this category, it can be inferred that some of them are well implemented in the construction industry (Babalola, et al., 2019).

Table 2-2: Planning and Control Practices

(Babalola, et al., 2019)

PCP	Description
Work structuring and scheduling	LPS is a planning and control improvement tool that is used to monitor the construction process. It involves the use of master planning, phase planning, looking-ahead planning and weekly planning.
Work structuring and scheduling	This is used to break down the construction work process into separate and sequential small parts, in order to achieve reduction of work variability.
Location-based management system	This models the construction process into the locations where the activities will be done. The modules are linked based on their

	relationships.
Benchmarking	Benchmarking involves dividing construction work into sections, with an encouragement package attached to each section assigned to a team of workers. This package serves to encourage competition between project teams and provide motivation.
6 Sigma	This helps to analyse the construction process (i.e. problem identification, performance measurement, analysis of variations) from a statistical perspective, in order to achieve continuous improvement of the process.
VSM	This is a strategy used in mapping out non-value adding activities in the construction process, in order to maximize value for the client.
Daily cluster or huddle meeting	A daily cluster or huddle meeting involves all site workers meeting with the project management team to discuss project issues. this helps to improve communication between site workers and project managers.
Pull scheduling/ planning	This is the pulling together of materials used in the entire value chain process, in order to get them ready in time for the production process, according to the project plan or schedule.
Error proofing (Poka-yoke)	This tool is used to scan the construction process ahead of time for errors, so as to avoid errors creeping into the construction process.

Table 2-3 shows the Construction and Site Management Practices (CSMPs) classified by Babalola et al. (2019), i.e. the third category of LCPs. There are 11 tools/ practices that promote proper management, organisation and coordination of site activities and processes at the construction phase. Some of the practices, such as JIT, Total Quality Management (TQM), Conference Management (CM) and teamwork and partnering, are implemented more often than others, like Gemba walk, Kanban system and first run study (Babalola, et al., 2019).

Table 2-3: Construction and Site Management Practices

(Babalola, et al., 2019)

CSMP	Description
Gemba walk	This involves interrogating the source of a problem to uncover the cause of and fix it.
Total productive maintenance	This is a hands-on preventive approach for maintaining the site operator's equipment. This ensures that operators take care of their equipment as they use it.
Kanban system	This is an ancient lean tool that involves the use of an inventory control card or sign for purposes of stock-taking at the project site. This helps to

	promote effective inventory and record keeping at the construction project site.
5S On-site management	5S means sorting, straightening, shining, standardizing and sustaining all site processes and activities, with the aim of achieving good construction site management.
First run study	This relates to modelling important construction site operations, especially those that have little or no idea about the operation. It requires investigation of errors and alternative approaches being used to prevent or mitigate them.
Kaizen	This encourages continuous improvement in every construction site process.
Teamwork and partnering	As the name implies, this involves collaboration between all stakeholders involved in the construction process, including clients, designers, planners, contractors and suppliers.
TQM	TQM is a construction management tool that is used to identify and assess possible problems, develop and apply new solutions and appraise results.
JIT	JIT enables prompt delivery of materials, information and drawings, or anything else required for a project, to the point of usage.
Visualisation management (VM)	VM is a tool used in passing specific instruction to workers on site. It might involve the use of sign boards or posts in designated areas on construction sites.
CM	CM is a lean tool for coordinating conferences, workshops and training sessions on a project.

Table 2-4 lists the HSMPs classified by Babalola et al. (2019). This category of LCPs helps in ensuring the correct health and safety conditions for workers and equipment on construction sites. Table 2-4 provides detailed descriptions of the key components of this category of lean practices. Of the three practices identified, fail safe for quality and safety appears to be the least implemented tool (Babalola, et al., 2019).

Table 2-4: Health and Safety Management Practices

(Babalola, et al., 2019)

HSMP	Description
Fail-safe for quality and safety	It helps in minimising harm on site. It can help to ensure that no employee is harmed on site, by predicting possible risks and ensuring proactive action is taken to prevent the risk.
Plan of conditions and work environment	This lean strategy is useful in planning for safety and health through assessment, identification and control of likely risks. It usually involves planning all aspects of safety for workers and setting the conditions required for achieving this.
Health and safety improvement management	This is an advanced lean tool that involves planning to ensure acceptable health and safety conditions for site workers.

2.2.5 Benefits of LCP application in the construction industry

Lean construction is significantly different from traditional project management practices. This is due to processes being actively managed and metrics being used in the planning system performance to ensure reliable workflows (Forbes & Ahmed, 2011). Lean methods tend to optimise projects at project level, rather than trying to optimise each activity in the project without integrating all other activities. This reduces total project performance. In traditional construction management approaches, individual activities focus solely on a specific task, to the detriment of other tasks. In a lean approach, all tasks are focused on (Ballard & Howell, 2004).

Table 2-5 shows how the benefits of lean construction have complimented traditional construction management in some countries.

Table 2-5: Benefits of lean construction that have been reported

(Mossman, 2009; Martins & Cachadinha, 2013; Issa, 2013)

Benefits	Countries
Improved project delivery methods.	Japan, UK, USA
Supporting the development of teamwork and transfer the responsibility on the supply chain.	Finland, Japan, Korea, USA
Managing uncertainties in supply.	Brazil, Finland, Japan, UK
Continuous improvement within projects.	Germany, Singapore, UK

Efficient use of resources.	Brazil
Delivery of products and services that enable the client's goals to be met.	Korea
Delivery of products and services on time and within budget.	Finland, Germany, Singapore
Delivery of custom products instantly, without waste.	Brazil, Finland, UK
Reduction of direct cost and time in terms of transportation and communication.	Brazil, UK
A well-informed business case design at all project levels.	USA
Improved quality control and minimisation of risks.	Korea
Minimisation of conflict that could dramatically change the budget and schedule.	Germany, Singapore, UK
Improved reliability, accountability, certainty and honesty in the project environment.	Germany, Singapore, UK
Reduces the owner's design-related requests, which eliminates waste.	Portugal
Mitigation and reduction of project risk factors.	Egypt

Forbes and Ahmed (2011) believe that that lean methodologies and thinking is the way to manage construction projects, because the principles and tools have formed the basis for new project deliveries. The benefits of the approach illustrated in Table 2-5 have encouraged some companies to implement LCPs to improve their performance.

As mentioned, the flow in lean processes focuses on two factors: waste reduction and value maximisation. This should redefine how people think, plan and complete construction activities (Fidelis & Heinrich, 2014).

By utilising lean construction techniques and eliminating waste in construction, lean construction delivers the following benefits (Akinradewo et al., 2018; Womack & Jones, 2010; Mossman, 2009):

- minimises double handling.
- minimises variance in input.
- reduces interpersonal dynamics.
- promotes a balanced team.

- minimises changeovers and difficult steps.
- results in greater customer satisfaction.
- outlines value from the project viewpoint.
- uses target costing and value.
- improves safety.
- increases productivity.
- shortens project schedules.
- improves quality.
- improves reliability.
- increases predictability.
- improves risk management.
- maximises the use of multi-skilled employees.
- improves effective communication between stakeholders.
- encourages lean thinking by all employees involved in the project.

2.2.6 Challenges facing the implementation of lean construction

Several studies have been conducted in various countries to investigate challenges encountered in the implementation of lean construction principles. These challenges are highlighted and discussed below.

Management: In order for the implementation of lean practices to be successful, it is vital that there is commitment to developing and implementing an effective plan. Providing the required resources and support to manage changes that arise during implementation is also key. Some challenges identified are related to management issues (Olatunji, 2008). Poor project definition, inadequate resources and delays in the delivery of materials were found to be some of the managerial issues that hinder the successful implementation of lean construction (Olatunji, 2008). Insufficient time for innovation and a long period of implementation are other challenges faced (Mossman, 2009).

Other challenges linked to poor management include poor communication, lack of clearly defined plans, subcontractor and supplier involvement, lack of transparency, inaccurate preplanning, delay in decision making, unsuitable organisational structure, weak administration and poor procurement strategies (Koskela, 1992; Forbes & Ahmed, 2001).

Financial: In order for LCPs to be implemented successfully, adequate funds are required to motivate staff, provide relevant materials and equipment and, in some cases, employ lean specialists to guide both employers and employees in implementing the concept (Bashir, et

al., 2015). Finance related issues are among the most common challenges to adopting lean practice in many organisations in various countries (Bashir, et al., 2015). Other financial challenges are paying acceptable wages, corruption, lack of incentives and motivation, and high implementation cost. These issues vary across different countries (Olatunji, 2008; Mossman, 2009).

Educational: In recent years, a significant amount of effort has been put into raising awareness, providing guidance and sharing knowledge related to lean construction by academics, researchers, practitioners and organisations. These organisational bodies are Lean Construction Institute (LCI), International Group for Lean Construction (IGLC), Construction Lean Implementation Program (CLIP) and Construction Excellence (CE). However, these bodies operate in very few countries and despite the large number of publications on lean construction, educational issues still appear to be the most common challenges to lean practice. Illiteracy and inadequate knowledge among workers, lack of awareness, lack of training and lack of information sharing are common educational challenges (Bashir, et al., 2015).

Mossman (2009) stated that a lack of technical skills in the field, insufficient training and knowledge sharing, illiteracy and computer illiteracy are educational issues that need to be addressed in order for the implementation of lean to be successful.

Governmental: Despite the significant economic contribution being made by the construction industry in various countries, it still faces numerous problems related to government policies (Bashir, et al., 2015). Challenges, such as. Inconsistencies in policies, corruption and the unsteady price of commodities impede the implementation of lean construction in some countries (Olatunji, 2008).

Technical: The implementation of lean construction may be affected by technical challenges, because these have a direct impact on the application of lean construction principles like reliability, simplicity, flexibility and benchmarking (Koskela, 1992). Design related challenges identified include incomplete designs, inaccurate designs and a lack of design constructability (Koskela, 1992).

Human attitude: “This is one of the major factors affecting the implementation of lean construction. Some of the attitudinal issues affecting lean construction practice include lack of cooperation by workers, poor understanding of client’s brief, misconceptions about lean practice, lack of committed leadership, lack of teamwork, lack of self-criticism, poor house-keeping and fear of unfamiliar practices” (Bashir et al., 2015: 11).

Bashir et al. (2015) revealed the results shown in Table 2-6 in terms of overcoming the challenges facing LCP in UK contracting organisation. These are linked to the nature of the challenge.

Table 2-6: Nature of challenges facing lean practice in organisations in the UK

(Bashir, et al., 2015)

Challenges	Nature of challenge
Resistance to culture change	Human related
Lack of cooperation from employees	Human related
Lack of long-term forecast and investment	Management related
Long implementation time	Technical issue
Cost of implementation	Financial issue
Lack of lean knowledge	Educational issue
Lack of incentives	Management related
Misconceptions about lean	Human related
Complexity of lean implementation	Technical issue
High expectations from management	Management related

Wandahl (2014) suggests that since lean construction has been adapted, the successful implementation of lean construction principles requires adaptation of a country's culture and the organisations that run it. Wandahl (2014) suggests that there is a wide range of implementation barriers in terms of lean construction, but some occur more often than others. The most common barrier relates to insufficient knowledge, lack of training and education.

Cultural issues are also an often-mentioned barrier. Lean construction is implemented worldwide, with much variation in cultural contexts. Cultural maturity and human capital are an evolutionary process, and empowerment and maturity are central to successful implementation of lean construction. The culture of the construction industry is known to be opportunistic, prone to conflict and resistant to change, but changing traditions and culture seem to be a prerequisite for implementing lean construction (Wandahl, 2014).

2.3 Construction project management

Construction project management involves the planning, control and coordination of a project from conception to completion. It requires that the client's objectives are identified, i.e. utility, function, quality, time, resources and cost. Project management provides the "single point of integrative responsibility" needed to ensure that all aspects of the project are managed effectively, in order to ensure a successful project deliverable. Integration, monitoring, control, optioneering and evaluations in pursuit of client satisfaction with the project outcome are essential facets of project management (Walker, 1984).

The South African Council for Project and Construction Management Profession (SACPCMP) defines construction project management as the management of projects in the built environment from conception to completion, including management of related professional services (SACPMP, 2012).

PMBOK (2004) states that project management requires the project manager to adopt and show expertise in a number of areas of knowledge. Table 2-7 describes these nine project management knowledge areas. It indicates the expertise required and provides a brief description of each area of expertise.

Table 2-7: Project management's nine areas of knowledge expertise

(PMBOK, 2004)

Expertise	Description
Project integration management	This is the heart of project management. It comprises the day-to-day processes that a project manager relies on to ensure that all the parts of the project work together. It is the art and science of ensuring that the project moves forward, that the project plan is fully developed and properly implemented, and it requires the project to mesh with the existing operations of the organisation.
Project scope management	This is the process required to ensure that the project includes all the work required and only the work required, to complete the project successfully.
Project time management	This is the process employed by using techniques and tools to schedule and use up time in the most effective way possible, to generate the maximum value for every second spent. It is required to ensure timely completion of the project.
Project cost management	This is the process required to ensure that the project is completed within the approved budget. It is more than just calculating the cost of the overall project, as it relates to creating the budget (the cost of individual elements of work) and the time scale of overall project

	expenditure.
Project quality management	This is the process necessary to ensure that the project will satisfy the need for which it was undertaken. It addresses both the management of the project and the product of the project. It improves project management as well as the quality of the product and ensures the delivery of both a high-quality product and a high grade of product.
Project human resource management	This is the ability to lead, direct and orchestrate the project team, customers, project partners, contributors and any other stakeholders, so to achieve the desired results for the project.
Project communication management	This is the management of the transfer of information from one person to another person. Communication management aims to have the receiver understand the message as it was intended.
Project risk management	This is the process of identification, analysis and response strategy of all significant project risks, with the aim of reducing the opportunity for and consequence of loss.
Project procurement management	This is the process of purchasing the products necessary for meeting the needs of the project scope. It involves planning, soliciting sources, choosing a source, administering the contract, and closing out the contract.

PMBOK (2000) stated that project management is widely regarded as the most efficient way of introducing unique change. Essentially, project management achieves this by:

- Defining what must be accomplished in terms of time, cost, and technical and quality parameters.
- Developing a plan to achieve these deliverables and ensuring that progress is maintained in line with the objectives.
- Using appropriate project management techniques and tools to plan, monitor and maintain progress.
- Employing people who are skilled in project management – including a project manager – who are given responsibility for introducing the change and who are accountable for its successful accomplishment.

2.4 Construction project management in South Africa

Project Management South Africa (PMSA) was formed in 1997 to provide a local and independent association for South African project managers. PMSA members include project practitioners, experts and project enthusiasts.

In 1997, the Minister of Public Works requested that PMSA assist government and the country to develop effective project personnel, practices and results. PMSA (2008) describes some of the results of the key government projects implemented since 1997:

- Formation of a project management Standards Generating Body (SGB).
- Contribution to and communication of the local project management standards and national qualifications.
- Contribution to the development of the Construction Professions Act.
- Discussions regarding the establishment of an Education and Training Quality Assurance (ETQA) for project management under the Services SETA.

The current association that governs the Construction and Project Management profession in South Africa is SACPCMP. The SACPCMP is a statutory body established in terms of section 2 of the Project and Construction Management Act, 2000 (SACPMP, 2012). SACPCMP was established to provide for statutory professional certification, registration and regulation of project and construction management professions in order to protect public interest and advance construction and project management education (SACPMP, 2012).

Presently, the process of planning for construction projects is done by segmenting project streams into activities or work packages. Time, cost and resources are estimated and then allocated to each respective activity. The CPM method is then used to plan the logical sequence of activities, which assists in determining the various parts of the works that must be outsourced or done by internal staff.

Scheduling programs are used by project managers to develop the project program. Project managers set the start time, as required by the client/ contract, and apply pressure to begin activities at the earliest start time. Activities are monitored and evaluated using project controls (monthly meetings, weekly financial updates, progress updates, etc.). If any deviation is observed, a control unit is set in place to correct the deviation from the program. This process also identifies whether or not each activity matches the primary project objectives.

This approach seems logical, so why do so many projects fail, and why do the time and cost of projects rise beyond the plan/ budget?

2.4.1 Traditional project management vs lean construction principles

Many differences between the lean construction approach and the Project Management Institute's (PMI) approach to construction are indicated by Howell (1999) and Ballard (2000). These are listed in Table 2-8.

Construction management is activity focused with contracts or assignments defining the objectives of various participants. Coordination between teams or organisations is controlled from a central project plan that establishes sequence and determines when an activity will start and end. Costs, errors and learning occur within activities. Cost reduction results from improving productivity. Project duration is shortened by accelerating activities or by changing logic to allow concurrent work. Waste is cost that could have been avoided within the activities, such as re-work, or cost due to extended activity duration along the critical path of the construction program (Howell, 1999; Ballard ,2000).

Lean construction presents a very different model from that of traditional project management, as lean construction is managed so that actions produce unique value for the customer. Project duration and cost are considered in "project-as-production system" terms, which makes concern for project total cost and duration more important than the cost or duration of any activity. Co-ordination is generally accomplished by the central schedule, while the details regarding workflow are managed throughout the organisation by people who are aware of and support the project goals (as opposed to activity or local performance). Value to the customer and the movement of information or materials to completion are the primary objectives. Improvement results from reducing waste (Howell, 1999; Ballard ,2000).

Lean construction thinking ensures attention is given to how value is generated rather than how any one activity is managed, as lean construction thinking views the entire project as a production system. In contrast, project management approaches view a project as a combination of activities (Howell, 1999; Ballard ,2000).

Table 2-8: Differences between the traditional project management approach and the lean construction approach

(Howell, 1999; Ballard, 2000)

Lean construction approach	PMI approach
With lean construction, optimisation efforts focus on making the workflow reliable.	In contrast, PMI focuses on improving the productivity of each activity, which may create errors and reduce quality, resulting in re-work.
Managing the interaction between activities and the combined effects of dependence and variation is the first concern of lean construction, as this have a significant effect on the time and cost of projects.	These interactions are not considered in PMI. With PMI, there is a lot of focus on a specific task, before moving on to tackle the next task. The various tasks are not studied or planned holistically.
The project is structured and managed as a value generating process, with value being defined as satisfying the customer's requirements.	PMI considers lower cost as value. The value defined here is value relating to completing the project within budget. There is no value defined in continuously improving staff, client and all other stakeholders.
Pull techniques govern the flow of information and materials from upstream to downstream.	Push techniques govern the release of information and materials.
Project control has the job of execution.	Control in PMI relies on variance detection after-the-fact.
Capacity and inventory are adjusted to absorb variation. Feedback loops included at every level help ensure minimal inventories and a rapid system response.	PMI does not consider adjustments.
It aims to mitigate variation in terms of every aspect (product quality, rate of work) of the project and to manage the remaining variation.	PMI does not consider variation mitigation and management.
The lean approach aims to implement continuous improvement in the process, workflows and product.	The PMI approach does not pay much attention to continuous improvement. PMI focuses on completing a specific task within an allocated time linked to a budget.
In lean construction, decision making is distributed in design production control systems.	PMI decision making is sometimes centred on one manager.
Lean construction aims to increase transparency between stakeholders, managers and labourers, in order to know the impact of their work on the project.	PMI does not consider transparency methods. PMI is very hierarchical and ensures that a chain of command and authority is followed.

In lean construction, a buffer of sound assignments is maintained for each crew or production unit.	The PMI method does not consider a backlog for crews.
Lean construction develops new forms of commercial contracts to provide suppliers with incentives for reliable workflow and optimization at the deliverable-to-client level.	PMI does not have such policy. With PMI, there is one central contract linked to a scope of works, fee of works and penalties for late delivery.
The lean construction production system design resists the tendency toward local sub-optimisation.	PMI persists in optimizing each activity.
Lean construction encompasses project and production management. It formally recognizes that any successful project undertaking will inevitably involve interaction between project and production management.	The PMI driven approach only considers managing a project at the macro level. This is necessary, but not enough to ensure the success of the project.

2.5 Conceptual framework

The conceptual framework developed illustrates themes (blue text in Figure 2-5) in the literature, as indicated in section 2.2.6, which relate to barriers to implementation of lean construction globally and in South Africa. From these themes, codes were developed. These codes were probed and searched for through the interviews and were linked back to a specific theme. As the interviewees were a source of data and have a significant amount of knowledge and experience in lean construction, other barriers to implementation of lean construction were discussed. The perspectives and theories of the participants were key to the study objectives.

Objective 1 of the research study relates to the current challenges experienced by the South African construction industry. As the interviewees were a significant contributor of knowledge in this study, their knowledge of the current challenges experienced by the South African construction industry was key to this research (magenta text in Figure 2-5). The third objective of this study was to make recommendations on how to address the barriers to implementation of lean construction in South Africa (red text in Figure 2-5). These recommendations also indicate further areas of research that could be investigated.

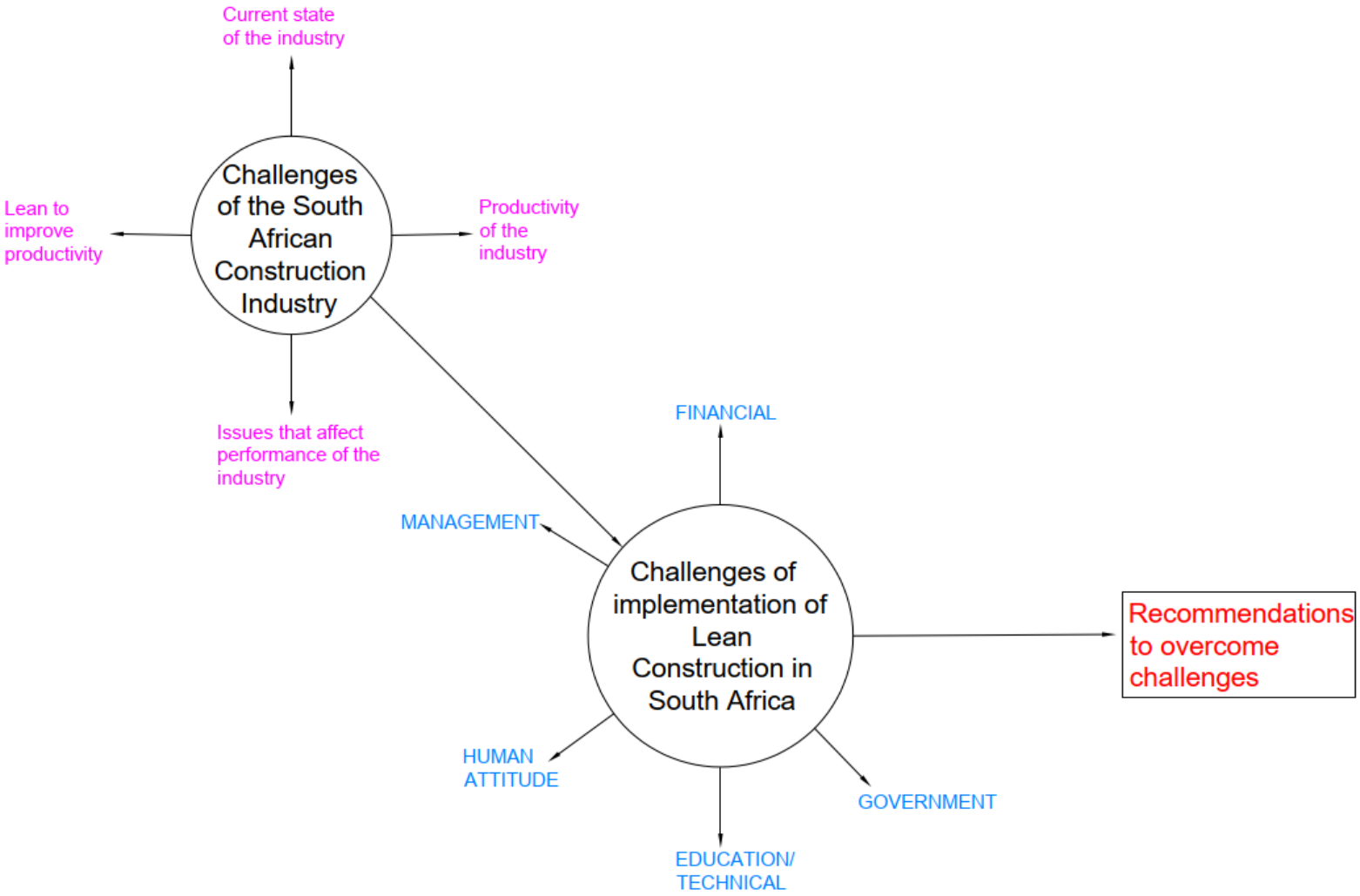


Figure 2-5: Conceptual framework

(Developed by author)

CHAPTER 3: RESEARCH METHODOLOGY

This chapter presents the research methodology designed to achieve the research objectives. This chapter explains the research process and approaches including the research methodology and the research method used. The relationship between the research method and objectives, data collection and the sampling methodology is also explained. In addition to this, the data analysis techniques used are discussed and finally the credibility, reliability and validity of the research findings are presented.

3.1 Research design

Research design is the framework developed by the researcher that assists him/ her in collecting and analysing data for the study. The purposes of a research design are as follows:

- To allow the research to be as effective as possible by developing a framework to gain maximum information with the least amount of spending (effort, money and time).
- To ensure that the relevant data and the data collection techniques are followed.
- To set out a map to guide the research.
- To assist the researcher to organise his/ her ideas, which in turns allows him/ her to identify and correct any faults.

(Pandey & Pandey, 2015)

There are several research methods that exist for satisfying various research requirements. To address the research question and objectives of this research report, an appropriate research model had to be identified and adopted to form the basis of the research report. A “what” question is posed with regard to a contemporary phenomenon, namely lean practices in construction (Yin, 2009). This research is also exploratory as the phenomenon of lean construction is still relatively new in South Africa. Thus, because a relatively unexplored phenomenon, in South Africa, is being investigated, a qualitative approach is most appropriate as the research method.

Information was obtained using two sources, namely, documentation and semi-structured interviews.

3.2 Study design

As it is with any study, generally accepted rules must be followed to maintain order throughout the data collection and analysis procedures. Each step listed below was repeated multiple times throughout the project. Each process worked with others to advance the study. Qualitative practices are iterative rather than linear in nature. The steps followed throughout the study were (Williams, 2011):

- sketch out a plan.
- ask questions.
- develop a focus.
- summarise and record.
- develop themes for the interview.
- conduct interviews.
- analyse the data.
- link to research question and objectives.
- conclude and recommend.

3.3 Sampling

A sample is a collection of respondents who fairly represent a population (Pandey & Pandey, 2015).

The respondents to the semi-structured interviews were chosen using a sampling method rather than the census method (Pandey & Pandey, 2015). The sampling method considers a small group of individuals who are selected to represent the population under study, in this instance the group of individuals involved in the construction industry in South Africa.

A purposive/ expert choice sampling method was used to select interviewees. Expert choice sampling was selected as the sampling method due to the knowledge that this researched gleaned from individuals who have expert knowledge or sufficient working experience in the lean construction and construction industry of South Africa (Wengraf, 2001). Expert sampling is particularly useful where there is a lack of empirical evidence in an area and high levels of uncertainty, as well as situations. This is relevant to the research as the topic of lean construction is new globally and more so, in South Africa.

3.3.1 Selection criteria for respondents

In deciding upon a criterion to select the appropriate people to be included in the sample selected for this research study, the initial criteria were to utilise the research question and interview questions to determine the character of appropriate material required from the appropriate people.

A specific list of criteria was used to select the appropriate participants for this research. The criteria are described below:

- Professionals with a post-graduate degree.
- Lean practitioners or engineers or construction project managers.
- Significant and appropriate years of experience related to the subject matter of this research, which is lean construction project management and the construction industry in South Africa.
- Minimum number of years of experience for each specific profession. Lean practitioners = 10 years' experience specifically in lean construction. Engineers and project managers = 15 years' working experience in the construction industry and a minimum of 5 years' experience of working knowledge of lean construction. Researchers = 15 years' of research relating to construction project management and lean construction.
- Willingness and capacity to share and express their experiences and thoughts.

- Usefulness of the participant.
- South Africans with a significant number of years of experience of the South African industry.
- Ease of access to the participant.

The participants were sourced from direct telephonic or email discussions with large companies in South Africa that are involved in lean construction. These participants aided in referring the researcher to other possible participants. Some of the participants were also sourced by contacting authors and researchers in the field of lean construction, based on the investigation done in the literature review stage of this research and through universities in South Africa.

Number of Respondents

In determining the number of participants required for this research, various factors had to be considered, saturation of data collected being a very crucial factor. In qualitative research, saturation is defined as follows by Glaser & Strauss (1967):

“No additional data are being found whereby the (researcher) can develop properties of the category. As he sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated ... when one category is saturated, nothing remains but to go on to new groups for data on other categories, and attempt to saturate these categories also”.

Saturation is the criteria used to determine the sample size; it is reached when the data being collected shows no new insight or different viewpoints. Collecting more data is unnecessary when the saturation point is reached (National Centre for Research Methods Review Paper, 2012). O’Reilly and Parker (2012) state that a vital factor to consider in terms of sample size is the depth of the data, as opposed to the frequency of data. However, researching until saturation point is reached is challenging, as it requires the researcher to sample, collect data and analyse the data simultaneously (O'Reilly & Parker, 2012).

There were various other practical matters, advice and research that were considered before deciding on the number of participants. For example, conducting semi-structured interviews, recording them, transcribing them and studying copious amounts of information and analysing the data is a labour intensive and time-consuming process. A balance between personal life, time available, work commitments and the successful completion of the research study had to be considered.

Considering all the above, the initial estimate was to complete eight to twelve semi-structured interviews. During the simultaneous process of data collection and analysis, data saturation was reached at eight interviews. The participants made similar inferences and conclusions in relation to the research question and objectives. The data collected was judged to be sufficient to achieve the research objectives and the inferences coded were beginning to be very similar hence it was decided that no further interviews were required.

3.3.2 Selected respondents

Some of the interviews were conducted with experts in lean construction who are lean practitioners in their organisation and who have extensive knowledge and experience of lean construction. The lean experts have between 10 to 20 years' experience each in the lean construction space and its implementation. They are professional academics who regularly host internal (within their own organisations) and external lean construction seminars and trainings at academic institutions and companies. The lean experts have also worked alongside internationally recognised lean construction and lean manufacturing researchers and practitioners, and they have also published journals and co-authored in books relating to lean leadership, lean construction, lean manufacturing and the implementation of lean construction across the globe.

The engineers and construction project managers selected for the interviews all have extensive experience in the construction industry, ranging from 15 to 30 years of experience each. They are individuals who have/ had senior roles within their organisation and other civil engineering statutory organisations in South Africa. These individuals have practiced lean construction principles and techniques in their respective organisation and within their projects for many years (5 to 10). They have a working and implementation knowledge of lean and lean construction on South African and international projects.

The researchers selected for the interviews are researchers who have 15 to 17 years of experience each. They are established researchers at recognised Universities in South Africa and have published journal articles and books relating to lean construction, lean construction techniques and lean construction implementation relating to the South African construction industry and other countries in which they have resided and worked.

The above information was part of the criteria in order to ensure that the successful participants will have meaningful knowledge and experience of various important aspects of this study. These aspects included, but not limited to, the South African construction industry, lean construction, lean construction implementation, lean construction principles applied in the South African construction industry and other international construction

industries, identifying the challenges in the industry as well as giving their recommendations on how to address these challenges.

3.4 Instrumentation

As stated, semi-structured interviews and sourced documentation were used to collect the data. The semi-structured interviews were recorded and transcribed. Semi-structured interviews enable deep research into the research question. It provided knowledge of the past and present and the interviews will provide a deeper insight into the lean construction industry and problems previously identified in its implementation.

Due to its flexibility in research, the interviews allowed for more open-ended questions and discussions that provided greater insight and understanding of lean construction in South Africa and the challenges experienced in its implementation.

3.4.1 Developing the interview questions

By utilising the information gathered from the literature review and developing the conceptual framework shown the literature review, the questions for the interview was developed.

In designing the interview questions, the interview questions had to be clearly differentiated from the research question. Wengraf (2001) states that theory questions should not be interview questions. The theory questions manage the production of the interviewer questions but the theory questions are formulated in the theory language of the research community and the interview questions are formulated in the language of the interviewee (Wengraf, 2001).

As mentioned previously, semi-structured interviews were a main source of data collection instrumentation used for this research. Semi-structured interviews tends to suggest a degree of standardisation of the questions yet a slightly different degree of openness to discussions emanating from the interviewee responses (Wengraf, 2001).

Wengraf (2001) was referred to when developing the interview questions, which proceeded as follows:

- Definition of the central research question and research purposes, i.e. research objectives. These have been described and motivated in Chapter 1.
- The central research question was further divided by the several theory questions which the interviews assisted in answering.
- From the theory questions, appropriate interview questions were developed pertaining to each theme identified. The themes are discussed in section 3.4.2.
- The intended interviewees needed to be defined in relation to the interview questions, theory question, research question and research purpose.

Figure 3-1 illustrates the development of the interview questions detailed above.

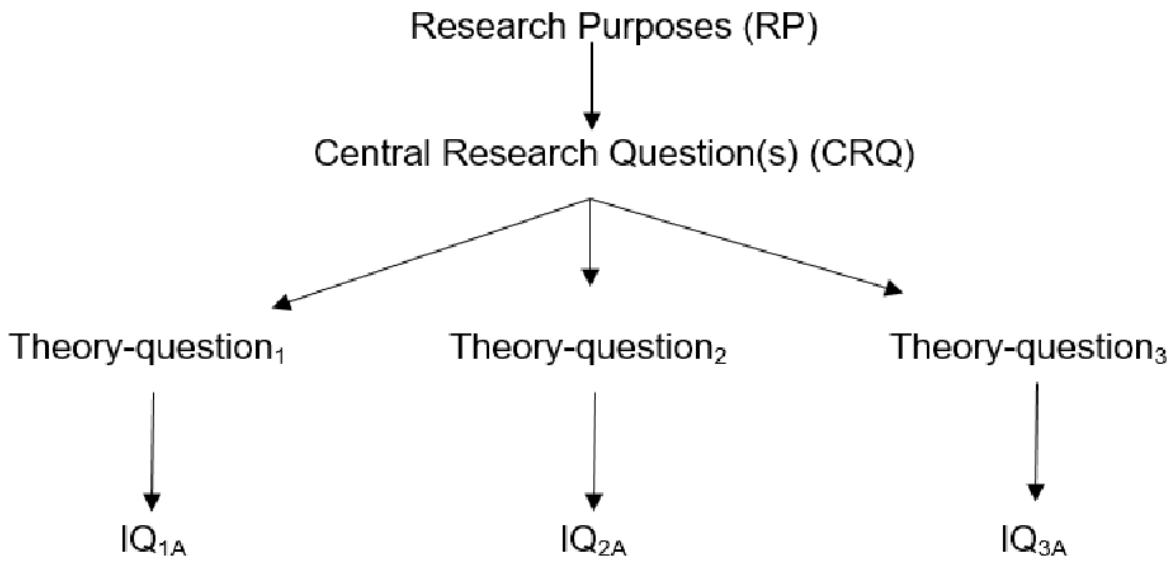


Figure 3-1: Development of interview questions using the pyramid model

(Wengraf, 2001)

From the literature, there were five predominant themes identified. These themes featured in majority of the literature reviewed. The development of the themes is discussed further in section 3.4.2. Based on these themes, three to five questions were developed per theme and these questions were developed to target the research objectives and ultimately provide a clear path to answering the research question (Wengraf, 2001).

Development of the questions greatly assisted in defining and ring-fencing the participants required for the interviews.

The interview questions are shown in Appendix C: Interview questions.

3.4.2 Developing themes

After defining the focus of the study, themes for the data analysis were developed. The themes described are a summary or expansion of the research questions. Themes provide the primary information about the phenomenon that is essential to the study. The themes were created, in part, based on the researcher's own personal lean implementation experience in the construction industry as well as reviewing the literature on the subject. The themes clarified the general research question for the study and provided a framework for gathering data.

The five pre-determined themes that were explored in this study are listed below, together with the other sections of the questionnaire.

- General questions
- Knowledge of lean construction
- Current challenges experienced by the construction industry (research objective)
- Government (Theme 1)
- Management (Theme 2)
- Education/ Technical (Theme 3)
- Financial (Theme 4)
- Human Attitude (Theme 5)
- Identification of other barriers
- Recommendations on overcoming these barriers of lean construction implementation (research objective)

3.5 Data collection

The primary data was collected from documents in the form of documentation throughout the research procedure and from references through the interviewees. These documents were from various industrial and civil engineering and project management journals, websites and books. No unpublished data was used in the development of this research.

The semi-structured interviews were pre-arranged and were physically and telephonically completed. The interviews had an expected duration of 30-60 minutes. The average duration of the interviews was 52 minutes.

Face-to-face interviews were preferred, as this made it much easier to communicate with the respondents and allowed for the discussions to be more flexible. The interviews were conducted in a private setting, such as an office or conference room, so as to minimise distractions and ensure privacy. A letter of consent was presented to each participant at the start of the meeting. See Appendix B: Letter of consent.

Face-to-face interviews were always not possible due to location and scheduling issues. Hence some of the interviews were conducted telephonically. In those cases, the letters of consent were sent to the interviewee by email.

Part of the interview procedure included agreeing, or not agreeing, to have the interview voice recorded. If participants did not agree, they had the option to either withdraw or to proceed without being recorded. All participants agreed to be recorded therefore, the researcher was free to focus on the responses and upcoming questions.

Ten interviews were conducted in total, two of which were pilot interviews. The pilot interviews were conducted to ensure that the questions are clear and understandable to the interviewee. Probing questions and the methods were also strengthened through the pilot interviews. The pilot interview was conducted with two external sources, not involved in the topic.

3.6 Interview process

The choice of venue of the interview was at the discretion of the interviewee so that their comfort and safety was ensured. They were introduced to the information sheet and consent form before the meeting. This built more trust and rapport as the data was kept confidential. The variation of trust and rapport was further eliminated as the participants chosen had some previous or current relation to the interviewer, of which there is only one.

Questions were asked at a broad level before the technical questions were introduced. Probing was performed by asking questions of what, where, when, who, whom, why and how. Repeating for clarity and pausing was used to probe for further details. The loading, uncertainty and redundancy of the questions asked were cleared by simulating the interview with peers outside the sample group, prior to commencement of the data collection process.

The interviews were audio recorded and later transcribed before starting the coding process.

3.7 Data analysis

The data obtained from the semi-structured interviews was analysed using thematic content analysis and coding. Thematic content analysis is a common method used to analyse qualitative data that share a focus on identifying themes (The University of Auckland, 2019).

The data collected was sorted using coding techniques. Coding is a technique that arranges things in a systematic order to classify or categorise that thing. When codes are applied and re-applied to qualitative data, this allows data to be segregated, regrouped and relinked in order to consolidate meaning to data (Saldana, 2009). Coding is a method that enables you to group data that share similar characteristics, into categories (Saldana, 2009).

The data collected from the semi-structured interviews and documents were analysed, coded and categorised. Themes were developed, which in turn assisted in linking the data collected to the objectives of this research and ultimately providing an answer to the research question.

Figure 3-2 shows the coding process.

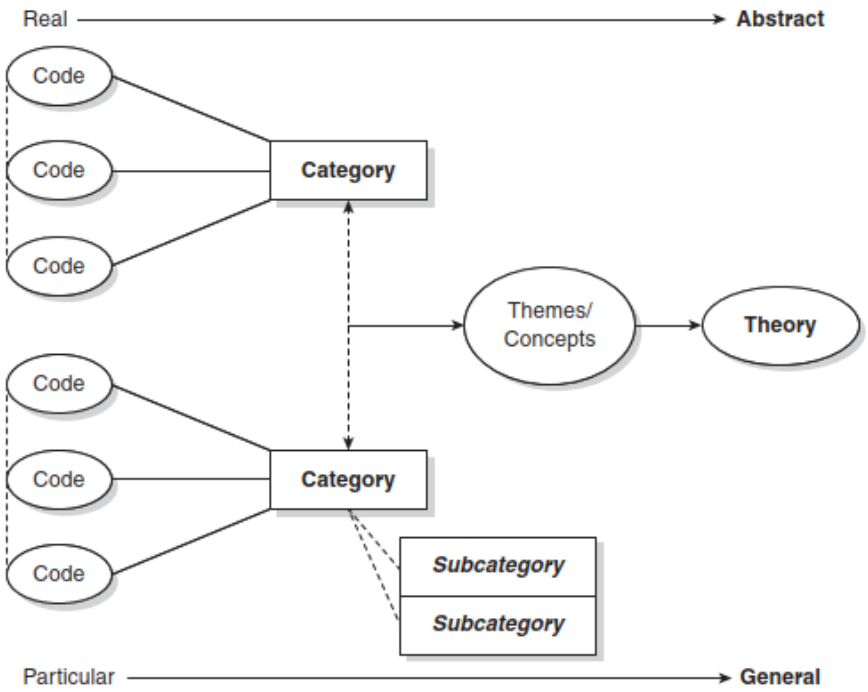


Figure 3-2: Streamlined codes-to-theory model for qualitative research

(Saldana, 2009)

Data analysis occurred in several ways throughout the entire research as the data was observed and recorded. However, as the “official” data analysis period began it was important to ensure that proper methods were followed.

The analysis process included searching for themes and patterns in participants' responses, or connections between responses, ideas, thoughts and interpretations.

The analysis that occurred when findings were compared to each theme led to making logical conclusions or assertions about the research topic. Each assertion was based on evidence or, in other words, findings from each interview. After recording themes and evaluating each response, the data analysis process began by judging the usefulness of each response. The importance and prominence of each theme was done by comparing one theme at a time. The most compelling findings were marked and identified to compose an assertion. This was accomplished by clustering each individual finding with similar findings of another to identify the most important patterns from the data. At this point, solidifying each assertion based on responses and themes was done. Assertions were prioritised according to prominence in the research.

Throughout the analysis phase, various impressions and story lines emerged and thoughts were continually directed to the contents of the final report. Along with the final assertions, experiences and stories were also strategically outlined for the writing phase.

3.8 Quality standards

All research endeavours have generally accepted qualitative standards that exist from past researchers, which assist in guiding future studies. Standards are set forth to establish reliability and validity in the research.

Validity refers to how well a test or procedure measures what it is required to measure. Reliability is the degree to which an assessment tool produces stable and consistent results that are replicable (Yin, 2009). Construct validity refers to developing the correct data collection procedure to gain the results required (Yin, 2009). Validity of this study is highlighted and discussed below:

Persistent observation: This means that the researcher studies the topic sufficiently to determine which pieces of information adds value to the study and which are irrelevant (Yin, 2009). The researcher had completed lean manufacturing and value engineering courses during this master's degree course and is a civil engineer, with seven years of overall experience including construction supervision experience of 18 months, a project manager for 18 months and completing this research report assisted in this regard.

Triangulation: Is a common standard in all research traditions, validates findings by verifying them with additional, related sources of information. Other means of triangulation include diverse methods of data collection and collecting information from multiple participants (Yin, 2009). As was previously mentioned, this study does this by the vast amount of literature reviewed as well as findings from different participants in the semi-structured interviews.

Peer debriefing: Occurs when the researcher allows a disinterested peer to question the methods, the process, and emergent conclusions (Yin, 2009). In part, this occurred naturally when discussing each stage of the research with the researcher's wife, who offered suggestions and questioned the researcher's methods and assumptions. It also occurred informally as the researcher bounced ideas and findings off work colleagues and managers.

Member checking: Contributes a great deal of credibility by allowing the participant an opportunity to review the collected data to verify appropriate representation of their position (Yin, 2009). This protocol was important to this study as several interviewees took the opportunity to make minor corrections to the researcher's transcriptions. The revisions had no effect on the data or the interpretation of the researcher. Changes made were limited to correcting dates, titles, typos and other minor inaccuracies.

Reliability relates to developing a protocol for the study that can be repeated and which should yield the same results if the study is repeated by another researcher. For this research study, this was done by documenting the full research design for this study. A full data base of all sources of information (semi-structured interviews, documents and literature) was created and filed during the literature review, data collection and analysis phases of the study (Yin, 2009).

3.9 Interview assumptions

The assumptions made for this research are described below:

- The semi-structured interview questions will be answered truthfully and accurately as possible by each participant.
- In order to enhance and reinforce the accuracy and validity of the information provided, the participants will be notified that their anonymity and confidentiality will be preserved. In addition, their participation is on a voluntary basis. Participants will also be assured that the questionnaires will get to the heart of the research problem and enable them to answer the research questions.

3.10 Ethical considerations

This research adhered to the framework and policies of ethical clearance that is to be obtained from the School of Mechanical, Industrial and Aeronautical Engineering, University of Witwatersrand, Gauteng, South Africa.

No research involving human subjects was done until ethics clearance was obtained from Human Research Ethics Clearance (HREC). Ethics clearance number for this research report: MIAEC 177/19 (Appendix E).

The research does not aim to harm or advertise any individual, company or organization that has participated. All participants were notified that their information will be strictly confidential.

Participation in the study was of done freely, as no-one was forced to participate.

CHAPTER 4: DATA ANALYSIS AND RESULTS

The purpose of this chapter is to illustrate the results of the analysis of the data that was collected, coded and analysed. All results are shown in either a table or graph and are discussed. The data analysis was done to answer the research question, by addressing the research objectives, i.e.:

1. To identify the challenges experienced by the South African construction industry.
2. To identify the challenges of implementing lean construction project management principles in South Africa.
3. To make recommendations on how to address the challenges of lean construction implementation that could assist in improving the state of the industry.

4.1 Overview of data collected

Interviews with eight expert chosen participants were conducted, as summarised in Table 4-1.

Table 4-1: List of interviewees

Interviewee	Interview date	Interview duration	Age	Gender	Qualification	Years of experience
A	25/10/2019	62 mins	32	Female	Metallurgical Engineer and Lean Practitioner	10
B	25/10/2019	49 mins	49	Male	MSc. Civil Engineer, Director and Engineering Design Manager	27
C	29/10/2019	59 mins	58	Male	Civil Engineer, Director and Construction Project Manager	32
D	31/10/2019	59 mins	41	Male	Quantity Survey and Senior Lecturer/ Researcher (Construction Management)	15
E	8/11/2019	52 mins	33	Female	MSc. Architecture and PhD in Environmental Design and Planning	10
F	8/11/2019	50 mins	-	Male	Quantity Surveyor and Senior Lecturer/ Researcher	15
G	8/11/2019	30 mins	39	Male	Chemical Engineer and Lean Practitioner	20
H	11/11/2019	58 mins	40	Male	Civil Engineer, Project Manager and Researcher	17
Average	**-**	**52 mins**	**42**	**(6 Male, 2 Females)**	**-**	**18**

Table 4-1 shows the age of the interviewees, which ranges from 32 to 58. The average age is 42. The average number of years of professional experience is 18.

4.2 Thematic analysis

The following pre-determined themes (see section 3.4.2) were analysed in this study:

- Knowledge of lean construction
- Current challenges experienced by the construction industry (research objective)
- Government (Theme 1)
- Management (Theme 2)
- Education/ Technical (Theme 3)
- Financial (Theme 4)
- Human Attitude (Theme 5)
- Identification of other barriers
- Recommendations on overcoming these barriers of lean construction implementation (research objective)

Each theme is analysed in the sections that follow.

4.2.1 Knowledge of lean construction

The data analysed in this section was collected from questions 4 to 6 of the interview and is focused on the interviewees' discretionary level of knowledge of LCPs, the LCPs which they are familiar with, and gauging their colleagues' level of understanding of LCPs.

It must be noted that the questions and analysis in this section simply assists the researcher in asserting the sample group's knowledge and experience of lean construction principles, ensuring the sampling criteria detailed in section 3.3.

i. Familiarity with LCPs (Question 4)

Table 4-2 shows the interviewees responses to question 4 and illustrates the LCPs that were recoded from these questions. Some of the LCPs were inferred during discussions and were not directly stated by the interviewee – hence a link between the discussion and the LCP was made. Each LCP coded to the corresponding interviewee and the frequency of each LCP coded is shown in the table.

Table 4-2 shows that the LCP mentioned by most respondents is LPS. Teamwork and Partnering, JIT and Target Value Design are ranked second in terms of the frequency. Total Production Management (TPM) is the least common tool.

Table 4-2: Commonly used LCPs

LCP	Mentioned by interviewee	Frequency
LPS	A, C, D, E, H	7
Teamwork and Partnering	A, C, D, H	7
IPD	A, D, G	7
JIT	D, E, F, H	4
Target Value Design	D, E, F, H	4
Visual Management	A, E	3
Resource balancing	C	1
TPM	G	1

ii. Level of lean construction knowledge (Question 5)

Figure 4-1 represents the interviewees responses to question 5.

The majority of the participants indicated that they are fully knowledgeable on most aspects of lean construction, lean construction frameworks and the implementation of lean construction. It must be noted that Interviewee B rated himself low (knowledge rating of 3) in comparison to the rest of the interviewees. The results shown in Figure 4-1 are the interviewees self-rating of their knowledge on LCPs.

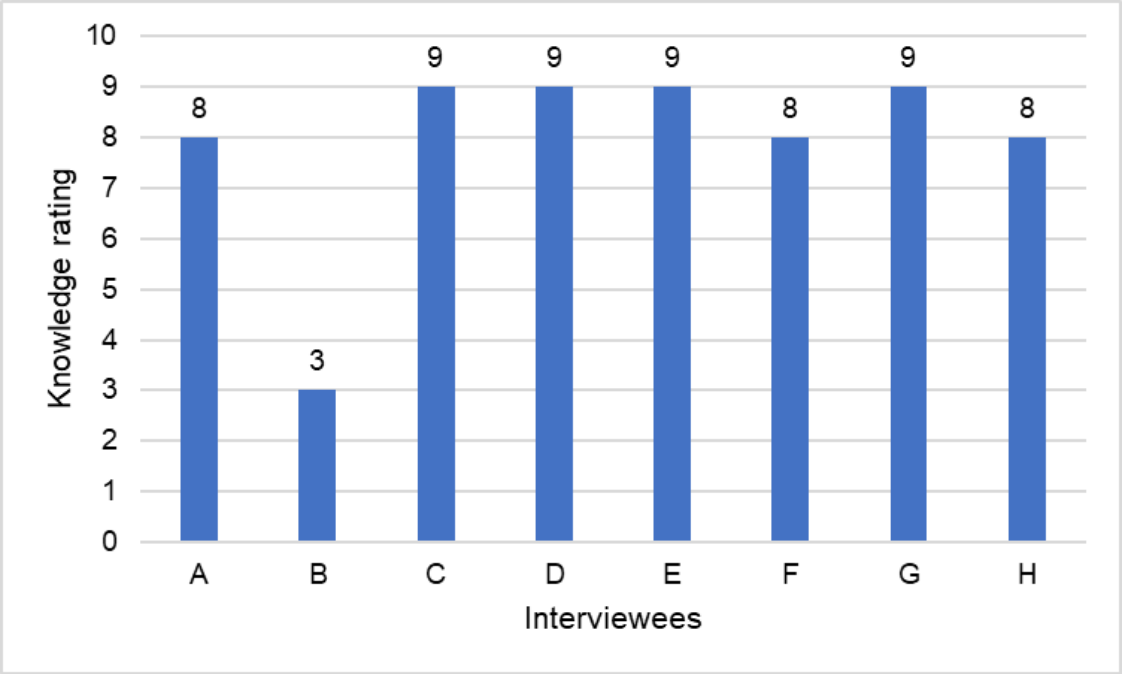


Figure 4-1: Interviewees' level of lean construction knowledge

In support of Figure 4-1, a summary of key responses from specific interviewees is provided in Table 4-3.

Table 4-3: Interviewee responses to question 5

Interviewee	Summarised response
A	Interviewee A responded by stating that she has a very good understanding of the lean construction framework, delivery and value add as she is a senior member of the Lean Construction Institute. Interviewee A stated that lean construction is based on three aspects that should be considered to promote successful implementation of lean construction. These are technical execution in design, organisational design and the setting up of your construction contract.
B	Interview B stated that he is not very familiar with the concepts of lean construction however he has been in conversation and discussions

	regarding lean and is aware of that lean construction is practiced in the UK.
C, D & E	Interviewees C, D and E stated that they are very familiar with lean construction concepts and have good working knowledge and experience of using LCPs. These are LPS, JIT, six sigma and resource balancing. Interviewee C, D and E also stated that they have extensive experience in how lean construction projects are packaged and how they are executed.
H	Interviewee H stated that he has a well-rounded experience of lean construction. Interviewee H stated that he has several years of experience in lean construction research, practice and general knowledge. Interviewee H state that he has good working knowledge of LPS, teamwork and partnering, JIT and target value design. He has managed and worked on several construction projects that utilised LCPs.

iii. Colleagues' and client's knowledge of lean construction (question 6)

Half of the interviewees (i.e. 4 of 8) stated that their colleagues and clients do not understand what lean construction is nor how to implement lean construction principles. Interviewee D stated that his/her colleagues and clients are partly knowledgeable regarding some of the topics related to lean construction, whilst the remaining three interviewees stated that their colleagues are knowledgeable about lean construction as lean construction training is done by their business unit and organisation. The results are a reflection of the interviewees' perception of whether their colleagues and clients have knowledge of lean construction.

Figure 4-2 is a graphical illustration of whether the interviewee's colleagues and clients have knowledge of lean construction.

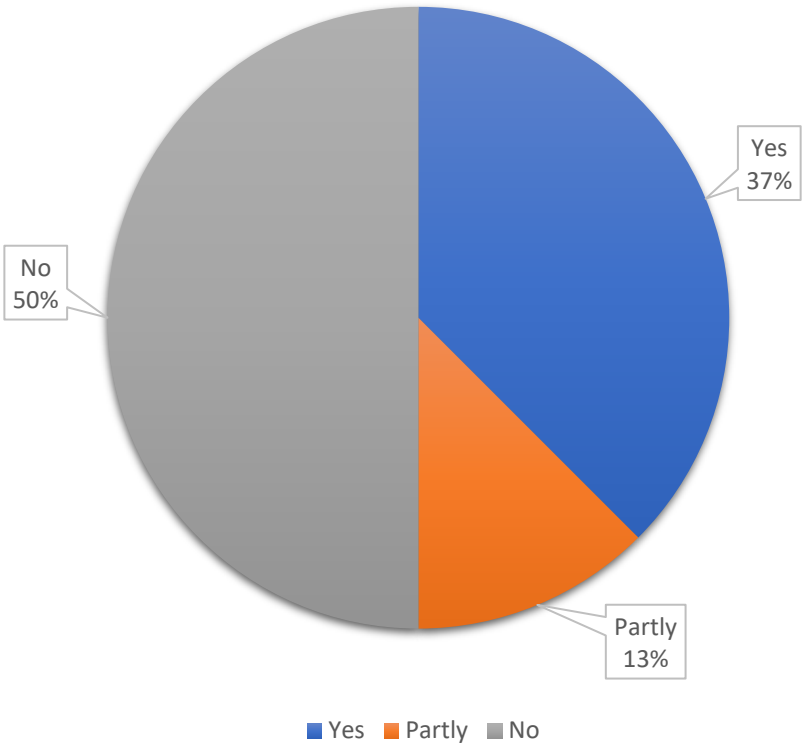


Figure 4-2: Interviewees' colleagues and clients' knowledge of lean construction

Further probing during the discussion of this question was done and the interviewees revealed the following summarised responses:

Table 4-4: Interviewee responses to question 6

Interviewee	Summarised response
A	Interviewee A has broken up her colleagues and clients into three groups and rated their knowledge accordingly: 1. The colleagues that work in her team at her company have a clear understanding of what lean construction is and how it works. 2. The South African clients do not understand what lean construction is about. Clients have heard the terminology but do not know what it is and how to use it. 3. General colleagues through projects, understand lean construction, understand its value but the mindset to continuously use lean construction is not completely visible and evident.
B	Interviewee B stated that lean construction in the South African industry is not something that is vastly spoken off or well used in comparison to his clients and colleagues in the UK.
C	Interviewee C stated that it was a very small group of people in his organisation that had an idea of lean construction. Interviewee C stated that it was an educational process to try and get people on board but in principle, it was a concept that was not very well known and bought into by senior management.
D	Interviewee D stated that some of his colleagues and clients are applying lean concepts but are not aware that they are. There is little knowledge, but it is not fully recognised as lean construction.
E	Interviewee E stated that her experiences in the South African industry is just beginning to gain momentum. These colleagues have a rating of 5 out of 10. Her colleagues in the African market have an interest in lean construction but do not have practical working history of lean construction.

4.3 Data analysis for research objective 1: identifying the challenges experienced by the South African construction industry

The data was collected from questions 7 to 10 presented in the interview.

The analysis of the data required the use of thematic content analysis. Themes were developed from literature and these themes were associated with the objective. The themes and codes are illustrated in Appendix D: Coding of data . Data was collected from pre-determined and probing questions in the interview.

This objective assisted in answering the research question by investigating the challenges experienced by the South African construction industry. These results were analysed, discussed and illustrated how the challenges of the construction industry has also led to the challenges of implementing lean construction principles, amongst other challenges investigated.

4.3.1 Current state of the South African construction industry

This section enabled the interviewees to state their opinions on the performance of the industry and how lean construction principles could or has added value (if any) to the performance of construction projects in South Africa.

i. <u>The current state of the South African construction industry (Question 7)</u>

Majority of the interviewees expressed their thoughts on the state of the industry as being in a bad state. They stated that this is due to poor productivity at various levels of the different stakeholders, lack of understanding and experience of project requirements from the clients and contractors, a lack of accountability and a lack of good decision making by management. They also stated that there is a lot of mistakes with no urgency to implement a plan to learn from the mistakes and implement change.

A summary of key responses from specific interviewees is shown Table 4-5.

Table 4-5: Interviewee responses to question 7

Interviewee	Summarised response
A	Interviewee A stated that the current industry is struggling financially but can improve if the thinking of how we manage our projects are changed. Interviewee A also stated that we need to change how we manage our projects, and this should be done in accordance with the type and scale of project. Interviewee A stated that we should not be implementing the same management style across all projects.

B	Interviewee B stated that there is a total lack of accountability, administrative and technical skills in organisations and by the government. This has led to the mismanagement of the current construction projects and the reduced outflow of infrastructure projects from government.
D	Interviewee D stated that the current construction industry does not paint a good picture. Interviewee D continues to explain that there is a lot of acknowledgement of the bad state of the industry but there is no innovation and urgency to change this state. Interviewee D also stated that the industry is not utilising new techniques and technology to transform from the old traditional ways of managing projects.
E	Interviewee E stated that the South African construction industry is broken, highly inefficient and non-profitable. Interviewee E also stated that there is no intentional innovation occurring in the industry.
F	Interviewee F feels that the industry is slowly but surely improving and with the embracing of concepts like lean, the industry will improve.

ii. Perceptions of the productivity of South African construction projects (Question 8)

This question focused on the interviewee's personal perception of productivity on construction projects in South Africa. The majority of the interviewees revealed similar answers, all of which ultimately point to poor levels of production in the South African construction industry.

A summary of key responses from specific interviewees is shown Table 4-6.:

Table 4-6: Interviewee responses to question 8

Interviewee	Summarised response
A	Interviewee A stated that the South African construction industry is driven by low skilled labour. Interviewee A also states that there is a lack of skills and knowledge transfer from international experts who work on large infrastructure projects. There is a lack of a collaborative working environment between all major stakeholders on a construction project. These major stakeholders are the engineers, contractors and the client. Interviewee A stated that in order for the successful implementation of lean construction, a collaborative and visible environment is key.
B	Interviewee B stated that the productivity of the industry is low and that this is due to several issues. These issues are due to the social historic issues of the country, a lack of knowledge and low skilled work force, a lack of senior decision makers and large levels of inequality across the board. Interviewee B stated that there are labour issues that have stemmed through inequality and a lack of involvement from all major stakeholders in a project: client, consultant, contractor and the community. Interviewee B also stated that there is a lack of community involvement. This is a problem especially since all construction projects are for a specific community and their involvement is key to the success of that project.
C	Interviewee C feels that there are senior managers who do not understand construction operations. Interviewee C also stated that there is alack good decision-making skills amongst the current senior managers in large construction companies in South Africa. These senior managers provide incorrect and uninformed decisions to important contractual and commercial decisions.
D	Similar to interviewee A, interviewee D also stated that the low productivity levels in the industry is due to an adaptation of non-transparent contracts. There is a lack of an integrated project plan, lack of a collaborative nature and no mutual trust between the major parties of a construction project.
G	Interviewee G stated that there are two major multilayer factors that result in poor productivity of the South African construction industry: poor quality of engineering by the various stakeholders, and the country's labour

	challenges.
H	Interviewee H stated that there is insufficient knowledge from lean construction professionals in South Africa and poorly enforced legislation to support effective construction. This has led to the poor productivity levels in the industry.

iii. Perception of whether the implementation of lean principle have improved productivity in construction projects (Question 9)

Almost all the interviewees indicated that the implementation of lean construction principles has improved productivity on the construction projects they have worked on or are currently working on. It is important to note the interviewees strong belief in how much productivity would be improved by using LCPs effectively on construction projects in South Africa.

A summary of key responses from specific interviewees is shown in Table 4-7.

Table 4-7: Interviewee responses to question 9

Interviewee	Summarised response
A	Interviewee A stated that she has recently completed a construction improvement project on one of the mines in the country. The projects programmed delivery date was March 2020 but has managed to save six months of the project by utilising lean construction principles, correctly. The project was delivered in September 2019.
C	Interviewee C stated that the simple implementation of lean construction has helped to improve the productivity of construction projects but also stated that simply implementing lean on its own will not help. Interviewee C stated that there is a lot of other support required from senior managers to ensure good productivity of construction projects in South Africa.
D	Interviewee D stated that there has been successful implementation of lean construction in many other developing countries, which has resulted in improved productivity. Interviewee D stated that Africa needs to be believe in the concept. Believing in the concept is a mind and behavioural change in humans and once the belief is there, implementation will be much easier resulting in improved productivity.
F & G	Interviewees F and G have raised an important point, that in order for lean construction projects to be successful, the implementation of lean construction must be done correctly and effectively. This was a general sentiment shared throughout the data collection process whereby several of the interviewees have stated that lean construction and its knowledge is known but the implementation is not well known or understood.

iv. Occurrences or issues that negatively impact the delivery and performance of construction projects in South Africa (Question 10)

This question is closely linked to question 8. Question 8 focused on the interviewee's personal perception of the productivity of construction projects in South Africa. Question 10 focuses on the issues that negatively impact the delivery and performance of the South African construction industry.

From the interviewees discussions of question 8 and 10, it illustrates the challenges of the construction industry. As indicated by the interviewees, the challenges in the construction industry include: an industry that is struggling financially; lack of accountability and poor decision making by senior people; no innovation; no urgency to improve; an inefficient industry; a lack of good technical skills; a low skilled labour force; poor knowledge sharing; a lack of transparency; corruption; poorly drafted and managed construction contracts; poor supply chain practices on projects; significant levels of inequality. These discussions further illustrate the challenges in implementing lean construction and illustrating how lean construction focuses on solving some of the major issues of the South African construction through its implementation.

A summary of key responses from specific interviewees is shown in Table 4-8..

Table 4-8: Interviewee responses to question 10

Interviewee	Summarised response
A & D	Interviewee A stated that there are two issues that negatively impact the delivery of construction projects in South Africa. One is the incorrect mindset of all stakeholders and the poor setting up of the construction contract. Interviewee A and D also shared similar thoughts regarding poor collaboration and poor construction contracts.
B	Interviewee B raised the issue about poor levels of labour, knowledge and skills in South Africa. Interviewee B also stated that there is a lack of inclusiveness with the community when constructing something. Interviewee B stated that we need to engage with the community being affected or benefiting from the construction.
E	Interviewee E stated that the industry needs to have an understanding of getting the right people for the right job at the right time. Labour unions and specific government laws are preventing innovation and ways of being effective. Interviewee emphasises on the corruption occurring in the industry. Interviewee E also stated that lean construction can mitigate corruption due to lean being a tool of working together and creating transparency.

F	Interviewee F stated that there is a lack of adoption of integrated construction tools. Interviewee F shared experiences of whereby the incorrect tool chosen, or the misuse of construction management tool has negatively impacted the delivery of construction projects in South Africa.
H	Interviewee H stated that poor project management, lack of ownership and innovation from all parties has negatively impacted the performance of the South African construction industry.

Table 4-9 summarises the key codes mentioned by the interviewees in response to questions 7,8 and 10 and are in relation to the current state of the South African construction industry.

Table 4-9: Elements that result in poor productivity of the industry identified by the interviewees

Elements that result in poor productivity
Inefficiency
Lack of transparency
Poor decision making at senior levels
Low skilled labour
Lack of skills transfer
Lack of technical skills
Social historic issues in South Africa
Project time and cost over-runs
Corruption in the government
Lack of labour force empowerment
Lack of inter-project collaboration
Poor setup and management of the construction contract
Lack of understanding of the project requirements from senior management and government

4.4 Data analysis for research objective 2: identifying the challenges of implementing lean construction project management principles in South Africa

The data collected for questions 11 to 25 relate to this objective. Thematic content analysis was done. Themes were developed from the literature and these themes were associated with the objective. The themes and codes are illustrated in Appendix D: Coding of data . Data was collected from the responses to pre-determined probing questions posed in the interviews.

This objective will assist in answering the research question by investigating the challenges experienced by the South African construction industry in implementing lean construction project management principles.

4.4.1 Government

This section enabled the interviewees to state their opinions on the South African government and its knowledge of lean construction.

Data was collected from the pre-determined questions asked in the interviews as well as from questions that arose during the interview when probing for further insight. Questions 11 and 12 relate to the issues with the South African government, which have resulted in challenges with implementation of lean construction principles. A total of 16 unique codes were collected from the responses to these questions.

The top seven codes based on frequency which arose from the interviews can be seen in the Table 4-10. These codes were developed from a combination of both questions, 11 and 12 and throughout the interview, in the context of this theme. The number of respondents can be seen in the last column.

Table 4-10: Top seven codes generated from the government theme

Rank	Code	Frequency	No. of Interviewees
1	Corruption	15	6
2	Implementation	14	6
3	Policies	11	6
4	Inefficient	11	5
5	Economy	10	6
6	Knowledge/ understanding	10	6
7	Skills development	9	6

Figure 4-3 illustrates the frequent codes generated during the interviews. The predominantly mentioned code is corruption and the least mentioned code was BEE with a frequency of only 2.

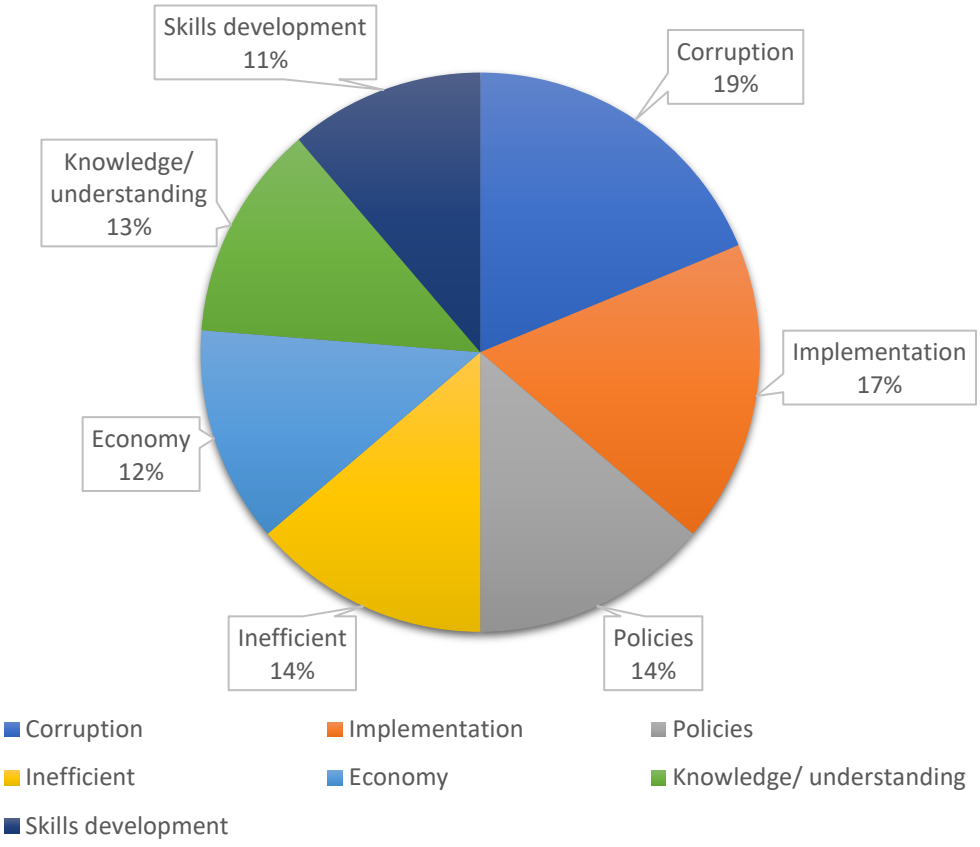


Figure 4-3: Frequent codes relating to the SA government

Interviewees were asked about:

i. <u>The role that the South African government has played in developing or deterring the current state of the construction industry (Question 11)</u>

All of the interviewees feel that the government has an inability to understand the concepts of lean construction and that they do not want to learn about the topic due to them being focused on a lot of other principles and issues facing the industry currently. These issues are detailed in the summaries provided in Table 4-11.

A summary of key responses from specific interviewees is shown in Table 4-11.

Table 4-11: Interviewee responses to question 11

Interviewee	Summarised response
A	Interviewee A stated that that the South African government is not doing much about the current, poor state of the industry. Interviewee A further stated that she has not noticed any positive movement by government to address the poor capability and lack of collaboration issues in the construction industry. Interviewee A has been in conversations with the SACPMP regarding lean and noted that during these conversations, South

	Africa is far behind where it should be in adopting, supporting and implementing lean construction.
B	Interviewee B stated that the South African government and infrastructure is stringed into two components. One is commercial infrastructure that the private sector builds. The other is community infrastructure that addresses the needs and wants of people, but it also creates the ability to fuel the commercial sector. Interviewee B stated that the South African government has mixed up the purposes and goals of the private and public sector. Interviewee B also stated the South African government does not stimulate growth and development of the economy, which ultimately leads to the deuteriation of the industry.
D	Similar to interviewee A, interviewee D stated that the South African government is not doing enough to improve the state of the industry. Interviewee D stated that the private sector should try to motivate and promote lean concepts and hope that the government will "join later". Interviewee D also stated that the government has several inefficiencies that it will not resolve any time soon.
E	Interviewee E stated two vital points. One of which is that the South African government has a long and bad history of corruption. The corruption issues have ultimately led to their inability to be innovative and strategic in trying to improve the industry. The other point mentioned is that the government has struggled to appoint jobs to the correct people with the correct skill levels and competency level required to exceed at that job.
G	Interviewee G stated that there is not enough focus from government on managing and improving on the correct skills from universities and trade schools. Further to this, interviewee G also stated that the governments implementation and management of BEE is incorrect and that there is a lot of construction companies not being able to attain work due to poor and incorrect BEE implementation.
H	Interviewee H stated that the government's lack of ability, lack of technically skilled people and their corruption has led to the demise of the South African construction industry.

ii. South African governments ability to develop policies and protocols to support the implementation of lean construction principles (Question 12)

All of the interviewees stated that the South African government has not developed policies or protocols to support the implementation of LCPs. Interviewees D and E stated that the government has very limited knowledge of lean construction principles.

A summary of key responses from specific interviewees is shown in Table 4-12.

Table 4-12: Interviewee responses to question 12

Interviewee	Summarised response
B	Interviewee B stated that the South African government has a problem. The problem they have is that they have tried to politicise all of the technical parties and this does not work. The few technical people we have in those departments have been made into politicians and then the rest of the of the departments are just about politicians trying to maintain those positions. Interviewee B stated that the government is focused on the incorrect things such as transformation without necessarily fixing the floors of the system. Interviewee B stated that our execution within the industry is a huge problem because we are measuring incorrectly.
C	Interviewee C stated that the South African government does not know what lean construction is.
D	Interviewee D stated that the South African government do not know what lean construction is. Interviewee D stated that the public sector does not have capacity to learn and implement lean construction. Innovative ideas will be shut down immediately, without even considering the advantages.
E	Interviewee E stated that the South African government is not educated about lean construction. Interviewee E stated that 90% of her engagements with public sector peers, clients or entities, she is just introducing the topic of lean construction and its concepts.
F	Interviewee F stated that there are other principles like value management, project management, risk management and the government cannot support all the principles at the same time.

4.4.2 Management

This section allowed the interviewees to provide information relating to their senior management and their value add to projects and their ability to understand, implement and support lean construction principles.

Data was collected from the pre-determined questions in the interview as well as questions that arose during the interview from probing for further insight. Questions 13, 14 and 15 investigated the issues relating to company management (engineering and construction) that have resulted in the challenges facing the implementation of lean construction principles. A total of 18 unique codes were collected from these questions.

Questions 13 and 15 are broader management related questions. Question 14 is focused on management's commitment to lean construction implementation. Through the combination of these questions, an attempt to identify the challenges of implementing lean construction due to managerial challenges will be developed and discussed in Chapter 5.

The top six codes in frequency, pertaining to management, that arose from the interviews can be seen in Table 4-13. These codes were developed from a combination of questions, 13, 14 and 15 and throughout the interview, in context to this theme. The number of respondents can be seen in the last column.

Table 4-13: Top seven codes generated from the management theme

Rank	Code	Frequency	No. of Interviewees
1	Transparency	13	5
2	Understanding/ awareness	12	5
3	High expectations	10	6
4	Scope requirements	9	5
4	Planning/ pre- planning	9	5
5	Unreasonable	7	4
6	Implementation	6	2

Figure 4-4 illustrates the frequent codes generated during the interviews. The predominantly mentioned code is transparency followed closely by understanding and awareness and the least mentioned code was value with a frequency of only 2.

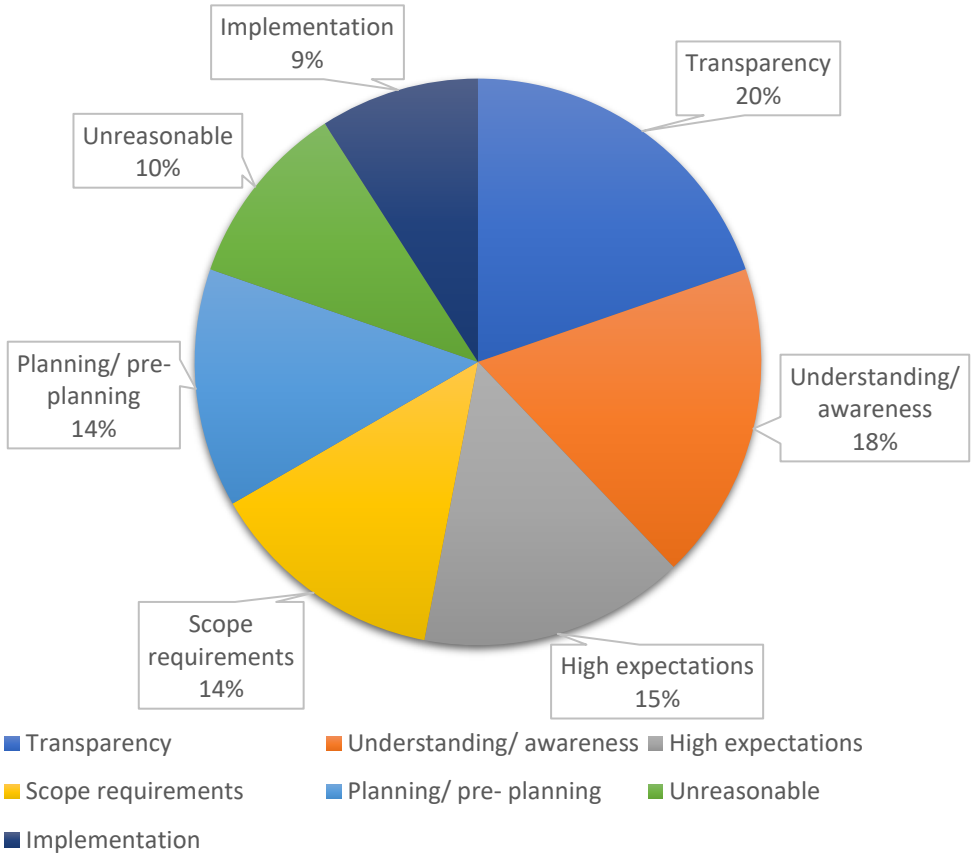


Figure 4-4: Frequent codes relating to management

i. <u>Organisations management and client's unreasonable expectations of projects (Question 13)</u>

Generally, the interviewees stated that management and clients generally set high expectation/ targets and do not understand the full scope and objectives of the project. Management have the inability to continuously learn and improve from mistakes, but rather, there are repetitions of the same mistake. There is a lack of pre-planning by management and transparency between management and other staff.

A summary of key responses from the interviewees is provided in Table 4-14..

Table 4-14: Interviewee responses to question 13

Interviewee	Summarised response
A	Interviewee A stated that clients set project expectations that they do not understand. Interviewee A also stated that clients tend to focus more on saving time as opposed to trying to understand the project and ensuring more reliability and a higher quality product.
D	Interviewee D stated that managements inability to plan correctly often leads to sudden and unrealistic deadlines, which ultimately compromises quality. Interviewee D stated that this happens a lot in organisations in the construction industry.
E	Interview E believes that management are not purposely incorrectly planning but fail to learn, implement changes and adjust for new projects, from the knowledge and lessons learnt of previous projects.
G	Interviewee G stated that management always set unrealistic expectations of their teams and of the project. Further to this, interviewee G stated that there is not enough upfront investment and planning from management, and this ultimately compromises the project budget quality and time. Interviewee also stated that clients and management are failing to understand the importance of education and training of lean construction.
H	Interviewee H stated that management are expected to lead, plan and make accountable decisions for projects to be successful. There needs to always be a good level of pre-planning accompanied by an implementable plan, which possesses transparency at all levels.

ii. Organisations commitment to develop and implement an effective plan and resources to support and manage the implementation of lean construction principles (Question 14)

Generally, interviewees stated that organisations in the industry are not committed to developing a plan and managing the implementation of lean construction principles. Clients, management and government do not understand what lean construction is. There is an inability and lack of ambition to investigate lean construction. Clients are refraining from deep diving into problems and in doing so, they are preventing problem solving and innovation.

A summary of key responses from specific interviewees is shown in Table 4-15.

Table 4-15: Interviewee responses to question 14

Interviewee	Summarised response
A	Interviewee A stated that clients do not want to actually work, they do not want to plunge deep in the project because they are exposed and that they do not want to be exposed to risks. Interviewee A stated that owners think that they are there to only quality manage. Interviewee A stated that if you want to implement lean construction effectively it needs to be collaborative. Clients and owners need to invest in people to work with contractors in helping them solve problems, help the team and bring in the different ideas that promotes collaborative working.
F	Interviewee F stated that there are low levels of awareness of LCPs in the industry, therefore it is difficult to support and manage its implementation.
G	Interviewee G stated that clients that he works with are not doing enough to implement lean construction. He further stated that lean construction should not be regarded as a once of project. You need to be fully committed to its continuous implementation practices.
H	Interviewee H stated that management and clients do not understand what lean construction is and they do not want to learn about it. There is a lack of ambition issue and poor leadership and management from clients, government and even the private sector. Organisations are not attempting to find out other techniques or tools to manage project.

iii. Middle and higher management adding more value to improve the success of projects (Question 15)

Respondents indicated that senior management in construction projects need to change their mindset in order to run a successful construction project. There is great opportunity to get management to add more value to projects, through the teachings of LCPs, in order to improve the project success.

A summary of key responses from specific interviewees is shown in Table 4-16.

Table 4-16: Interviewee responses to question 15

Interviewee	Summarised response
A	Interviewee A stated that getting management to believe in lean construction is 80% of the work done already. Interviewee A stated that implementing lean is simpler once senior management and the client believe and understand lean construction. Once feasibility is shown and understood by management, the implementation of lean construction principles becomes much simpler.
B	Interviewee B stated that management are required to match specific management methodologies to specific deliverables of different projects. Management can add more value to projects by attempting to understand the bespoke requirements of each project and manging that accordingly. Interviewee B stated that understanding a management methodology at the start of every project is key to its success.
C	Interviewee C feels that management would add more value to the success of their projects if they attempted to understand the requirements of the project and if they created the ability to change their technical behaviour. Interviewee C stated that lean construction promotes and enforces this behaviour.
D	Interviewee D stated that more value could have been added to projects if all stakeholders are thoroughly involved and contributing to the success of the project. Lean construction success requires the involvement of everybody. Interviewee D stated that part of the challenges facing lean construction implementation is that everybody is not involved and equally contributing to the success of the project.
E	Interviewee E stated that management need to change their technical behaviour. A lot about lean design construction is about behaviours and it is common that a lot of influence is placed on technological innovation. Interviewee E believes that the technological implementation curve is becoming too steep and this is where management are supposedly required to assist in ensuring easy implementation of new technology and tools.

4.4.3 Education/ Technical

The section enabled interviewees to provide information relating to education, training, knowledge and technical competence issues in the South African construction industry that is hindering the successful implementation of lean construction.

Data was collected from the pre-determined questions in the interview as well as questions that arose during the interview from probing for further insight. Questions 16, 17, 18, 19 and 20 investigated the issues relating to educational and technical competencies as well lean construction awareness and knowledge creation, which have impacted on the challenges facing the implementation of lean construction principles.

The top seven codes in frequency, pertaining to the education theme, that arose from the interviews can be seen in Table 4-17. These codes were developed from the combination of questions 16 and 17 and throughout the interviews, in context of this theme. The number of respondents can be seen in the last column.

Table 4-17: Top seven codes generated from the education theme

Rank	Code	Frequency	No. of Interviewees
1	Skills/ Technical skills	14	6
2	Training	14	7
3	Awareness	12	5
4	Knowledge	9	6
5	Research	6	4
6	LCI SA	6	4
7	Competence	3	2

Figure 4-5 illustrates the frequent codes generated during the interviews. The predominantly mentioned code is skills or technical skills followed closely by training and awareness and the least mentioned code was SACPMP with a frequency of only 2.

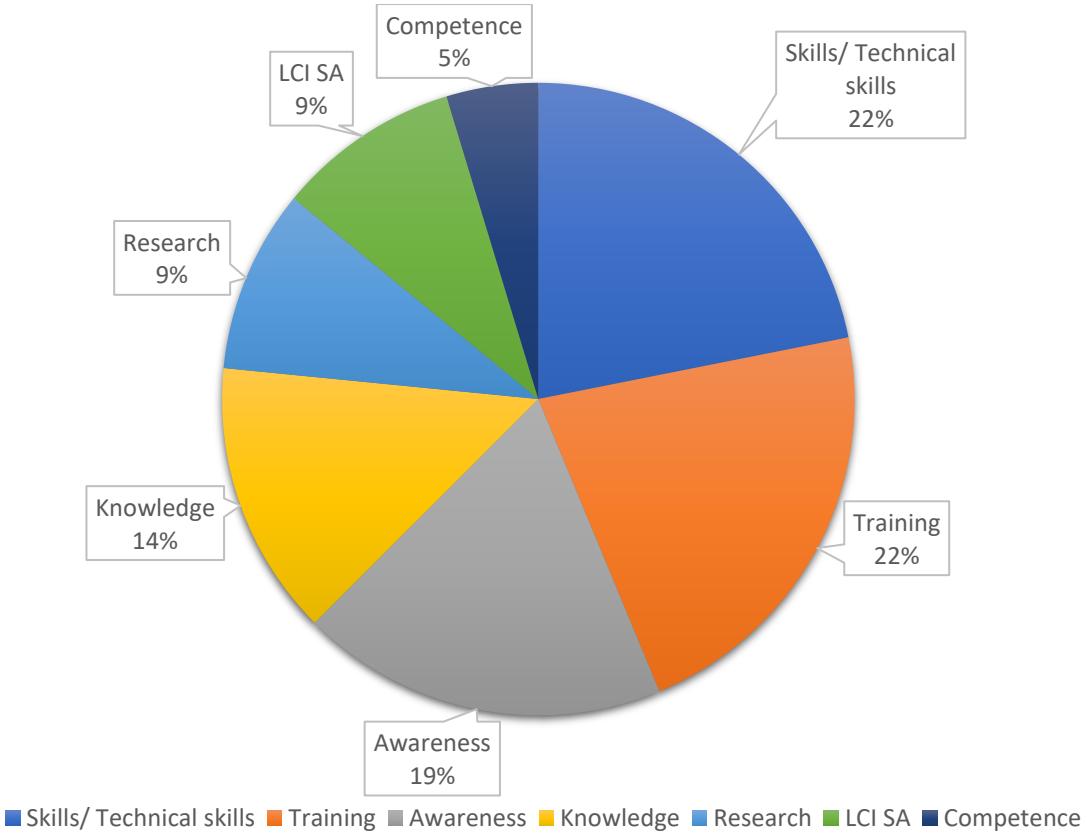


Figure 4-5: Frequent codes relating to education/ technical

i. Knowledge and awareness of lean construction (Question 16)

Generally, the interviewees stated that there is insufficient knowledge and awareness created around lean construction. The SACPMP is not doing enough to create awareness and promote the knowledge of lean construction. Due to the lack of awareness, there is no need for training, and this is a barrier to lean construction implementation in South Africa. A need for further publications illustrating the benefits of lean construction implementation in South Africa is required to promote the concept.

A summary of key responses from specific interviewees is shown in Table 4-18.

Table 4-18: Interviewee responses to question 16

Interviewee	Summarised response
A	Interviewee A stated that there are insufficient organisations providing training resulting in a lack of awareness of lean construction. Interviewee A stated that the current organisations such as LCI SA, which she is part of, as well as SACPMP is not doing enough to raise awareness, conduct training and enforce implementation of lean construction in South Africa. Interviewee A stated that these bodies should be assisted by government organisations because of their stature and wider network of other integrated organisations in order to assist with educational workshops and training of lean construction.
B	Interviewee B feels that there is not enough awareness and training created around lean construction implementation and states that there is only awareness created around its benefits. Interviewee B also stated that there is not enough publications and research illustrating practical implementation of lean construction in South Africa.
C	Interviewee C believes that besides the shortage of knowledge, which is not provided by bodies such as SACPMP, an understanding of the South African culture is required with changes to organisations to ensure the successful implementation of lean construction. Interviewee C emphasised that lean construction will not work in a hierarchical organisation and majority of major construction companies in South Africa are set up this way.
D	Interviewee D stated that construction and project management bodies do not have sufficient knowledge about lean construction and nor are they willing to learn about it.
G	Interviewee G believes that further implementation knowledge is required by all stakeholders but does feel that that there is not enough knowledge created in South Africa relating to lean construction.

ii. Shortage of technical skills and knowledge relating to lean construction principles in the South African construction industry (Question 17)

Majority of the interviewees believe that the South African construction industry suffers from a shortage of technical skills, lean construction skills and knowledge. There are various reasons why the interviewees felt and stated this. These reasons are insufficient time and funds to train and educate people, a large skills and age gap, very few lean experts practicing in South Africa and a lack of financial investment and focus by the South African government.

A summary of key responses from specific interviewees is shown in Table 4-19.

Table 4-19: Interviewee responses to question 17

Interviewee	Summarised response
A	Interviewee A stated that South Africa does not have sufficient feasibility and organisations to educate and train people in lean construction. Interviewee A stated that organisations and government are not providing sufficient funds and time to train people. South Africa does not have the capability, specifically for lean construction.
B	Interviewee B stated that there is a large age-related skills gap in the industry. There is a decline in the number of over 65-year-olds and there is a big group of people coming into the industry who are between 25 and 35. But the skills gap in the 35 to 45 age group has increased. This is the skills gap in the industry that must be addressed.
F	Interviewee F stated that there are few lean experts and dedicated lean construction researchers in South Africa.
H	Interviewee H stated that there is a lack of education and artisan investment by the South African government. There is no great financial investment by the government in training people in the construction industry anymore. There is no focus on artisan skills such as welders, builders, plumbers, painters, etc. Interviewee H stated that those are all key skills and that those are the actual labour force required. If there is no investment in that there is no investment in lean and training to be experts

It was only Interviewee D who believes that the South African construction industry does not suffer from skills shortage and knowledge regarding lean construction. Interviewee D believes that a fair part of its (lean construction) successful implementation is changing the mindset of people to learn, embrace and implement lean construction in South Africa.

iii. Formal lean construction training throughout your organisation (Question 18)

Figure 4-6 shows that the majority of the interviewees have received some form of formal lean construction training, on their own account or within their organisation. Only interviewee B has not received any formal lean construction training.

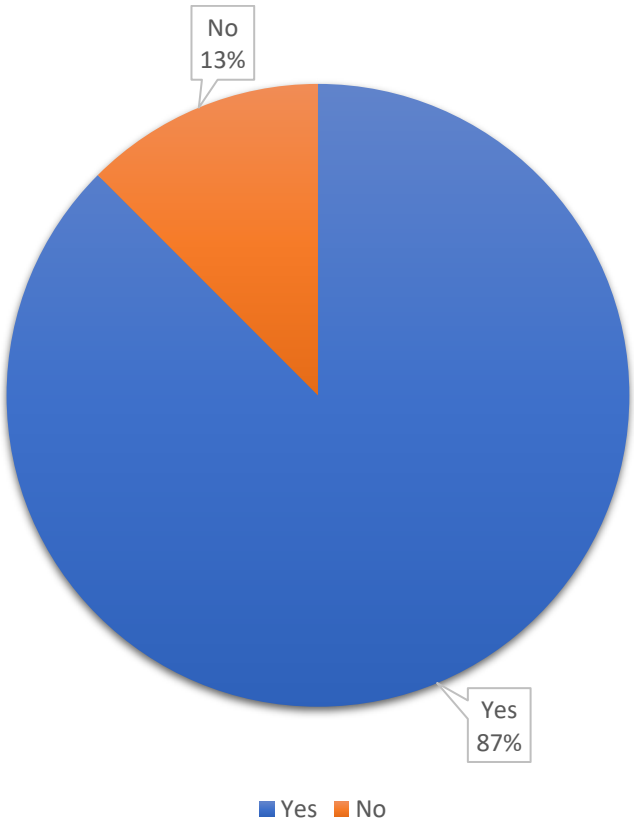


Figure 4-6: Lean construction training completed by interviewees

iv. Formal lean construction training of organisation's management (Question 19)

Figure 4-7 shows that only a quarter of all managers in the interviewees' organisations have attended formal lean construction training courses.

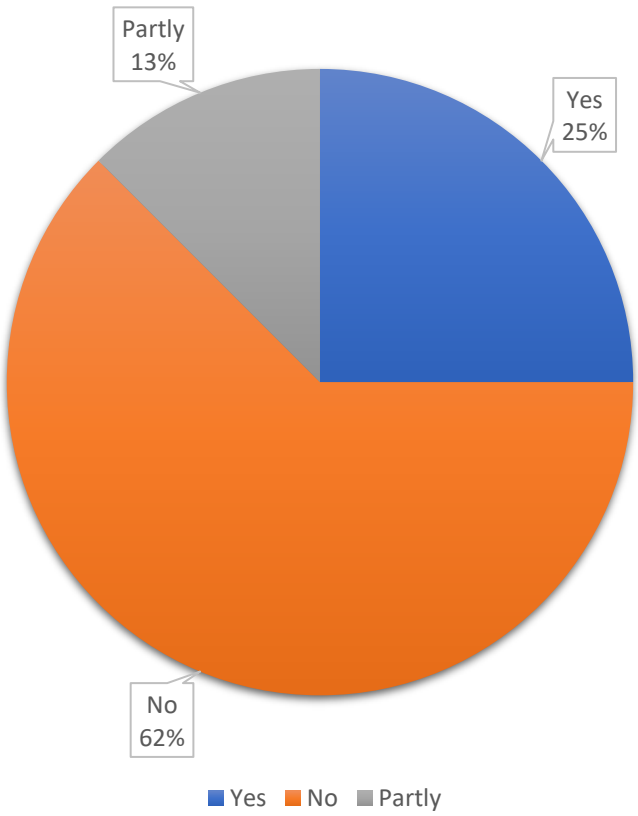


Figure 4-7: Lean construction training done by managers at the interviewees' organisation

Table 4-20 summarises the results seen in the graphs above and presents an explanation stated by the respective interviewees in respect of the training they have been on or their organisations management.

Table 4-20: Interviewee and interviewee management training on lean construction

Interviewee	Have you been for any formal lean construction training in your organisation?	Has your organisation's management been for any formal lean construction training?	Explanation
A	Yes	Yes	Conducting training in organisation and in LCI SA and at Wits University.
B	No	No	-
C	Yes	No	Conducted training in organisation.
D	Yes	Yes	Conducting training in organisation and in Lean Built Environment Organisation for Africa (Level 2 lean construction) specifically relating to behaviour of people.
E	Yes	No	-
F	Yes	No	Researcher and senior lecturer at a University hence limited training provided.
G	Yes	Partly	Only management involved in lean construction and construction management have been on training relating to lean construction.
H	Yes	No	-

v. Training to improve awareness and successful implementation of the lean principles (Question 20)

All of the interviewees answered yes to question 20.

A summary of key responses from specific interviewees is shown in Table 4-21.

Table 4-21: Interviewee responses to question 20

Interviewee	Summarised response
B	Interviewee B stated that if you demonstrate why something is good and why it can work and if you demonstrate how it can be done, the benefits of lean construction will be promoted a lot more.
D	Interviewee D stated that more workshops are required to create more awareness about lean construction. People will start to embrace lean construction and what lean construction is about.
E	Interviewee E stated that individuals can educate themselves about lean construction, but more effort is required from organisations to promote this. South Africa requires formalised organisations that conducts lean construction training. Interviewee E stated that structured learning is necessary if you want groups of people to behave and adopt lean construction, together.
H	Interviewee H stated that quality training and application is vital. Knowledge is available but implementation and awareness is key to the success of lean construction.

4.4.4 Financial

This section enabled the interviewees to state their opinions relating to the financial investment and effort required to implement lean construction techniques as well as any financial barriers affecting the implementation of lean construction principles in South Africa.

Data was collected from pre-determined questions in the interview as well as questions that arose during the interview from probing for further insight. Questions 21, 22 and 23 investigated issues relating to the financial barriers of lean construction techniques, which have impacted on the challenges facing the implementation of lean construction principles.

i. Adequate financial investment by consultants, contractors and clients to educate and implement lean construction techniques on projects (Question 21)

All interviewees stated that there is not enough financial investment in lean construction, its principles and teachings in South Africa. Interviewees stated that there is not enough investment from clients, consultants and contractors to educate themselves on lean construction and implement lean construction principles. The interviewees also stated that there should be more investment into lean construction. The interviewees further emphasised that the implementation of lean construction is affordable to the South African industry and should be invested into.

A summary of key responses from specific interviewees is shown in Table 4-22.

Table 4-22: Interviewee responses to question 21

Interviewee	Summarised response
A	Interviewee A stated that lean construction principles are not difficult to understand or expensive to implement. The biggest effort or cost to implement lean construction successfully is to ensure that a lean mindset is present. Interviewee A emphasised that once the correct mindset is in place, lean construction starts to become a way of life and operating. Lean construction should not be regarded as a once of project but rather as a continuous improvement tool. It does not require a large financial investment.
B	Interviewee B stated that the poor supply chain of work has resulted in a very competitive market resulting in training budgets cut down or diminished in order to win work. Interviewee B also stated that, irrespective of lean construction, companies do not invest sufficiently in training and upskilling staff, continuously.
C	Interview C emphasised that the implementation of lean is a long-term investment and it starts with the collective commitment of senior

	management, industry leaders, clients, consultants, contractor and government.
D	Interviewee D believes that consultants are key to improve the awareness and implementation of lean construction principles. The current economic times makes it difficult for contractors to invest in lean construction hence the ownness should be put on consultants to improve on the low levels of awareness. Consultants have the environment and surrounding to invest, create and improve on the awareness of lean construction principles.
E	Interviewees E stated that the investment into lean and the value add from that investment will outweigh any cost of the initial investment. Interviewee E emphasised this point by stating that if we focus on simple aspects such as removing waste, you could pay for that education through the waste that is removed. It is a fallacy for companies to believe that this is an additional cost to the job where probably the job can generate the education.

ii. Ability to invest more in educating and implementing lean construction principles (Questions 22 and 23)

In response to questions 22 and 23, all interviewees unanimously answered yes to both the questions.

A summary of key responses from specific interviewees is shown in Table 4-23..

Table 4-23: Interviewee responses to question 22 and 23

Interviewee	Summarised response
B	Interviewee B stated that companies can invest into lean construction training. Interviewee B stated that if there is a pipeline and good consistency of work, companies will invest in training and recruiting.
D	Interviewee D stated that companies have to invest into lean construction. There is great benefit into implementing lean construction. Interviewee D stated that we need to convince clients to buy into it. This will than transfer onto consultants who are required by the client to implement lean construction.
E	Interviewee E stated that if you want to be successful in your projects and if you do not want to invest in your people and give them the support to be motivated, the likelihood of succeeding is very low.
G	Interviewee G stated that companies cannot afford not to invest. And that companies need to invest to stay alive.
H	Interviewee H stated that the world is digitising so investment into lean construction is becoming more crucial.

4.4.5 Human attitude

This section allowed the interviewees to provide information relating to human attitude and the issues relating to the human acceptance or rejection of lean constriction principles in South Africa.

Data was collected from the two pre-determined questions in the interview as well as questions that arose during the interview from probing for further insight. Questions 24 and 25 jointly investigated issues relating the human attitude and resistance, which has resulted in the challenges facing the implementation of lean construction principles. A total of nine unique codes were collected regarding these questions.

The top seven codes in frequency, pertaining to human attitude, that arose from questions 24 and 25 and throughout the interviews, in the context of this theme can be seen in Table 4-24. The number of respondents can be seen in the last column.

Table 4-24: Top seven codes generated from the human attitude theme

Rank	Code	Frequency	No. of Interviewees
1	Mindset	14	5
2	Misconception	12	7
3	Awareness	10	4
4	Resistance	8	5
5	Teamwork	7	3
6	Fear of unfamiliar practices	5	4
7	Ignorance	4	3

Figure 4-8 illustrates the frequent codes generated during the interviews. The predominantly mentioned code is mindset, followed closely by misconception. The least mentioned code was irrational, with a frequency of only 2.

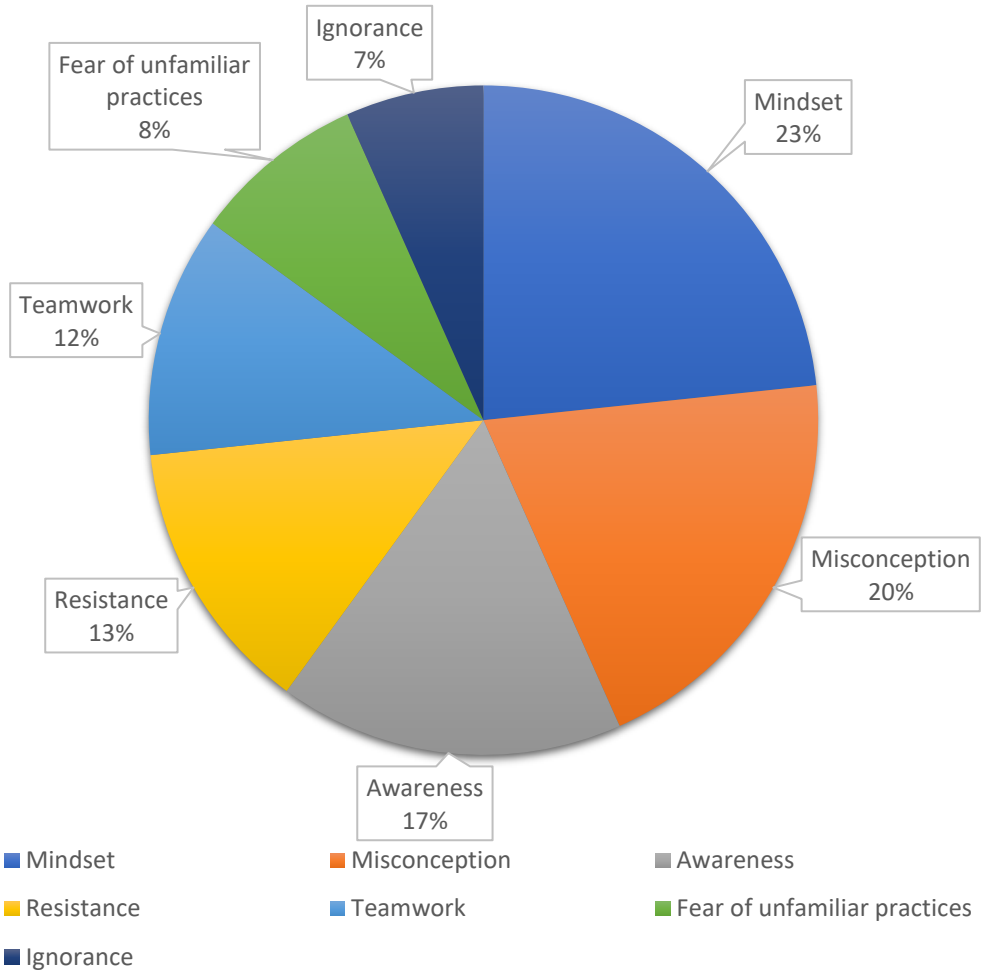


Figure 4-8: Frequent codes relating to human attitudes

i. <u>Human attitude barriers affecting the successful implementation of lean construction principles (Questions 24 and 25)</u>

All interviewees shared very similar sentiments: there is an industry wide misconception of what lean construction is and there is resistance to invest in attempting to educate and implement lean construction. The reasons for this is due to the general human behaviour to resist until explicitly shown the benefits, general misconceptions of what lean construction is, inability to collaboratively work and share knowledge, lack of implementation understanding of lean construction, lack of readily and easily available knowledge of lean construction and the inability to innovate in order to improve the construction industry.

A summary of key responses from specific interviewees is shown in Table 4-25.

Table 4-25: Interviewee responses to questions 24 and 25

Interviewee	Summarised response
A	Interviewee A stated that clients are the driving force towards the enforcement of the implementation of lean construction. interviewee A also stated that in order for the implementation to be successful, all stakeholders and staff working on construction projects need to change their mindset to work collaboratively in order for the project to be successful. Interviewee A believes that a change in human behaviour is difficult to alter but it is essential to ensure the successful delivery and implementation of lean construction techniques.
B &D	Interviewee B and D share similar sentiments as interviewee A. Humans are generally resistant to shift their mindset unless you can evidently illustrate the values and benefits of the implementation of lean construction. This point further illustrates that there is a lack of awareness of the topic.
C	Interviewee C stated that resistance to change is also a major aspect hindering the successful implementation of lean construction in South Africa. One of the biggest hurdles in adjusting the mindset to believe in lean construction is the statement of "we have always done it this way". Interviewee C stated that this is the mindset of senior members in the industry, generally, and this mindset ultimately influences the entire industry, i.e. young engineers, managers, etc.
E	Interviewee E believes there is two general misconceptions. One is that lean is a technology tool rather than it actually being a human and process tool relating to a shift in mindset and behaviour. The second is that the industry believes that that lean construction is not for Africa. Interviewee E stated that other than changing our mindset and attitude, there is no other way to ensure the successful implementation of lean construction. Computers and creating more engineers will not help assist in improving the current state of the construction industry. Interviewee E emphasised that humans need to innovate, which means to change in order to improve.
G	Interviewee G feels that there is not a lack of understanding, but rather a lack of understanding of how to implement lean construction techniques. This point is further illustrative of the education and training theme.

4.5 Data analysis for research objective 3: to make recommendations on how to address the challenges identified

Further to the above themes discussed under objective 2, interviewees were asked to mention and discuss any other evident barriers they feel is hindering the successful implementation of lean construction in South Africa (Question 26 and 27).

It must be noted that all interviewees stated yes to question 26 and did state other barriers that were not explicitly discussed under the themes of the interview or throughout the interview discussions.

Interviewee A and B stated that another significant barrier is the engineering construction contract – how it is set up and how it is understood. Interviewee A stated that construction contracts need to be incentivised for all parties and needs to enforce an integrated management plan between all parties.

Interviewee B stated that clients, contractors and consultant need to ensure they fully understand the full scope of the contract. Further to the above, interviewee B also stated that the roles of responsibilities of the client, contractor and consultant needs to be understood thoroughly and implemented throughout the project.

Interviewee C stated that construction companies need to create a more involved and inclusive management structure that involves everyone's input. Interviewee C also stated that in order for lean construction to be successfully implemented, construction companies need to focus on good strategies, that align to the economy and lean construction may assist with this.

Similar to interviewee A, Interviewee D also promoted the implementation of IPD and a collaborative method of working to. All parties should engage and understand each other to enable the ease of lean construction implementation and increased productivity of the construction industry.

Interviewee E focused on the knowledge and technical skills theme. Interviewee E stated that their needs to be more awareness created about the successful projects that have implemented LCPs.

Interviewee F focused on the government theme and stated that government should familiarise themselves with the teachings and implementation of lean and support the implementation. Interviewee believed that government should also focus on the integration on LCPs with other existing construction management tools.

Interviewee G stated several suggestions to overcome the barriers to lean construction implementation. The initial suggestion mentions the requirement of a defined scope that need to be well understood by all parties.

Interviewee G also stated that scope needs to also clearly define performance measurement tools. This will clearly measure the performance of specific major milestones of a project and will subsequently promote the use of LCPs. LCPs use clearly defined performance measurement tools.

Interviewee G also focused on the knowledge and technical skills theme by stating the correct levels of knowledge by competent personal is key to the successful implementation of lean construction. The procurement process is key to ensuring you have the correct level competence to implement LCPs.

Lastly, interviewee H stated that due to human resistance to change (resonating from the human attitude theme), a gradual implementation and integration of LCPs with other construction management tools is required, in order to ensure successful implementation of LCPs.

Table 4-26 summarises the responses from each interviewee for questions 26 and 27. Table 4-19 states the barrier stated by each interviewee and the description column provides a summary of the barrier and a suggestion from the interviewee on how to overcome the barrier.

Table 4-26: Overcoming barriers to implementation of lean construction principles

Interviewee	Barrier	Overcoming barriers to implementation
A	Set up of construction contracts	Construction contracts need to be collaborative and should be incentivised for all parties. Construction contracts need to implement IPD systems. This will ensure accountability and responsibility is shared equally by all parties: client, consultants and contractors. The philosophies of lean are focused on accountability, continuous development, integration and trust.
B	Understanding our construction contracts	Contracts are not well understood and implemented, and this creates an issue when we want to implement tools such as LCPs. Clients, consultants and contractors need to understand the contract much better in order for the implementation of LCPs to be more successful in South Africa.

B	Roles and responsibilities	Clients, contractors and consultants all need to understand their roles and responsibilities in the entire delivery chain of a project. Integration is key with well-defined roles and responsibilities.
C	Strategic operations	Construction companies are not focussing on good strategic operations to assist with improving their business. As a result of this, lean construction is not a prudent and obvious tool for management to understand and implement, strategically. In order for lean to be successfully implemented, construction companies need to focus on good strategies, that align to the economy. Lean construction may assist with this.
C	Hierarchical mindset	Construction companies are managed in a hierarchical manner and this a barrier to implementation as lean construction and lean itself is centred around everyone's input, responsibility, accountability, motivation, etc. Management styles need to change in order to implement lean construction successfully. Senior leaders need to understand that lean construction is imperative to the survival of companies and the survival of the South African construction industry.
D	Engagement and collaboration	Policies and legislation are required that forces the supply chain of the project to ensure engagement of all parties, before the start of the project. All stakeholders should (client, contractor, engineer, sub-contractors) engage, understand each other and the overall philosophy and objectives of the project. Lean construction requires engagement from well before the start of the project. This will create trust and reliability when the project begins.
E	African experience	In order to illustrate that lean construction is fit for the African market, we need to showcase more completed successful projects that have implemented LCPs. South Africa requires more lean construction practitioners, who have international experience, to implement lean construction in South Africa.

		More on the job lean construction implementation, learning and development is required.
F	Government backing	Government should support the implementation of LCPs in their projects but first they would need to ensure they understand the concepts.
G	Defined scope	In order for lean construction to be easier to implement, a well-defined scope of works is required. Currently, contracts are not clear, and the scope is not well defined in terms of work, reporting, performance measurement and progress.
G	Performance measurement	In order to illustrate the successful implementation of LCPs, the correct performance measurement tools need to be adopted.
G	Level of education	The construction industry needs the correct level of education throughout the contract implementation. The procurement process is key to ensuring you have the correct level competence to implement LCPs.
H	Integration with construction management activities	Due to humans' resistance to change, a consideration of gradual implementation of LCPs along with tools that can be integrated with other management styles in order to showcase LCPs and build support, trust and a history of successful implementation in South Africa, is required.

CHAPTER 5: DISCUSSION

This chapter discusses the results and analysis from Chapter 4 and draws reasonable and fair discussions relating to the objectives and themes developed. These discussions ultimately feed into the research conclusion in Chapter 6.

The current challenges experienced by the South African construction industry are deep, embedded challenges that requires in depth analysis and attention by various stakeholders. These various stakeholders (government, private sector, public sector) are required to work together to develop and implement an infrastructure development recovery plan to address the issues discussed. This is currently not evident by the current government and current construction industry. Due to this not being evident, the implementation of lean construction becomes much harder and challenged. The need and support to successfully implement lean construction in South Africa is evidently hindered and set back by various other challenges experienced by the current construction industry. It is also important to note that some of the challenges experienced by the industry, mentioned is largely related to themes of objective 2 of this research report.

5.1 Knowledge and understanding of lean construction

Almost all the interviewees stated that they are largely familiar with LCPs and its implementation. Interviewee A, who is a senior member of the LCI, stated that she has a good understanding of the lean construction framework, delivery and value add. Interviewee A stated that there are three important aspects of lean construction: technical execution design, organisational design and the structuring of the engineering construction contract. All three of these aspects mentioned by interviewee A is supplemental information to that mentioned by Fidelis & Heinrich (2014) in section 2.2.2, which focuses on four key concepts that promote the successful implementation of lean construction. The four concepts that Fidelis & Heinrich (2014) mentioned are awareness, policy, training and contract. These are reflective of the points mentioned by interviewee A by comparing technical execution design and organisational design to training and application, and engineering contract to policy.

All other interviewees stated that they are very familiar with lean construction concepts and have good working knowledge and experience of using LCPs such as LPS, JIT, six sigma, target value design, IPD and resource balancing. Interviewee B was the only interviewee who does not have a vast application experience of LCPs but is aware of the concept, its advantages and limitations. This is due to the fact that interviewee B is largely involved in a senior position of large consulting firms and national bodies, which pertain largely to the engineering consulting industry.

In terms of the interviewee's knowledge of lean construction, the average rating was 8. Majority of the interviewees expressed that they are fully knowledgeable on most LCPs, the lean construction frameworks and the implementation of LCPs. Interviewee B gave himself a rating of 3. As mentioned above, this is due to his vast experience in consulting engineering, design and construction administration as opposed to first-hand construction experience and lean construction.

Table 4-2 shows that the most common tools that were mentioned by the interviewees (in terms of frequency) were LPS, Teamwork and Partnering, JIT and IPD. LPS, Teamwork and Partnering and IPD obtained a frequency of 7. JIT obtained a frequency of 4. These finding are in line with that of the literature researched. IPD is repeated the second most number of times (behind LPS = 7, and Teamwork and Partnering = 7) and this is due to the fact that Interviewee A and G expressed that the organisations they work in focus a lot on IPD and it is part of their lean project delivery processes. From the literature review, Figure 2-4, illustrates that LPS is the most commonly utilised LCP followed by JIT and Teamwork and partnering.

The interviewees are either lean practitioners, engineers, researchers or construction project managers. They all have experience in the built environment and large infrastructure projects and would have been exposed to other professions or similar professions. In order to gauge the level of lean construction understanding of the participants' colleagues and clients, Figure 4-2 reveals that the majority (50%) of the participants have colleagues and clients who do not have a good understanding of what lean construction is and how to implement lean construction techniques in South Africa.

Figure 4-2 further shows that only three (37%) of the interviewees (A, D and E) have colleagues or clients who have an understanding of lean construction and its implementation. Interviewees A, D and E are members of lean construction organisations in South Africa and have colleagues that have been on lean construction training. This synthesis is in line with the findings discussed in section 4.4.3 and shown in Table 4-20.

Only Interviewee G stated that part of his organisation has some knowledge of what lean construction is but not much knowledge of its implementation.

It must be noted that the results described are the interviewees self-rating of their perceived knowledge of LCPs. It must also be noted that the above is a pure reflection of the interviewee's perception of whether their colleagues and clients have knowledge of lean construction.

5.2 The challenges experienced by the South African construction industry (Objective 1)

The challenges experienced by the South African construction industry are largely related to the South African government, companies' poor management, lack of education, lack of financial investment and a weak human attitude. These challenges are illustrative of the challenges of implementing LCPs, amongst other challenges investigated.

Almost all of the interviewees have expressed their thoughts on the state of the industry as being in a bad state. This is due to poor productivity, lack of understanding and experience of projects from the clients and contractors, a lack of accountability and good decision making (Section 4.3.1, question 7). There is also a lot of mistakes being made by the government with no urgency to implement a plan to correct. Only interviewee F feels that the industry is slowly but surely improving and with the embracing of concepts like lean, the industry will improve.

Majority of the interviewees have stated that the South African construction industry illustrated very poor levels of production (question 8). Interviewees stated the elements that result in poor productivity, to name a few, is lack of technical improvements, cost and time over-runs of the projects, lack of empowerment of the labour force, poor level of planning and engineering, lack of collaboration between all parties and poor setup and management of the construction contracts. The extensive list of responses is summarised in Table 4-9. These responses directly associate with the research background in section 1.1, which discusses skills shortages, lack of skills transfer, corruption and project cost and time over-runs.

As indicated in section 1.1, PWC (2016) emphasised that various specialist skills and knowledge are required to deliver successful construction projects. The skills gap in South Africa makes it extremely difficult for companies to successfully complete contracts. Construction companies in South Africa are struggling to deliver projects successfully. These are a result of poor project execution, poor quality control of the management teams and poor service delivery, lack of involvement and poor policy implementation from government, and poor-quality control on site. This results in re-work, increased cost and, ultimately, delayed delivery of projects. Poor service delivery in the construction sector is also fundamental challenge to the South African government.

It is important to note that interviewees A, C, D, F and G show a strong belief in how much productivity will be increased by using LCPs effectively on construction projects in South Africa (question 9). As stated by interviewee C, the simple implementation of LCPs has

helped improve the productivity of construction projects but also further stated that a lot of other support is required from senior managers to ensure good productivity of construction projects in South Africa. Interviewee D stated that there has been successful implementation of lean construction in many other developing countries, which has resulted in improved productivity. Belief in the concept and its implementation is key to success. Interviewees F and G have raised an important point, that productivity will improve utilising LCPs, but stated that in order for lean construction projects to be successful, the implementation of lean construction must be done correctly and effectively.

The findings from the question 9 align to the findings of Forbes and Ahmed (2011) stated in section 2.2.5. Forbes and Ahmed (2011) believe that that lean methodologies and lean thinking is the new way to manage construction projects because the principles and tools have formed the basis for new project deliveries.

5.3 The challenges of implementing lean construction project management principles in South Africa (Objective 2)

5.3.1 Government

The key issues relating to the South African government that have resulted in the challenges facing the implementation of lean construction principles are inefficiency, corruption, social historic issues and a lack of various factors. These include a lack of skilled labour, skills transfer, technical improvements, labour force empowerment, collaboration between all stakeholders, accountability, general lack of understanding of the project requirements from government.

Majority of the interviewees feel that the South African government has very poor implementation skills and policies to manage, maintain and develop the construction industry. Interviewees believe that the public sector is very inefficient in delivering and assisting contractors to deliver successful construction projects. The economy is not stimulated enough to enable a continuous social and infrastructure development. Due to the reasons stated above, the implementation of lean construction in public sector projects is currently few and far between. All of the interviewees believe that the government is not aware of lean construction principles. They believe this is due to the government's inability to understand the concepts. Government does not want to learn about the topic. Government are more focused on a lot of other principles due to the current state of the industry. The government does not have capacity to implement and enforce lean construction principles and they are not open to innovation. The interviewees are confident that the government does not support or understand lean construction.

Interviewee B stated that the South African government has mixed up the purposes and goals of the private and public sector. Interviewee B also stated the South African government does not stimulate growth and development of the economy, which ultimately leads to the deuteriation of the industry. Further to this, interviewee E stated that the South African government has a long and bad history of corruption and this has ultimately led to their inability to be innovative and strategic in trying to improve the industry. Interviewees A and D stated that the South African government is not doing much to improve the current state of the industry.

The findings from question 12 supplement the finding by Olatunji (2008) and Bashir et al. (2015) as described in section 2.2.6. The successful implementation of LCPs faces numerous problems that are related to government. These challenges are lack of support or understanding, inconsistency in policies and corruption.

Figure 4-3 indicates that corruption is the most frequently mentioned code in relation to the government theme. This indicates that the corruption within the South African government hinders the development of the construction industry and infrastructure development in the country. In turn, this hinders the successful implementation of lean construction in South Africa. According to SABC News (2019), South Africa has a relatively high corruption rating and is ranked as the 73rd most corrupt globally, scoring a rating of 43 out of 100 (0 = highly corrupt and 100 = very clean).

5.3.2 Management

The main issues relating to company management (engineering and construction) that have resulted in the challenges facing the implementation of lean construction principles are lack of transparency, lack of understanding/ awareness, poor upfront project expectations, poor planning and a lack of scope requirements. (See Figure 4-4).

Figure 4-4 illustrates that transparency is the most frequently mentioned code in relation to the management theme. This illustrates that a lot of the interviewees believe that management are not transparent enough during the planning and during the projects to ensure the successful completion of the projects. From these codes we can see that management are expected to lead, plan and make accountable decisions for projects to be successful. There needs to always be a good level of pre-planning accompanied by an implementable plan that is transparent at all levels. This is not currently happening at management level of projects and transparency throughout all stakeholders is key to the successful implementation of lean construction, as discussed in section 2.2.6.

From the results, all the interviewees believe that management do not invest enough, time and money, at the start of projects to understand, plan and implement a sizeable and viable plan to achieve the project requirements. This results in unnecessary quality and commercial issues and risks that impact the project negatively. Clients are also victims of not creating an environment whereby correct decision making is done with sufficient planning. Clients do not understand what role they are supposed to play in the project. Ensuring quality of works is just one aspect of a broader spectrum of supportive and directive roles that they should be playing. In line with the above, interviewee G stated, clients are not creating enough awareness about lean construction. Clients, management and government do not understand what lean construction is. There is the inability and lack of ambition to investigate lean construction. Clients are refraining from deep diving into problems and in doing so, they are preventing problem solving and innovation. Important project stakeholders are not educating themselves about lean construction, its benefits and how to manage its implementation. This ties up with the education and training theme. Lean is a way of life, and

clients and management are failing to understand that. As stated by interviewee E, management are not maliciously planning incorrectly but fail to learn, implement changes and adjust for each new project. This is essentially management not understanding the requirements and not developing a plan that is correctly developed.

From the discussions with the interviewees, the behaviour of management needs to shift to being fully committed and accountable at every stage of the project, most importantly, at the start of the project. Planning and pre-planning is crucial to the success of these projects. It requires time, investment and understanding – which senior management is not currently doing. Management need to ensure they understand and fully support of all technical decisions being made. In the engineering and construction space, this is vital to the success of the project. Senior management are not innovative, and this ultimately results in ill planning and incorrect decision making, consequentially resulting in delays, re-work, cost over-runs and quality issues. These are shown and supported by several authors and references mentioned in Chapters 1 and 2. These issues are the challenges facing the successful implementation of lean construction. Lean construction addresses several of the issues identified above by creating a centralised environment that focuses of transparency, responsibility, accountability, strategising, morale and continuous improvement and leadership. These findings are shown in section 2.2 and illustrated by Fidelis & Heinrich (2014) in section 2.2.2 Literature Review.

5.3.3 Education/ Technical

From the results, it is important to note that all interviewees feel very strongly about lean construction training and knowledge sharing. All interviewees have stated that more training and knowledge relating to lean construction principals and implementation would be beneficial to its successful implementation and will benefit the industry, positively.

In Figure 4-6, we can see that only 13% of the interviewees have not been on lean construction training, but Figure 4-7 further reveals that that only 25% of the managers at interviewees' organisations have attended a formal lean construction training course. This further illustrates the lack of investment and emphasis around lean construction training.

Interviewee A feels that there are not enough lean construction organisations in South Africa and that this is resulting in a lack of awareness of what lean construction is and what its methods are. The current bodies such as LCI SA and SACPMP need assistance from government due to their network and engineering and construction industry experience.

Interviewees, B and G also feel that there is insufficient awareness and training created around lean construction. The benefits seem to be the most commonly known details of lean construction, rather than full understanding of implementation and methodology matters – specifically in South African terms.

Interviewee C and D seemed to share different views on the shortage of knowledge and skills. They both believe that while there is a shortage of knowledge, a greater aspect that needs to be focused on is the culture change required in the industry and shifting the mindset of people to embrace lean construction, learn about it and believe in its implementation and methods. This is mentioned in section 2.3.6. Interview C stated that lean construction will not work in a hierarchical organisation and majority of major construction companies in South Africa are set up with a hierarchical structure that is not favourable for successful implementation of lean.

Majority of the interviewees believe that the South African construction industry suffers from a shortage of technical skills and knowledge and skills relating to lean construction. There is no knowledge and skills transfer between the different generations coming into the industry, middle management and those retiring. There is insufficient budget or funds available in organisations or projects to train and upskill people in the industry. There is a lack of lean experts in South Africa. There is a need for further South African publications related to the benefits and implementation of LCPs. The government's lack of investment in infrastructure has also resulted in the shortage of investment of training and educating people to acquire the correct skills to implement and improve the construction industry.

5.3.4 Financial

From the results, it is evident that there is not enough investment in lean construction, its principles and teachings in South Africa. Interviewees stated that there is not enough investment from clients, consultants and contractors to educate and implement lean construction principles. They also stated that there should be more investment into lean construction. The interviewees further emphasised that the implementation of lean construction is affordable to the South African industry.

Interviewee A stated that the biggest challenge is the mindset as opposed to funds not being available. Lean construction is not difficult to implement. The most important factors at this stage in South Africa is the awareness, knowledge and mindset shift. If these are increased and achieved to some successful degree, we will start to see the benefits of its (lean) implementation.

Interviewee B stated a crucial point relating to spending on training. The poor supply chain of work has resulted in a very competitive market resulting in training budgets cut down or diminished in order to win work. Companies are not spending enough on training, let alone lean construction training. This has obviously had a knock off effect on the successful awareness and implementation of lean construction.

All interviewees unanimously answered yes to both the questions. Section 2.2.6 of the literature review indicates that, according to Bashir et al. (2015), successful implementation of lean construction requires adequate funds to motivate staff, provide relevant materials and equipment and, in some cases, employ lean specialists to guide both employers and employees in implementing the concept. Other financial challenges facing the successful implementation of lean construction is corruption. This is a cross-themed challenge between finance and government.

In summary the financial investment required to invest in lean construction is not a lot. It does require the time and money of senior management, training and educating staff but these costs will have to start of slow and eventually the benefits and rewards will offset the investment.

5.3.5 Human attitude

The main issues relating to human attitudes that have resulted in the challenges facing the implementation of lean construction principles is the inability to change to the correct mindset, a general misconception of lean construction is about, resistance to learn and practice lean construction principles, fear of unfamiliar terms and practices and ignorance.

All interviewees have expressed that there is a lack of understanding of what lean construction is. There is a resistance to the topic of lean construction, as people in the construction industry reveal a level of ignorance regarding the topic and unwillingness to educate themselves about it.

Figure 4-8 shows that mindset is the most frequently mentioned code in relation to the human attitude theme. This proves that a lot of the interviewees believe that in order for lean construction principles to be successfully implemented, a mindset shift is required by all concerned parties' stakeholders. Figure 4-8 illustrates other common codes developed from the interviews: misconception, awareness, resistance, teamwork, fear of unfamiliar practices, and ignorance. A misconception of lean construction is an evident issue hindering the implementation of lean construction in South Africa. The misconception code was the most repeated code by different interviewees relating to human attitude.

Interview D and E expressed vital points as to why there is a misconception and what the general misconceptions are. As stated by Interviewee D, there is a misconception regarding the terminology of lean construction, which ultimately creates resistance to education and implementation. People tend to become defensive about a term that they are not familiar with. Interviewee E illustrated that a misconception of lean construction is that lean construction is not fit for Africa. This is a major implementation obstacle is incorrect. Similar countries with similar struggling markets have adopted lean construction and have seen the rewards of successful implementation. This is shown in Table 2-5.The entire concept of lean is a human and process related tool but there seems to be a misconception that lean is a technological tool. This was another misconception stated by interviewee E.

A common sentiment developed through the interviews is that the driving force towards the enforcement of the implementation of lean construction should be the client. Interviewee A stated that for the implementation to be successful, all stakeholders and staff working on construction projects need to change their mindset to work collaboratively for the project to be successful. Interviewee A believes that a change in human behaviour is difficult to alter but it is essential to ensure the successful delivery and implementation of lean construction techniques.

Resistance to change is expected of humans, as discussed in section 2.2.2 and 2.2.6. Humans are generally resistant to shift their mindset and investment to a new concept unless you can evidently illustrate the values and benefits of lean construction. This was a point developed by both interviewees B and D. Resistance to change is also a major code hindering the successful implementation of lean construction on South Africa. This could be due to ignorance, mindset and behaviour or the fear of unfamiliar practices. This a cross-themed challenge between human attitude and education (lack of awareness). Ensuring a mindset shift from the traditional method of project management to lean construction is key to the successful implementation of lean construction in South Africa. The mindset shift should create a collaborative environment, which in turn may ultimately assist in improving the challenges facing the industry as well.

It is important to note that all themes previously discussed are centred around a shift in mindset, behaviour and culture change. As mentioned by several authors in Chapter 2 and by interviewees, implementing lean construction is not a tool or project but it is a behavioural lifetime shift. The shift in mindset, accompanied with previously mentioned suggestions, is vital towards the implementation of lean construction and improvement of the South African industry.

5.4 Recommendations on how to address the challenges identified (Objective 3)

Given the themes developed from literature and the other challenges mentioned by the interviewees, it must be noted that the most prudent and difficult challenge to address is mindset/ human attitude. The ability to address the mindsets of South Africans in the construction industry to see and understand the benefit of lean construction is the most difficult challenge facing its implementation in the country.

Supplemental to the recommendations, to the various other challenges identified, provided in Table 4-26, in order to address the mindset challenge, there should be a concerted effort by all major role players in the industry to firstly educate and train themselves in the teachings and implementation of lean construction. These major role players should be client bodies, government entities and senior management of construction companies as well as consulting. This minority should understand and see the need for lean construction in order to assist with improving the current challenges facing the South African industry. These needs should than create a motivation create more knowledge and promote the awareness of lean construction to the majority in the industry. The majority in the industry reaches the young engineers, artisans, technicians, foremen, programmers, mid-levels and your general construction worker. This will require financial and time investment to create the knowledge and train the implementation to all parties and people in the industry. Government should start to gradually create policies that support the implementation of lean construction. The support of government and major clients is crucial to the success of lean construction in South Africa. All of the above will and should promote the correct technical skills and expertise required in order to successfully deliver a lean construction project. This is what lean construction is however it all should start with addressing the mindset.

5.5 Research limitations

- The research method is a quantitative method hence there was no research done or literature reviewed in relation to the actual monetary cost of lean construction implementation over the life cycle of a project. This is a limitation of the research method followed for this study.
- There is not a lot of previous South African based research done in relation to the similar research topic. This was a limitation that could have been more beneficial to the study if further South African literature was included in the literature review.
- The research method selected is time consuming and required a lot of effort to source the appropriate respondents that matched the criteria of respondents required.
- The research thematic content analysis and coding approach is very difficult to implement 100% correctly and effectively. Inappropriate mergers and organisation of themes by the author may have had an impact on the exact results displayed and discussions and conclusions drawn.
- Due to this study being qualitative and self-reported data from the interviews, the self-reported data could contain several sources of bias (unaware by the author). These biases could be in many forms (exaggeration, emphasis, attribution, etc.) and may have an effect on the results and conclusions drawn. Self-reported data is limited by the fact that it seldom can be independently verified.

CHAPTER 6: CONCLUSION

The purpose of this study was to determine the challenges experienced by the South African construction industry in delivering projects when adopting lean construction principles. The research background showed that one of the fundamental challenges of the South African government is service delivery. The government's contribution to the industry plays a vital role in meeting the demands of infrastructure requirements through construction projects. However, the South African construction industry has been struggling. The struggling industry has been exemplified by a declining GDP and part of the current situation is due to the lack of new infrastructure projects from government.

The South African construction industry has also fallen victim to poor project performance and poor project execution. Construction companies are struggling to deliver successful projects. These are a result of poor project execution, poor quality control of the management teams and poor service delivery, poor innovation, poor policy implementation and involvement and support from government. Poor execution of projects results in profit margins diminishing and eventual losses

The productivity of the global construction industry has been on a decline for the past 40 years. Research shows that this is due to poor quality control, less value add, poor execution and a lack involvement from major role players, which has led to delays and cost over-runs. Poor implementation and use of traditional project management techniques are the common causes of these delays and issues. The downfall of traditional project management is that that good workflow, performance measurement and value-adding for the client and the project has been ignored. The introduction of new management philosophies requires new measures that focus on waste, value, time, innovation, productivity and variability.

Lean construction is a new and transformational method to engineering construction design, management and building of construction projects. Lean construction focuses on maximising value and minimise waste using specific techniques to apply them to a new way of project management. Lean construction consists of a precise collection of purposes and these are directed at maximising the achievement for the client at all stages of the project. It is a new concept to the South African construction industry and Its implementation and the successful delivery of projects that are attempting to utilise lean construction principles is facing challenges.

In light of these issues, as pointed out in the work of Fidelis & Heinrich (2014), there is more scope to explore the challenges experienced by the South African construction industry in delivering projects when adopting lean construction principles.

6.1 Research objective 1

The current state of the South African construction industry is in a bad state. This is due to poor productivity, lack of understanding and experience of projects from the clients and contractors, a lack of accountability and poor decision making. The South African construction industry illustrates very poor levels of production. The elements that result in poor productivity, to name a few, is lack of technical improvements, cost and time over-runs of the projects, lack of empowerment of the labour force, poor level of planning and engineering, lack of collaboration between all parties and poor setup and management of the construction contracts. The detailed list is summarised in Table 4-9.

The current challenges experienced by the South African construction industry are deep, embedded challenges that requires in depth analysis and attention by various stakeholders. These various stakeholders (government, private sector, public sector) are required collaborate and be transparent with each other to develop and implement an infrastructure development recovery plan to address the issues discussed above relating to the industry challenges and low levels of production. This plan is currently not evident by the current government and current construction industry. Due to this not being evident, the implementation of lean construction becomes much harder and tested. The need and support to successfully implement lean construction in South Africa is evidently hindered and set back by the various other challenges experienced by the current construction industry. It is also important to note that some of the challenges experienced by the industry, mentioned above is largely related to the themes of objective 2 of this research study.

6.2 Research objective 2

From the literature review, through to the conceptual framework, data analysis and discussions, the five common themes that is prevalent to the challenges experienced by the construction industry in delivering projects by utilising LCPs are: government, management, education/ technical, financial and human attitude.

6.2.1 Government

In can be concluded from the research that the South African government does not have the ability to build the country's infrastructure suitability. They do not have defined roles and responsibilities to ensure correct development measures. There is bribery and corruption in the industry and between private sectors and the public sectors. There are not enough technically skilled people employed at government entities and parastatals to manage and implement large scale infrastructure projects and the construction economy is not stimulated sufficiently. There is a lack of skills transfer, a lack of labour force empowerment, a lack of inter-project collaboration, lack of accountability and good decision making and a general lack of understanding of the project requirements from government. All of these reasons are hindering the implementation and limiting the support provided by government in implementing lean construction in the South African construction industry.

The South African government, along with its current challenges identified in objective 1 is a major hurdle that needs to be overcome in order to promote the successful implementation of lean construction. Organisational policies will describe the principles that guide decisions, procedures and protocols. Policies should establish why the organisation supports lean construction principles as well illustrate how and what areas should be applied and in what projects. The organisation here should be the government.

6.2.2 Management

It can be concluded from the research study that management and clients generally set high expectation/ targets and do not understand the full scope and objectives of the construction project. Management have the inability to continuously learn and improve from mistakes. There is a lack of pre-planning by management and transparency between management and other staff. Senior management are not committed to developing a plan and managing the implementation of lean construction principles. There is an inability and lack of ambition to investigate lean construction. Clients are refraining from deep diving into problems and in doing so, they are preventing problem solving and innovation.

In order for the implementation of LCPs to be successful, there is a requirement from management to develop and implement an effective wholistic plan prior to the start of any construction project. As mentioned in the problem statement of this research, lean construction is a new concept to the South African industry. Lean construction will assist in improving the construction industry challenges but not without senior management and clients hindering its implementation even further. Lean construction addresses several of the issues identified above by creating a centralised environment that focuses of transparency, responsibility, accountability, strategising, morale and continuous improvement and leadership. Management need to ensure they understand and fully support all technical decisions being made. In the engineering and construction space, this is vital to the success of the project.

6.2.3 Education/ Technical

It can be concluded from the research that there is insufficient knowledge and awareness created around lean construction. Construction bodies such as SACPMP are not doing enough to create awareness and promote the knowledge of lean construction. Due to the lack of awareness, there is no need for training, and this is a barrier to lean construction implementation in South Africa. Majority of the interviewees believe that the South African construction industry suffers from a shortage of technical skills relating to lean construction. There is no knowledge and skills transfer between the different generations coming into the industry, middle management and those retiring. There is a need for further South African publications related to the benefits and implementation of LCPs. The government's lack of investment in infrastructure has also resulted in the shortage of investment of training and educating people to acquire the correct skills to implement and improve the construction industry.

There is a need for further publications illustrating the benefits of lean construction implementation in South Africa is required to promote the concept. There should be a strategy to train people before attempting to implement the philosophy. Training is very important in the implementation of lean as it involves teaching stakeholders and practitioners of the lean tools and techniques available.

6.2.4 Financial

It can be concluded from the research that there is not enough financial investment in lean construction, its principles and teachings in South Africa. There is not enough investment from clients, consultants and contractors to educate themselves on lean construction and implement lean construction principles. Adequate funds are required for the successful

implementation of lean construction. This is to motivate staff, provide relevant materials, training, equipment, and in some cases employ lean specialists to guide both employers and employees in implementing the concept. Other financial challenges facing the successful implementation of lean construction is corruption. This is a cross-themed challenge between finance and government.

In summary the financial investment required to invest in lean construction is not a lot. It does require the time and money of senior management, training and educating staff but these costs will have to start of slow and eventually the benefits and rewards will offset the investment. There needs to be more financial investment into lean construction in South Africa. The lack of financial investment has impacted the implementation and has ultimately led to lack of education and training, lack of awareness and lack of research, which leads to poor implementation.

6.2.5 Human attitude

It can be concluded from the research that there is an industry wide misconception of what lean construction is and there is a resistance to invest in attempting to educate and implement lean construction. The reasons for this are due to the general human behaviour to resist until explicitly shown the benefits, general misconceptions of lean construction, inability to collaborate, lack of implementation understanding of lean construction, lack of easily available knowledge and the inability to innovate.

Humans are generally resistant to shift their mindset and investment to a new concept unless you can evidently illustrate the values and benefits of lean construction. Resistance to change is also a major code hindering the successful implementation of lean construction on South Africa. Ensuring a mindset shift from the traditional method of project management to lean construction is key to the successful implementation of lean construction in South Africa. The mindset shift should create a collaborative environment, which in turn may ultimately assist in improving the challenges facing the industry as well. Implementing lean construction is not a tool or project but it is a behavioural lifetime shift. The shift in mindset, accompanied with previously mentioned suggestions, is vital towards the successful implementation of lean construction and improvement of the South African industry.

6.3 Research objective 3

In conclusion and summarising the recommendations of the interviewees, construction contracts need to be collaborative projects and that there should be incentives for all parties involved. A well-defined scope of works is required in the construction contract. Currently, contracts are not clear, and the scope is not well defined in terms of work, reporting, performance measurement and progress.

Clients, consultants and contractors need to fully understand the scope and requirements of the construction contract.

Construction companies need to focus on good strategic operations to assist with improving their business and LCPs should become a tool for management to understand and implement. Management styles need to change in order to implement lean construction successfully. Senior leaders need to understand that lean construction is imperative to the survival of the construction industry in South Africa.

Government should develop and drive policies and legislation that are required to focus on the supply chain of the project to ensure engagement of all parties.

All project stakeholders should engage, understand each other and the overall philosophy and objectives of the project. Lean construction requires engagement from well before the start of the project. This will create trust and reliability when the project begins.

There is a requirement to illustrate more South African research of LCPs and there is a need for require more lean construction practitioners in South Africa, who have international experience, to implement lean construction in South Africa.

There is a need for more on the job lean construction implementation, learning and development is required. This will require investment of finances and effort. The construction industry needs the correct level of education throughout the construction contract implementation.

6.4 Further research

It is recommended that research be done on government organisations and parastatals on their level of understanding of lean construction and investigate if there is an implementation strategy and what the strategy is. It is important to establish if the South African government does want to promote lean construction in the South African construction industry. This will indicate if there will be support (financially and educationally) from the government. A similar study should be carried out with large scale private sector clients in the construction industry.

Future research should consider interviewing a larger variety of individuals, including those who might be impartial and possibly resistant towards lean. The limitation of this study was that all participants selected were highly supportive of lean construction in South Africa. A lot could be learnt from those who are not so enthusiastic.

Finally, the study of lean learning ability and perception would benefit the industry. Understanding how to reach each group effectively would allow for improved implementation and saturation. Just as companies continuously strive to become lean, lean construction as a system is continuously improving as well. Innovative employees are finding new ways to implement lean concepts at their organisations. Lean construction is an exciting journey that is just beginning in the construction industry. Properly harnessing lean provides the potential to transform a poorly performing construction firm into a top-performing organisation.

REFERENCES

Akinradewo, O., Oke, A., Aigbavboa, C. & Ndalamba, M., 2018. *Benefits of adopting lean construction technique in the South African construction industry.* Pretoria and Johannesburg, s.n.

Al-Aomar, R., 2012. Analysis of lean construction practices at Abu Dhabi construction industry. *Lean Construction Journal,* pp. 105-121.

Arunagiri, P. & Gnanavelbabu, A., 2014. Identification of major lean production waste in automobile industries using weighted average method. *ScienceDirect,* Volume 97, pp. 2167 - 2175.

Aziz, R. F. & Hafez, M. S., 2013. Applying lean thinking in construction and performance improvement. *Alexandria Engineering Journal,* Issue 52, pp. 679-695.

Babalola, O., Ibem, E. O. & Ezema, I. C., 2019. Implementation of lean practices in the contruction industry: A systematic review. *Building and Environment,* Volume 148, pp. 34-43.

Ballard, G., 2000. *Last planner system of production control,* Birmingham: University of Birmingham.

Ballard, G. & Howell, G., 2004. Competing construction management paradigms. *Lean construction journal,* 1(1), pp. 38-45.

Banki, M. & Orumchi, H., 2007. *Lean construction: The modern philosophy of the construction industry.* Iran, Construction management conference.

Barboza, R. F., 2012. Implementing Lean construction in a traditional project management culture: challenges and roadblocks. pp. 835-846.

Bashir, A. et al., 2015. Overcoming the challenges facing lean construction practice in the UK contracting organisation. *International Journal of Architecture, Engineering and Construction,* 4(1), pp. 10-18.

Bischeno, J. & Holweg, M., 2016. *The Lean Toolbox.* 5th ed. Buckingham: PICSIE Books.

Crawford, M., 2016. *5 lean principles every engineer should know.* [Online]
Available at: https://www.asme.org/topics-resources/content/5-lean-principles-every-should-know
[Accessed 11 August 2019].

Eastern Kentucky University, 2015. *The seven wastes of lean manufacturing.* [Online]
Available at: https://safetymanagement.eku.edu/blog/the-seven-wastes-of-lean-manufacturing/
[Accessed 8 September 2019].

Eriksson, P. E., 2010. Improving construction supply chain collaboration and performance: A lean construction pilot project. *Supply Chain Management,* 15(5), pp. 394-403.

Fidelis, E. & Heinrich, U., 2014. Change in South Africa construction: Lessons from lean thinking. *TA 22nd Annual Conference of the International Group for Lean Construction,* pp. 1121-1131.

Forbes, L. & Ahmed, S., 2011. *Modern construction: lean project delivery and integrated practices.* London: CRC Press.

Glaser, B. & Strauss, A., 1967. *The discovery of grounded theory: Strategies for qualitative research.* New York: Aldine Publishing Company.

Gleeson, F. & Townsend, J., 2007. *Lean construction in the corporate world of the UK,* Manchester: University of Manchester, School of Mechanical, Aerospace, Civil and Construction Engineering.

Green, S., 1999. The missing arguments of lean construction. *Construction Management and Economics,* 2(17), pp. 133-137.

Green, S. D. & May, S. C., 2005. *Lean construction: Arenas of enactment, models of diffision and the meaning of leanness.* Reading: s.n.

Hame, N., Kowang, T. & Fei, G., 2017. Categorisation of lean research and development tools and techniques: a process- based approach. *Indian Journal of Science and Technology,* 10(3), pp. 1-7.

Henshall, A., 2018. *What is muda? The 7 wastes every lean business needs to combat.* [Online]
Available at: https://www.process.st/muda/
[Accessed 08 September 2019].

Howell, G., 1999. *What is lean construction?.* California, Internation Group for Lean Construction (IGLC).

Issa, U., 2013. Implementation of lean construction techniques for minimizing the risk effects on project construction time. *Alexandria Engineering Journal,* 52(4), pp. 697-704.

Jorgensen, B. & Emmitt, S., 2008. Lost in transition: The transfer of lean manufacturing to construction. *Engineering, Construction and Architectural Management,* 15(4), pp. 383-398.

Kew, J., 2019. *Fin24.* [Online]
Available at: https://www.fin24.com/Opinion/group-five-collapse-signals-sa-construction-demise-20190312
[Accessed 20 March 2019].

Koskela, L., 1992. *Application of new production theory in construction.* Stanford University, USA: s.n.

Lean Construction Institute, 2016. *Lean construction defined.* [Online]
Available at: https://www.leanconstruction.org/wp-content/uploads/2019/06/LeanConstructionDefined.pdf
[Accessed 26 July 2020].

Lean Engineering Institute, 2020. *What is lean?.* [Online]
Available at: https://www.lean.org/WhatsLean/
[Accessed 25 February 2020].

Lean Enterprise Institute, 2020. *Principles of lean.* [Online]
Available at: https://www.lean.org/whatslean/principles.cfm
[Accessed 25 February 2020].

Martins, J. & Cachadinha, N., 2013. *An exploratory study of lean construction in Portugal owners and designers perspectives.* Fortaleza, Brazil, International Group for Lean Construction (IGLC).

Modi, D. & Thakkar, H., 2014. Lean thinking: Reduction of waste, lead time, cost through lean manufacturing tools and technique. *International Journal of Emerging Technology and Advanced Engineering,* 4(3), pp. 339 - 344.

Mossman, A., 2009. Why Isn't the UK construction industry going lean with Gusto?. *Lean construction journal,* 5(1), pp. 24-36.

National Centre for Research Methods Review Paper, 2012. *How many qualitative interviews in enough?.* [Online]
Available at: http://eprints.ncrm.ac.uk/2273/
[Accessed 16 August 2020].

National Treasury, 2018. *Public sector infrastructure update.* [Online]
Available at:
http://www.treasury.gov.za/documents/national%20budget/2018/review/Annexure%20D.pdf
[Accessed 09 August 2019].

Olatunji, O., 2008. *Lean-in-Nigerian construction: State, barriers, strategies and "go-to-gemba" approach.* Machester, UK, Proceedings of the 16th annual conference of the internation group of lean construction.

O'Reilly, M. & Parker, N., 2012. Unsatisfactory saturation: A critical exploration of the notion of saturation sample sized in qualitative research. *Qualitative research,* pp. 1-8.

Pandey, D. P. & Pandey, D. M. M., 2015. *Research methodology: Tools and techniques.* 1st ed. Buzau: Bridge Center.

Pavnaskar, S., Gershenson, J. & Jambekar, A., 2003. Classification scheme for lean manufacturing tools. *Int. J. Prod. Res. ,* 41(13), pp. 3075-3090.

PMBOK, 2004. *A guide to the project management book of knowledge.* 3rd ed. Pennsylvania: Project management institute, Inc.

PMBOK, 2004. *A Guide to the Project Management Book of Knowledge.* 3rd ed. Newtown Square, Pennsylvannia: Project Management Institue, Inc. .

PMSA, 2008. *PMSA profile.* [Online]
Available at: https://www.projectmanagement.org.za/page/profile
[Accessed 21 November 2019].

PWC, 2016. *SA Construction: Highlighting trends in the South African construction industry.* [Online]
Available at: https://www.pwc.co.za/en/assets/pdf/sa-construction-2016.pdf
[Accessed 25 March 2019].

Rumsey, C., 2018. *BizCommunity.* [Online]
Available at: https://www.bizcommunity.com/Article/196/494/181245.html
[Accessed 20 March 2019].

SABCNews, 2019. *SA ranks among the world's most corrupt countries: Transparency International.* [Online]
Available at: http://www.sabcnews.com/sabcnews/sa-ranks-among-the-worlds-corrupt-

countries-transparency-international/
[Accessed 29 November 2019].

SACPMP, 2012. *The South African Council for Project and Construction Management Profession.* s.l.:s.n.

Saldana, J., 2009. *The coding manual for qualitative researches.* 1st ed. London: SAGE Publications.

South African Government News Agency, 2019. *Construction sector faces many challenges: Gigaba.* [Online]
Available at: https://www.sanews.gov.za/south-africa/construction-sector-faces-many-challenges-gigaba
[Accessed 26 March 2019].

StatsSA, 2019. [Online]
Available at: http://www.statssa.gov.za/
[Accessed 1 April 2019].

The University of Auckland, 2019. *Thematic analysis | a reflective approach.* [Online]
Available at: https://www.psych.auckland.ac.nz/en/about/our-research/research-groups/thematic-analysis.html
[Accessed 4 July 2019].

Trading Economics, 2019. *South Africa GDP from construction.* [Online]
Available at: https://tradingeconomics.com/south-africa/gdp-from-construction
[Accessed 1 April 2019].

Walker, A., 1984. *Project management in construction.* Granada: s.n.

Wandahl, S., 2014. Lean construction with or without lean - Challenges of implementing lean construction. *Proceedings IGLC,* Volume 22, pp. 97-108.

Wengraf, T., 2001. *Qualitative research interviewing.* 1st ed. London: SAGE Publications Ltd.

Williams, D., 2011. *Qualitative inquiry in daily life.* [Online]
Available at: https://qualitativeinquirydailylife.wordpress.com/
[Accessed 11 October 2019].

Womack, J. & Jones, D., 2010. *Lean thinking: banish waste and create wealth in your corporation.* s.l.:Simon and Schuster.

Yin, R. K., 2009. *Case study research: design and methods (4th Edn.).* CA: Sage Publications.

APPENDICES

8.1 Appendix A: Participant information sheet

Date:

Dear Sir/ Madam,

Re: Participation in Research- Semi Structured Interview

I am a part-time MSc student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand, under the supervision of Ms. Bernadette Sunjka. My MSc. Title is: **Investigating the challenges experienced by the South African construction industry in adopting lean construction principles to deliver projects**

My MSc. Is sponsored by my employer, Mott MacDonald.

With your experience and knowledge in the lean engineering/ construction industry I would like to formally invite you to participate in this study. Your knowledge and experience would contribute significantly.

The study will be conducted between July and November 2019. Involvement in the study would entail a face-to-face semi-structured interview with you, at your convenience. During these interviews I would like to understand your take on the implementation of lean construction principles in South Africa and your thoughts on the industry. The interview will basically assist me in moving closer to meeting to the research objectives, which are:

1. To identify the level of understanding and knowledge about lean construction and lean construction principles in the South African civil and construction industry.
2. To identify the challenges of implementing lean construction project management principles in South Africa.
3. To make recommendations on how to address these challenges.

Participation in the study is voluntary, and you may withdraw at any time. Anonymity (regarding company name and any owner/manager/employee names) and confidentiality of information provided will be assured and respected. I would like to record the interviews, so I

can later transcribe them. Your consent at the time of the interview will be requested. If you do not wish the interviews to be recorded this will be respected.

The results of the study will form part of my MSc. Research report and may also be reported in academic papers and at conferences. A summary of the results of the research will be made available to you on request.

Please contact me if you have any questions regarding the research and participation in the study.

I look forward to hearing from you.

Yours faithfully

……

Priyesh Dowra

Tel: 073 579 8491 Email: pdowra@yahoo.com

Supervisor: Tel: 011 717 7367 Email: Bernadette.sunjka@wits.ac.za

8.2 Appendix B: Letter of consent

Dear Participant,

Thank you for accepting to participate in this study. Please complete this consent form as you see appropriate. By signing this consent form, you are indicating that you have read and understood the description of this study and that you agree to the terms as described below:

	Mark with X	
	YES	NO
I confirm that I have read and understood the information about this study as provided in the participant's information sheet.		
I understand that my participation is voluntary and that I am free to withdraw at any time without any penalties or negative consequences against me.		
I grant permission for the interview to be audio recorded.		
I agree that the information I provide may be treated as strictly confidential and anonymous and only the research team will have access to the interview data.		
I understand that the information acquired from the interview will not be recorded in excess of what is required for this study.		
I agree that the results of this study may be recorded in academic journals and at conferences.		
I have had the opportunity to ask any questions related to this study and I have had all my questions answered to my satisfaction.		
I may request a report summary, which will come as a result of this study.		

With full knowledge of all above-mentioned terms, I agree to participate in this study.

Participant		Consent taken by (Researcher)	
Name		Name	
Signature		Signature	
Date		Date	

8.3 Appendix C: Interview questions

1. What is your work experience and how many years of experience do you have?
2. What is your current responsibility in your business or projects that you work on?
3. What is your current position in your company and age (if comfortable with giving age)?
4. Are you familiar with lean construction concepts/ ideas? If so, which concepts are you familiar with?
5. If you had to rate your knowledge of lean construction concepts and principles (1 = no knowledge, and 10 = fully knowledgeable), how would you rate your knowledge on the topic?
6. Throughout your experience, would you say that the colleagues you have worked with are familiar with lean construction concepts and principles? Please briefly explain
7. In your opinion, how would you describe the current state of the South African construction industry?
8. In your opinion, how would you describe your perception of the productivity of South African construction projects?
9. In your opinion, could/ has (if any) the implementation of lean construction principles improve/d productivity in construction projects? Please briefly explain.
10. In your opinion, what occurrences/ issues negatively impact (if any) the delivery and performance of construction projects in South Africa?
11. In your opinion, what role has the South African government played in developing or deterring the current state of the construction industry? Please briefly explain.
12. In your opinion, do you think that the South African government has developed policies and protocols to support the implementation of lean construction principles?
13. In your opinion, has management in your organisation set very high, sometimes unreasonable expectations of projects?
14. In your opinion, do you believe that your organisation and other similar organisation in the industry, is committed to develop and implement an effective plan and resources to support and manage the implementation of lean construction principles?
15. Throughout your professional experience and the projects that stand out for you, do you believe that middle and higher management could have added more value to improve the success of projects? Please briefly explain.

16. In your opinion, do you feel that professional bodies create sufficient knowledge and awareness about lean construction? Please briefly explain.
17. In your opinion, do you think that the South African construction industry suffers from a shortage of technical skills and knowledge regarding lean construction principles? Please briefly explain.
18. Have you been for any formal lean construction training in your organisation?
19. Has your organisation's management been for any formal lean construction training?
20. Do you feel that any training would improve awareness and successful implementation of the lean principles in your organisation?
21. In your opinion, do consultants, contractors and clients adequately invest financially to educate and implement lean construction techniques on their projects? Please briefly explain.
22. Do you think they SHOULD invest more in educating and implementing lean construction principles?
23. Do you think they CAN invest more in educating and implementing lean construction principles?
24. In your opinion, do you feel there is a misconception or lack of understanding of what lean construction is? Please briefly explain.
25. In your opinion, do you feel that there is a resistance, in industry, to implement lean construction techniques? Please briefly explain.
26. Are there any other barriers that you strongly believe affect the successful implementation of lean construction principles?
27. What are your suggestions to overcome the barriers discussed throughout the interview and the previous question?

8.4 Appendix D: Coding of data

Table 8-1: Coding of data

Research question	Theme	Codes
What are the challenges experienced by the South African construction industry in delivering projects when adopting lean construction principles?	Management	high expectations, excellence/ achievements, leadership/ responsibility/ accountability, communication, Implementation, understanding and awareness, margins/ profit/ cost, resources, value, transparency, scope/ requirements, unreasonable, planning/ pre-planning, productivity, resources, quality, technical support, innovation
	Financial	inadequate funds, lean specialists, wages, corruption, incentives, motivation, training, inflation, unstable markets, and implementation cost
	Educational/ technical	awareness, knowledge sharing, researchers, practitioners, professional bodies (LCI, IGLC, CLIP, CE), Illiteracy, workers, technical skills, ignorance, development, training, technical skills, reliability, flexibility, competent, knowledge and constructability
	Governmental	policies, corruption, commodities, lack of understanding of the topic, efficiency, economy, implementation, qualified, skills development, BEE, history, social development, infrastructure, labour issues, innovation, procurement

	Human attitude	Mindset, teamwork/ group work, misconceptions, understanding and awareness, self-criticism, resistance, irrational, fear of unfamiliar practices, ignorance, lack of co-operation, commitment

8.5 Appendix E: Ethics clearance certificate

2/25/2020 University of the Witwatersrand, Johannesburg Mail - Dowra Priyesh ethics clearance number

WITS UNIVERSITY

Priyesh Dowra <1455094@students.wits.ac.za>

Dowra Priyesh ethics clearance number

1 message

Bruno Emwanu <Bruno.Emwanu@wits.ac.za> 27 September 2019 at 16:56
To: Priyesh Dowra <1455094@students.wits.ac.za>
Cc: BERNADETTE Sunjka <Bernadette.Sunjka@wits.ac.za>

Dear Priyesh,

I am pleased to inform you that the School Ethics Committee has completed assessing your ethics application for your MSc 50/50 research report and clearance has been provided.

The ethics clearance number for your research report is MIAEC 177/19

Please use your ethics clearance number as a reference for all future correspondence on this matter.

By copy of this email, your supervisor is also informed.

Regards,

Dr. Emwanu

8.6 Appendix F: Interview transcripts

8.6.1 Interviewee A

START

I: Uhm ok so there is a set of general questions first and I just want you to tell me what is your work experience and how many years of experience do you have in your industry?

R: So, I graduated understand as a Metallurgist and I started working I the mines as a Metallic engineer and then I left them mines after 4 years to join Mthunzi and I have been with Mthunzi for 4 and half years now. And I have spent around 80% of the time doing what we call typical projects and infrastructure, and I was focusing in the area on construction delivery and as one as one of the techniques that we use in construction is lean construction, so I have been doing lean construction since I got in the firm. I am a member of the Lean Construction Institute in the US, we have recently started again construction institute in South Africa. I need that community of practice and yeah that's pretty much me.

I: Ok, ok on that question can you maybe just spend a minute elaborating in your role in Lean Construction in South Africa.

R: Uhm sure, we have implemented lean construction specifically in South Africa I have got a few projects that were running, and I think they are currently still running in South Africa. Uhm I think from the SOE and we did that about 2014, I joined the team in 2015 and I started in the team as an associate and I was just pretty much just coaching the people in the front line about how to implement the technique. Again with that to engage in mining as a project manager and then that role was trying to align the owner, you know the owner of the asset that is being constructed and the contractor to start adopting the lean technique and moving down to coaching them with that. I have done a couple of training from that, from the client side and in the institute. We normally do the trainings at Wits for Honors students in construction management; we also do them to the general public and members of the LTI as part of the chancelling. So, we have got the chamber of the legis- training sessions that we run on that and they are normally done. The launch that we have done, to another that we have done that is in Indonesia the construction of refinery in Canada, we have construction of-, it was refinery as well in Orange farm east and South Africa that's construction of power plants.

I: Ok, ok that's quite an in-depth role there. The next question that I want to us it just briefly what your current position in the company is that you work at and if you are not comfortable with giving your age could you please try to give an age bracket.

R: Ok, senior implementation coach and my age-, how old am i? 32, I am 32 yeah there you go.

I: Ok so you are 32 years yeah, uhm the next set of questions-, ok that was just general questions. The next set of questions there is about 5 categories and there is about 3 questions in each, 6 categories and about 3 or 4 questions is each. So, the next question is, are you familiar with lean construction concepts and ideas, if so, which concepts are you familiar with?

R: Uhm so I am very familiar with lean construction, some in the firm we have been-, like we have a [unclear] to work around that and adopted the entire of the lean construction institute, the developer of the role in construction and understanding of the framework, understanding of delivery, understanding of how we wanted to build. And you know taking from the case study what do we capture from limitation of lean construction, so uhm in campus what I understand the framework, I understand how it's engineered, I understand the value.

I: Ok uhm can you just maybe state one or 2 concepts that you are familiar with, maybe last planner whatever it is?

R: Sure, uhm lean construction is cut off 3 things. One it's around the technical execution be it in design as well as construction execution, and then organization design in terms of how are you sweating up your people, what kind of people do you have and how are you interacting because we've got different frames that come in together for an asset. So, you initial sob up an organization that works amongst the different frames.

And then the last point is a bit sensitive and very controversial, it's around contracting and how you manage the setup of your contract. You know this a contract; you have to set you a contract. How do you set up your contract first, uhm so those are the key 3 things that drive lean construction; last planner is just an element within execution delivery which look at how do you collaboratively plan to the team execution for work and it's being done by the executor instead of a planner sitting in front of a team of their own. That's that planning of team is mostly about, but there is a bigger thing that you need to think about.

Contracting and setting up an organization for the plan, uhm what we usual do in the plan is to add on an element of digital to it which becomes super interesting I think because you

can-, you know in visual management when you are done managing can now be done through VR, through whole lot of things. So, it's really becoming super interesting, yeah.

I: Ok, ok next question is if you had to rate-, now this is like throwing an ocean type of question, if you had to rate your knowledge of lean construction from 1 being no knowledge at all and 10 being fully knowledgeable about all concepts and continually learning, where would you rate yourself?

R: Oh, this is super interesting, uhm I think I would be at about 8 to 10, round about 8. I have done this quite a few times; I have held even multiple clients on it. So, I would like to argue about 9.

I: Ok throughout your experience would you say that colleagues that you have worked with-, maybe they weren't specifically in lean but let me say in mining, the experience that you have there. Were they familiar with lean concepts as well?

R: So, if I look at my colleagues, I would put them at in 2, pretty much 3 groups. If I look at my internal colleagues at the firm, I think this concept is clear and they knew about it and just how it works. You know beyond even just construction projects, when you've got clients, colleagues, especially in South Africa it's a bit far from where it should be. Like people don't really understand what it's about, there is a little bit of-, yeah, it's there, people are talking about it but they don't know what is it and how to do it. And they think it's a once off thing that you are goings to do when you are done. The fact that I would put in a rate is that colleagues from time to time the understand lean and hey understand the value but it's not so-, with that mindset, I've got colleagues with that mindset, they choose to ignore it and not, and be like you don't understand. So they chose to ignore them first and not understand but they do understand it's just the mindset that that they have that they are not going to adopt.

I: Ok I think I know what you mean there, now I am moving on to the next set of questions we are actually focusing I construction in construction industry in South Africa. I your opinion how would we describe the current state of the construction industry here in South Africa?

R: The current state of construction if we look at contracting or I think most of these drivers are struggling financially. I think one of their major downfalls is around productivity, that' what kills them. There is a whole lot of talks about not having fate, there is an element of new beginning there, but I think there is also another-, people feel that they can just push on and you know, I've got the thing for them. So, from EPC kind of view I can say it's struggling a lot and the industry is going down and people are losing a lot of money, and there is potential

for them to recover if they can just start thinking differently. From an honors perspective I think we don't have experience in driving, especially the mega projects. We tend to deliver our projects like any other project that you do, like a daily business project. But the thinking has to be different and we turn to then be chased around by the EPP, they are in the game for longer than the owner because the owner who would do a mega project is coming once in 10 years. While the EPP is doing the survey every day of its life, so they get trained by the EPP and they turn to move up as well. So, we are in the midst of this situation in South Africa because EPP are playing games, but the games are not benefiting them, the owner doesn't know how to do their job and it's getting trade on and we are carrying that on. So, it's a lose - lose situation.

I: Ok, ok it's a good point that you have mentioned there of productivity and that is actually my next question. In your opinion how would you describe the perception of productivity of South African construction projects?

R: The construction at the moment I think it's driven by low skilled labor, uhm and everyone is saying no I need to bring in extras to do the work because I do not find skills in the country. There is an extent of this thing true but there is also an extend of us not supporting the locals to be great, even if we bring in experts we do not make sure that we bring in thorough skills transfer so that we can capture the skills locally and then we absorb it. Uhm top of the pile is cheap labor, they do what they have to do and then they go. In the country there is labor issues in terms of [Inaudible 00:15:05] so that unions would support at the end of the day and then you have to pay a little more, and then there is an issue around 'oh they are not sure' but I think there is an opportunity to improve that. I don't think that we can't do anything about it, so that is where I am. Beyond skills I think we really don't know it properly. To be honest we go and develop a 10 000 line prematurely schedule that literally in the next hour it's absolute, it's not that full tension and probably to be tried and it's just absolute. And we are now we put on the design; half of the time the design is completely parallel with construction. You know it's a bit of a mistake and it's driven by a lot of such. Agency of delivery of the aspect and the owner not having experience and doing a thorough job in the beginning or making sure that designs are up to scratch, contracts are up to scratch and by contract being up to scratch I mean having enoughly rich to get the EOC, to control the EPC game. So that the EPC doesn't have to play the game that they do, so what EPC doesn't instead say that they do not do, they do not talk that they are completely undervaluing the projects so that they get the tenders. And once they are in they start playing the claim games to make up for the short fall that they have out in, hardly ever work because they end up doing second thoughts fights that prolong the schedule and they end up being bankrupt and it just becomes even a bigger mess and you've got a pile of claims, people don't look at the

race and all sort of things. So, to be honest with your productivity is a challenge in South Africa, yes but there is still something that we can do. So please note those some of the other stuff.

I: Ok uhm next question, in your opinion could or has the implementation of lean construction improved productivity of South African projects that you are still in or have worked on?

R: Definitely uhm I mean we have recently done an in-construction improvement in one of the mines in the country, so we are doing a green fruit construction of the mine and we really regent that the estimated delivery date was-, the focused delivery date was March 2020 and we had our first product being delivered in September 2019. So, we have saved 6 months from you know adopting of lean in construction. Uhm in terms of from the cost-effective form of managing, it's a bit tricky you can cut out data on X amount of days and X amount of money for the construction. So, I have saved 6 months, that's about X amount. The challenges come with all the little claims that it's attached to be filled and it's very difficult to calculate them from monitory project, so what we normally do is that we save that from schedule, and we struggle to monetize that. From looking at a schedule the other thing that is very important and I think that people turn to miss in construction it's that the drive is not for you to reduce the schedule. Reducing the schedule with like 7 months is giving liability to your schedule, so the planner would tell you that I am going to deliver this in December. When you go and do collet last learners and you really do root cause analysis, you do constrain management you then end up saying no this is not going to be delivered in December, it's going to be delivered in April. The contractor then they don't want to hear that, they want to hear 'I am reducing days' it's not about reducing days it's about the liability, I am going to deliver what I said I am going to deliver. That's the important thing first and I think that's the message that turns to be last when we talk about lean construction.

I: Ok in your opinion what occurrences or issues negatively impact the delivery and performance of construction projects here in South Africa? I think you might have covered it in all of your extra notions in this chapter but if you could just briefly go over that so that I can record it for this question specifically.

R: Ok cool, so 2 things for me mindset and contract. Uhm mindsets, constructive again for lean construction to completely work you need to collaborate with the environment, you need EGC short contractors, owners, designers and you work together. Everybody should have that collaborative mindset of solving problems, identifying problems. And being proactive about solving them, the minute one person is not part of the board you are already out. The mindset that I am talking about is EPP; they undervalue the project and the timeframe to

play the claim game. So, they would never be part of the team, so they would come in and they try to find any opportunity to cool the train towards the owner. You know, so the one thing is that it cannot create visibility for the client. For lean construction to work, collaborative and visibility. So everybody needs to understand what's happening and when it's happening but we forget each other, if you are going to play the claim game that means you need to play open cards. Which plays visibility, either you might win and when. So, if you cannot create that then it's not going to work, we are both driving on different directions.

Contracting on the second part, contracts are set up in such a way that again it becomes a change in.

We don't have collaborative contract but with both parties we have incentives to work together, the main construction Institute is to develop IPP, Integrated Project Delivery which are drive for an incentive for both the EPP and the owner to deliver construction in that manner. How we do this is, they say we've got a pot of money and whatever is not in the pot of money we share it equally.

So, everybody works towards breaking that pot of money as much as possible so we don't-, if there is any chance, we take from that pot. So, player 2 was not taking from the pot because we know that we are going to leave out from it, so that's the main things that has changed in the new act that they leave out. Those who can get approach of thinking of having win-win situation instead of I am trying to win and then you lose, it would change a lot and production would be much easier. So, if we can talk about it and if we can change our mindset then I think everything would work. The element of knowledge of capability just is a challenge but I think it's solvable, it's easy to solve compared to these 2 mindset and contract.

I: Ok, ok uhm in your opinion what role has the South African government play in developing or deterring the current state of the construction industry?

R: Uhm so I am not really inclined with public assets, I am not really sure what the government is doing. But in terms of addressing capability in the country I am not seeing anything happening to be quite honest. I work a lot with South African project management and construction something. SACP or something, I don't know.

I: SACPMP.

R: Yeah that one, yeah those guys, I feel that their still working high in terms of adopting lean construction and some of the digital tools and being in conversation with them in terms of how do we help to get the industry going, we are still far to be honest I don't see that

happening but I don't see government doing much about it and I don't know of any projects happening that are driving this. Uhm we try to initiate that with the LTI, it's going very slowly and the only part that we seem to work is again in that same PNP, whatever the acronym.

I: Ok.

R: Yeah that's as far as I know, I don't know any other government projects that are driving this.

I: Ok that's fair, ok from your-, as you said very little impact involved in the government. In your opinion do you think that the South African government has developed policies and protocols to support the implementation of lean, specifically as you said speaking about SACPNP or any other organization linked to the government?

R: Honestly, I am not sure, maybe there is work that I am not aware of but with what I am aware of I don't think so. And its simple things that we are achieving that I am talking about, if we were to push especially if government wants to implement this infrastructure then it's ruled by government to be IPD contracts and that would go a lot way. The government won't lose a lot of money from these mega projects, if you look at the 2 Boiler mega projects they went way over budget. You know if we have had 1 good contract, well there were other effects with capabilities and designs and all of that, that could have ran in parallel but a cheaper good contract we would have a key to better leverage in term of how we would have managed the cheap big contract. So personally, I think what the government could do, could make a big change is to push all the government tenders to IPD contract.

I: Ok I know even my company we are suffering with a legacy project which is Kusile, which is the biggest loss-making project of our entire organization.

R: I know, I know

I: Ok we are almost halfway through, in your opinion has now speaking of your organizations that you have worked. In your opinion has management in your organization set very high, something unreasonable expectations of the projects that you work on.

R: So, in generally at the firm we always set our-, we always set the project high. We always drive towards being super excellent, which is great. In terms of achieving it it's dependent on the willingness of the client and half of the time they are not willing, especially the EPDP, ad for reasons that I have already mentioned around EPDP. The second point is owners set up

expectations that they don't even understand, they would say I want you to save me days. As I have said it's not about saving days, it's about giving you reliability. I think for my leadership internally perspective as well as the ownership, the owner leadership perspective they need to understand that we are not bringing this in construction to save you days. We are bringing this to bring you reliability, yes once you start implementing you start flowing and that's an opportunity to save days because you start to understand the other processes in it, which they don't but it's one of those in 'I am finishing this on the X and I want you to do me X -5' it doesn't work like that.

I: Mh.

R: I would give you reliability, if my-, in total it's just X -5 works then great. If it's just X4, 5 take it that's how it is, it's reliable. Instead of you, what you would expect we all know for a fact that it's not going to margin, you know. So I think that's one thing that expectations are always-, you know people are always willing to save days.

I: Mh.

R: saving days is a resulting thing that you know counts into place but what is super important is doing the reliability.

I: Ok uhm do you believe that your organization, other similar organizations in the industry is committed to developing and implementing and effective plan and resource to implementing and manage the implementation of lean construction in principles?

R: So, for me it's the basic tools to do that because we are not in construction, our business is not construction. But what we offer is how do you see that, we cannot say we are committed to giving planner, you don't give planners, we don't even-, we don't make plans. We can help you make a plan; we can help you plan but we don't d plans. But I think we would rather be more relevant to an old model than to do that, but if you were to ask my judgment on projects that I have worked in.

Yeah I think I saw how EPC sort of proven themselves in giving resources and willingness, I think EPC don't want to work, they don't want to *plunge deep shit* [unsure of the statement] because they are exposed, they don't want to be exposed. They always complain about it and that [Inaudible 00:33:10] owners don't understand their role to be honest, they think they are there to just quality manage and that's about it. If you want to implement lean construction effectively it needs to be a collaborative work, they need to invest people to go

and work with EPC in helping them problem solve, climb to the team, bringing in the different take that you have to work together and that element is not there on the wonder.

I: Mh.

R: They are building, they have people I won't say it's a natural but they don't have the capacity to work, they just don't know that they have to do this. Uhm they think they are going to use the concept to say 'oh you said you are going to deliver on me day X, I want it on day X' it's not like that. You need to get off the chair and help that person to deliver on day X, a tick on paper is not going to make that person deliver on day X. they are not going to deliver and they are going to come with all sort of excuses why they cannot deliver, and you are going pay for it.

R: So until that mindsets has changed, honestly the resources they have they are not willing to go and help. They don't understand that they have to do it.

I: Ok.

R: When that conversation is on lean construction half of the time they say 'mh I am fine, I've got a contract, I vet my weekly report from the contractor, I am happy'. That's not enough my friend and soon enough when they are 80% into construction they realize because now they are seeing that things are not getting done, they are still getting the same reports and things are still not getting done and instead they are getting claims that's when they start panicking that 'oh come and help us' and by that time they have already lost so much. Had you done this thing at the right time when we just started then you could have been way much better.

I: Yes, yeah, it's a bit too late by then. They are already out of time and them would just minimize the damage, but you can't make it positive again.

R: Exactly.

I: Yeah ok throughout your professional experience the projects that stand out for you, do you believe the remodel or higher management could have added more value to improve the success of projects? I know you have stated that you are not really in the construction industry but maybe from the projects that you have worked with, with some of the clients, maybe some of the managements you have worked with in terms of engineering consultant do you feel their managers could have done more to understand the concepts? As you said they don't realize at the beginning and it's a bit too late when they realize it.

R: Yeah no definitely I think there is a real opportunity in terms of getting a buy in from higher management and the reason why I am saying this is they've got a contract, the aim is to make money, right? So, they've got a contract and they are fine to play with the contract and see how they can make money, so if you could change their mindset into you just want to get this thing done then it would be a win-win situation. It would be 80% of the work done, people on the ground are easy, easy to go and get them to do stuff but they are driven by people on top and people on top don't want to create feasibility. The minute you turn the people to create that feasibility then 80% if your effort in implementing construction is done.

I: Yeah.

R: So, both EPC and Aura they need to-, from a higher leader perspective they need to understand the value of this for them to drive it. And for the own perspective because if it means that the value would be for the owner, it would be in both directions.

I: Yes.

R: If they could understand that and that would be a game honestly because the guys on the ground implementing it it's super easy, it's super easy for them but they are driver by people up who don't want to create the feasibility.

I: Ok uhm thank you for that we are done with that section, the next section is specifically education and technical skills in South Africa in engineering. In your opinion do you feel that bodies such as SACPNP, this one might be a conflict of interest for you, but Lean Construction South Africa creates sufficient knowledge and awareness about lean construction?

R: So as much as I am running Lean Construction South Africa as Lean Construction Institute South Africa, I am doing to say I don' think that I am doing much.

I: Ok.

R: You know, and I think opportunity like-, even the SAP-, whatever the acronym couldn't get to me.

I: Yes.

R: Has access, has more access than I do.

I: Yes, thank you, they have a wider network absolutely.

R: Exactly, and even leveling down to feasibility building its one way that you can get this thing out. South Africa I have never seen a vast planner training what we do, I have never seen it. Maybe there is some tone who is doing it somewhere, but I know that Mthunzi is driving it, I know that LCISA is driving it and again LCISA is sponsored by Mthunzi, its again Mthunzi. So, I don't think we are doing enough honestly, and I think that's an opportunity and I think it should be driven by a government organization because they've got access and network to the industry.

I: Ok uhm do you think that the South African Construction Industry suffers from shortage of technical skills and knowledge specifically in relation to lean construction principles and role perspective as well?

R: Yes, we don't have that feasibility, we are really-, I mean remember I spoke to you about the budget of people and there are people that understand that they could not do it?

I: Mh.

R: That budget is really small compared to the budget of people that don't know, people honestly don't know it's that-, these people are quite small and when you start talking about them and they are like 'oh yes that makes sense'.

I: Yes.

R: But the mindset is not there, they really don't know. They don't know how to do this and because of their mindset being in the wrong place they cannot say they want it.

I: Yeah.

R: So, we don't have the capability, specifically for lean construction I would say confidently from a personal perspective that we don't have sufficient capability. Every time when I hold the lean construction institute session of ban, they would start asking what lean construction is. None, no one in that room knows what I am talking about.

I: Yes.

R: So, I think the gap is really there.

I: It's quite frightening.

R: It is, it's scary, it's super scary. You have no idea every time when I look at people's faces and they are like 'what are you talking about?'

I: Yeah

R: it's like how did you study construction?

I: Yeah I have been a civil engineer for about 7 years now but I am in consulting, and I have done my maters for about 3 years and I have done courses relating to lean manufacturing and engineering and when you get to those courses you just realize that it's just logical solutions and you expect people to understand that but they actually don't. The actually oppose to it, they are resisting it to understand it.

R: Yeah, yeah no it's a mindset thing honestly and because of the mindset it's really surprising the thinking that this is logic. It surprises me so badly and it's really unbelievable, like you get to a point where you are like really are you where you are and are you supposed to really be there?

I: Yes.

R: Yeah, but yeah, the opportunity is really there, and I mean with the way that we are developing construction in the country I think it's really scary that we are not thinking about it.

I: Ok the next 2 questions are quite simple; it's been any formal training for lean construction in your organization? I think for you it's quite simple now.

R: Yeah, we do.

I: Ok has your organization's management been on a formal lean construction training?

R: I mean internally we do, and we also offer our client for of that.

I: Ok the last questions is-, ok you have answered yes to that, the last question is if you answered no to the above question do you feel that training would improve awareness and successful implementation, so you have answered yes so it's fine.

R: Yeah but it will.

I: Ok.

R: Beyond that I think it's needed.

I: Yeah, ok the next section is relating to investment, financial investments into the concepts of lean. In your opinion do consultants, contractors, clients adequately invest financially to educate, train and implement lean construction principles on the projects?

R: No, I don't think they do and when-, that's one thing when they bring consultants like us coming out and by ten it's 80% into issues and they want clients cover. Or legally they might refer the damages, but they don't and it's not a huge investment to do, I don't think it's a lot of money.

I: Mh.

R: I just think it's just a matter of at the beginning your investment should be getting the right contract, that it must be organization for success and just getting people that you are dealing with trained on lean then you are set up. I don't think it's a huge investment honestly, especially compared to the losses that they get. If you calculate the benefit that you get out of this versus that, a little of this, a little of that, you are getting the right contractor instead of copying and pasting the contract from team [inaudible 00:45:53] I think it's really nothing.

I: Ok the next 2 questions are quite simple to answer; do you think they should invest more in educating and implementing these techniques?

R: Definitely.

I: Ok and the next question is do you think they can invest more in educating and implementing these techniques?

R: Yeah, I think we still can, so an organization that has-, let's go with the government. You know they are doing a lot of infrastructure, if you are going to go and just understanding IPD and then you say this should come by contract and then it becomes a roll out of all contracts that are coming in as I have mentioned you are done. Then you've got people that are delivering this project, you go and train them, you set up organization. I think-, I feel like it's a once off thing that would give you so much venture. Yes, people go and get out but when you bring new people because you don't even complete new set of people, you'll still have the old people there because they would have the mindset you just transfer. These things are not difficult, it's not like you are going to learn some scientific things that has never been created on earth, it's not like that. Once the mindset is there and everyone is running in that direction and new people that are coming, they know the direction is there, there is no way, it becomes a way of life.

I: Mh.

R: When people talk about lean I don't like them thinking about it as a project, it's not a project it's how we-, it should be a plot, it should be a way of life, the way of doing this thing,

and once you can instill that in an organization I feel like you are almost done, it becomes a mindset and they think about working for improvement every single day.

I: Yeah.

R: It's not an investment like I have to do transformation every 3 month, 3 years because I am on this lean thing. No, you just instill the mindset then you are done.

I: Yes, no I agree with you, I understand what you are saying. Ok we are on to the last 5 question, the next topic, chapter rather is in your opinion do you feel-, oh the next chapter is about human attitude in the industry, in your opinion do you feel there is a misconception or lack of understanding of what lean construction is?

R: Yes, I am it comes first to the mindset.

I: Yes.

R: The EPC they use that if I am implementing construction I am going to be from a clear visibility, I don't have leverage to play the claim game and I need the claim game because the way I tendered this it's not going to make me money, so claims are the way to make money. So that's the first one, so the owner, I am not going to do extra work, I've got a contract that abides these guys to be delivering, that's enough. But don't need lean construction, I don't need to work with it.

I: Mh.

R: So that needs to go, that mindset need to go. We need to get rid of it just now because it doesn't work like that honestly, it's just doesn't work. So, we need to change the mindset and get people to understand what the principles are, what the benefits of us going with this thing.

I: Yes, ok do you feel that-, well you have touched on this a while before I f I remember, I your opinion do you feel that there is resistance I the industry to move away from the old project management ways and techniques and learn about lean construction and actually implement it? Do you feel that there is resistance from contractors and clients and engineers to try something new?

R: Yeah, I mean human behavior I general is difficult to change, right? It's even worse if you think the old ways where you turned to [inaudible 00:51:02] so they believe that this way works for me even though they don't make money, so resistance to change is definitely there, it's definitely there.

I: I know I have been under construction site in KZN for about 2 years as an assistant, as an engineer and I must say that because the contractor was an older guy you could see he was very resistant to try new ways of improving just the way people use this plant around, this material around that 'no I did it this way and I'll continue to do it this way'.

R: Yeah.

I: Ok in your opinion-, yes continue.

R: No, I think we don't do enough of coach motto after the project to re-eject the root cause so that we can have an understanding of where we go wrong, so that we can change. I feel like that element of trying to change mindset if we can really do a thorough post motto after project to see what went well and what went wrong, I think that's one element that helps the mindset.

I: Ok do you feel that the construction industry requires a culture change to improve the industry?

R: Definitely.

I: Mh.

R: We need to start working together, we need to stop playing the claim game, we need to stop holding our cards close. We need to play open cards, that's the only way that we would success both EPC and contractors. I mean [Inaudible 00:53:13] they need to help these guys understand that they are sitting somewhere and when they are processing to go and find this guy then she doesn't get it, then it's just a Maths and you spend hours trying to teach him and getting a qualification it's time wasted.

I: Yeah.

R: We need to get out of this and start on this together.

I: Ok uhm the last section that I am just going to focus on it's just 3 questions remaining, so through my literature review I have picked up themes Wellington, Africa and in the UK and other countries with similar conditions to South Africa where lean is also an issue and the issues that they have picked up are either linked to government, either linked to management and organizations, educations, finances and investments, human attitude which was the last section now the last section is in your position do you feel that there are any other barriers that you strongly believe

that affect the success and implementation of lean? Other than the ones that I have mentioned.

R: Uhm I think maybe you have touched to my side of knowledge but the contracts the way they are set up, the way we are setting up our contracts it's also a barrier.

I: So, the way contracts are set us?

R: Yeah, we need to create an incentive for both-, contracts should have an incentive for both parties to adopt in a construction so at the moment the way the contracts are set there is no incentive.

I: Ok uhm so you answered to the above question and you gave additional point that the way we set up contracts to make it attractive to implement lean.

R: Yeah.

I: What are your suggestions to overcome this barrier, how do we-, in your capacity or maybe people above you try to implement changing these contracts?

R: So, I am going to go on and preach the same thing that I believe works with IPD.

I: Yeah.

R: We need to work with integrated project delivery, we need to say we are going to deliver this project, this is the value ad we are putting it here for anything that goes wrong this is the money that we work from.

I: Mh.

R: And whatever is left from that pot we share it, and that's an incentive for both parties to work towards not taking anything from that pot but they know that whatever is left in that pot if being shared. So, for me I think we could change our contract set up to an acutely contract. I mean if you get some time spend some time reading a little bit about acutely contract through the lean construction institute, that would be helpful and I mean in terms of a mindset for you to get there that is going to be a challenge because you need parties to trust each other for you to do that.

I: Ok uhm I will do that and the last question what strategies if any could contribute to improve the delivery of quality of our projects here in South Africa?

R: Lean construction, we need a strategy, right? So honestly, I think when you go out and finding out about creating an asset and contracting about an asset, I think on the TPF that

should be a back. How are we going to deliver that in terms of the principles of creating feasibility offers, the organization and you know how you are setting up organization and such that and the sad part, putting a contract that would support the delivery of that is in a manner that you want it to be delivered. So have a contract that would support the first point that I have mentioned.

I: Yes.

R: So if you can have those 3 things then I think you are almost there, you know to take you to the next level you can have [Inaudible 00:58:36] but that will help you to make things a bit easier and you know to make human errors less, you know critical to be less of an issue and so on. But those 3 things are-, get those things back and especially as an owner.

I: Yeah.

R: Then you are done, then I think you would have a fairly successful project.

I: Ok.

R: And the other thing, what owners are doing that is very interesting I think it was done in the US was having an accident. So lean construction was a way of having an institutional site and for every contractor that they were bringing in, had to go through their academy, understand the lean construction principles before going on site that this is how we work. Then after that we do an assessing induction, you go through this academy before you go on site to understand how we got here. We are not working like we used to, we are not questioning people's technical capabilities, we are not. All we are saying is change your way of working, be more reliable and that's reliability, that's all we are saying.

END

8.6.2 Interviewee B

START

I: So basically, the interview is about 30 questions long, should be an hour and my topic is issues regarding successful implementation of lean in our South African Industry. Ok so the first topic is general questions, what is your work experience and how many years work experience do you have? Your work experience at this company or CESA, or any other organization you have worked for?

R: I started working when I was 12 years old, so I don't think you would take that?

I: No, no, no.

R: Post University I have been working since 1993.

I: Mh.

R: So that is how many years? 26.

I: 26 years, yeah.

R: This is the 27th year, yeah.

I: Ok so which companies have you worked for?

R: So I started my-, so I was a bursary student at Van Wykenlou which became Africon, uhm and then from Africon I joined PD Naidoo and Associates and that was really at the-, it wasn't really absolute start but it was really supervision. And then I was with PDN which was acquired in 2013 after I was a researching for 2 companies.

I: Ok, uhm what is your current responsibility in your company and the projects that you work in?

R: So I serve as the developing director at the Africa Unit in My [Inaudible 00:02:03] and I also serve as the transport sector lean in Africa in GDNA and over and above that I generally take the role of a project principal in certain key projects, no not in certain key projects, in certain projects. But then key is miss interpret-, that's the biggest watches.

I: Ok uhm you have said your current position, you don't have to answer but you can try to give a bracket. What is your current age?

R: I am 49.

I: Ok.

R: Listen in my role I also serve 2 other roles; is I am one of 2 locals' statutory directors for the businesses in Africa.

I: Ok.

R: The rest of the statutory directors are based in the UK.

I: Ok, so now we are moving on to the knowledge of the topic of this research.

R: Ok.

I: Are you familiar with lean construction concepts or ideas in particupar set of tools or framework and which ones are you familiar with?

R: No I am not familiars with it, I have heard lean mentioned, I have in conversations where it's been done and I am aware that it was trying and gained providence I think in the UK. Uhm I am also aware that there are certain limitations in its application in Australia, South Africa together. I am not, as I said I am not sure what those were and where it's at right now.

I: Ok so you don't specifically know any tool or nothing, nothing literate?

R: I have not dealt into it; I have not gone into it, but yeah.

I: Ok, so if you were to rate your knowledge on the topic from 1 being no knowledge to 10 being-, just just a throw in the ocean type f question, from 1 being no knowledge to 10 being fully knowledgeable where do you stand in it?

R: Somewhere between 2 and 3.

I: Ok uhm throughout your experience, the companies that you have worked for and the organizations that you are part of would you say that the colleagues that you have worked with are familiar with these concepts? Or can you name any colleagues, not

basically names but I am just trying to get basically in organizations not just you but people around you are familiars or not a lot of people or-?

R: Not in the local entities, not a lot.

I: Mh.

R: Uhm in some of the courses that have been on courses that have been on connective leaders and so on globally definitely I would count about 3 in the UK, my colleagues in the UK are familiars with it but if I just confine it to the African continent not a lot.

I: Ok and do you have communication with contractors and other consultants, not really?

R: Not really, it's not seething that gained prominence and it's not something that's well-spoken abut. I mean there may be from the industry point of view, contract forms our words would come out, contract models our words would come about, contract tools not so much.

I: Ok so that's knowledge of the topic, now we are going on to the current state of the construction industry in South Africa, uhm so not only focusing on lean now.

R: Yeah.

I: So, in your opinion how would you describe the current state of our industry?

R: The problem in that is-, some view of the current construction is that there is-, the pipeline of projects doesn't reflect the need, we have made irrational excuses why projects can't come out, why we can't plan projects adequately, there is an abundance-, in my view, an abundance of money to try projects, we lack the administrative skills and we lack the technical skills in the organizations where we put out our projects. And we can almost find a reason why projects can't go out as opposed to why can they go out, and that mindset needs to change. So even with president announcing his 100 Billion scheme unless you shift that people have to make some difficult decisions in terms of saying that I am assuming these projects for these reasons and that stacks up, yes in 5 years someone might come after me for making a wrong decision but I am sticking to my grounds because I believe that there are done on the right technical grounds, right social grounds and right commercial grounds.

I: Mh.

R: Willing to take accountability, finish and klaar and we don't have enough people in government or in client bodies doing that.

I: Ok you said that we lack administrative skills, that's we-?

R: From a country point of view.

I: Country point of view?

R: Yes.

I: Ok uhm in your opinion how would you describe-, what is your perception or what is your understanding of the productivity of out construction projects in South Africa?

R: Poor, poor on the basis that we have-, remember without making an excuse we do have a lot of social issues that are grass Hooper. So you can't come through 1994 and give everybody a vote and say everybody is forgotten, carry on. Ok, we have a lot of hang ups of the past that unfortunately needs to be addressed to the future and it can't be addressed by simply looking at enriching a few people.

I: Ok.

R: We need to restore dignity to people as opposed to just giving them money, and that is what I feel we have done. So, our black empowerment policies have enriched people as opposed to restore their dignity, and my view to dignity revolves round education. You can spend money, you can lose money, you can use money, money it tangible.

I: But educating people you are not, giving them dignity.

R: I can't educate you and take that away from you.

I: Yeah.

R: And that's a simple analogy, you would rather give somebody the ability to be able to-

I: Make their own money eventually.

R: Money will come, that's something that you would make.

I: Yeah.

R: It's like the best illustration of that is giving people houses.

I: Ok.

R: People don't need houses, people need dignity. You give people dignity they have the ability to go and buy a house and make a house, find a house and so on. And in my view is a

lot of what we see comes out in efficiency, it comes out in skills and all those things. Our social issues that we haven't fixed from the past.

I: Ok.

R: So your initial questions about efficiency, it's poor because have we now come to 1994 there is an expectation that everything will be fixed and then we as a society have given the wrongful impression that we are gang to turn the switch and everything is going to be perfect. There is a long hard process that we needed to acknowledge that there is probably a 50 years generational gap that we need to cover.

I: Yeah.

R: And there is no way that I can go back and give back a man that has no ability, I am going to try and train them and so on but I am going to say I am doing it for the country but the truth of the matter is that you can't do it. You need to try and refresh that system and that's going to take you-, mind you to clean up generations.

I: So do you say that the poor productivity, like have we always been speaking about apartheid and stuff like that; that due to the state or our industry right now that there was no sufficient planning in terms of setting up a framework and policies an protocols to implement, or just the lack of implementation of the policy set up?

R: Yeah, it's probably not fundamental in that, you had black people only allowed to be labors. They were not allowed to do anything else and those that were allowed to go ahead, continued. So, the masses that we had literally we have not-, even have not educated themselves, we have not said listen become a builder or an Artisan or something and build yourself. We have kept them in that position, they have built their lives as labors and now that's all they can do we are saying let's make sure that there's many construction projects out there retuning the tabs by putting those projects out.

I: Yeah.

R: And by virtue, or creating this picture that everything is good we have made-, we have created the expectation that they can be lazy, not efficient and things would come right.

I: Mh.

R: Whereas if we had given them the fundamentals that there is a big bag out there, you dare going to need to meet the Chinese and the Indians, you know what you are 50 million and they are 1.3 billion. So for every one of you there is-

I: So many more.

R: So many hundreds, and unless you get your act together you never are going to complete them.

I: Yeah.

R: So, I means we have created-, as a society-

I: We have created the issues that we are in now?

R: Yeah.

I: Ok, do you think that from whatever knowledge that you do have or the very little knowledge that you do have do you think that do you think that implementation of lean principles could improve the productivity or if not which of the concepts do you think is about that, or what would improve productivity?

R: [No response]

I: If you take a construction project-

R: What would improve productivity?

I: Yeah, is it the planning that are-

R: Yeah, I would say productivity comes from, when people are idle, they become lazy. When people don't have work they try to draw things out, so you look at all of these assignments, I means it's so clear that a contract would run perfectly fine for the first 8 month or 10 month of the program and the last 2 months we would start experiencing all the problems. From strikes to loiterers, and the simple truth is those people don't know where they are going to get their next plate of food once the contract ends. So, I think the basis of out notable issues comes from the lack of continuity of work, the lack of a pipeline. So, I f I draw that back to lean I think the problem is in terms of understanding the projects out there, so I don't think it's lean so much in lean or construction site.

I: Just itself.

R: I think its overall context of projects.

I: Broad spectrum, ok, ok. What occurrences or issues negatively impact the delivery and performance of our projects in South Africa? Would it be Implementation strikes, labor issues?

R: We've got labor issues because of inequality.

I: Ok.

R: We've got lack of pipeline of projects because of skills maladministration, like I paid earlier.

I: Mh.

R: We have-, I do think that social hand ups, we have a community wide issue, which is this business which is now resulting in business forms but I don't think that's-, I think that's simple barony. I think it comes from an underlying sentiment that project are done for people, people's involvement.

I: Mh.

R: So, we try and build something for the community without engaging the community, whereas I have been talking recently about these 3 Cs that are generally employed in contract but actually there should be 4 C4, that's a Chinese company. It should really start with the community; the other 3 Cs is normally the client, contractor and consultant.

I: Yeah.

R: We forget that, all the projects that we do are for people and the community should be involved in all of those. How that emanates and how we practically do that, I don't have the answers, but I am saying we forget about that. You are building a road and you worry about SANRAL, what's that? SANRAL is not owning the road.

I: The service is for the community.

R: Yes.

I: Or maybe issues like-, do you think their issues relating to knowledge or technical competency in South Africa, education or governmental issues that result in the negative effect on projects?

R: Yeah knowledge is the issue, I think we are not-, we've got some very skilled people and we have a lot of people that are not skilled. Or we have a lot of people that are in positions that require a lot more skill but by virtue of trying to overcome these social issues we have them in positions that they are aren't able to make decisions.

I: Ok.

R: For the decisions required, and then we have a huge pool of people that we basically sold them a dream that would never fulfil that. And we see that in the number of graduates.

I: Graduating.

R: Coming out of Universities and Technikons in the cities and if you take all of that back up, if there was plenty of work there would be plenty of opportunities for continuity and so on, and so on.

I: Ok, ok just 2 questions on the topic of government, in your opinion what role has our government played in developing or deterring the current state of our industry?

R: So I think our government has infrastructure can be stringed in 2 components.

I: Mh.

R: You have commercial infrastructure that the private sector will build, when I say infrastructure, I include buildings.

I: Ok, ok.

R: And let's say our work is infrastructure, commercial infrastructure for the private sector would be for our benefit and they would derive their commercial benefit and they would run the company and so on.

I: Mh.

R: And then you have a social infrastructure that from besides everything else addresses the needs and wants of people, basic rights but also has the ability to fuel the commercial sector, in other words enable the commercial sector.

I: Ok.

R: Our government has not-, or I would say African clients, government on the African continent mixed up those concepts. So, they are trying to get the private sector involved in social development programs when that's not the best, I mean they shouldn't be doing that. Then they try to get involved in commercial ventures that we should be leaving for the private sector, we try to mix the 2 by going this PPP route where we should first identify what projects are social projects and the government should pay what project are commercial projects and private sector.

I: There is a link between that rather than-

R: So, we confuse that, and the second thing is that we don't do enough of the stimulating the economy, stimulating community growth and development. Because ultimately starting off saying giving people dignity, if you give people the ability to manage you can give them jobs and so on. They can get that, they can train, they can educate, and they can do all of those things.

I: So, the government is stimulating all those to do those trainings and -

R: Some of those decisions are not made purely in commercial cause; they need to be made in other parameters. You know spending 1 billion might actually give you 100 billion in terms of net benefit. But in terms of purely if you mention that in Rands and cents it might not give you that.

I: The value is immeasurable.

R: The value is immeasurable.

I: Ok do you think that the South African government developed sufficient and correct policies and protocols to implement lean construction or they mainly focused on old traditions, say PNP way of doing things?

R: So, I think South African government has a problem and I think the problem is that government clines than to serve people, they must stick to what they have to do. The problem they have is that they have tried to politicize all of the technical parties and it doesn't work, the few technical people we have in those departments they have made them politicians and then the rest of the of the departments are just about politicians trying to maintain those positions. So, I think what I think we've got wrong is that we are so happened in transformation and making sure that everything looks right without necessarily fixing the floors and the system.

I: Ok.

R: And if you fix the floors of the system everything would end up looking great but if you start in terms or trying to get things to look right you would get some cracks, and basically you would have a pretty unstable foundation. Mind you that's what they are trying to do, so we've got the best policies in the world, we've got the best constitution I the world, all of those things are great but our implementation and our execution is huge because we are measuring the wrong things.

I: Ok and the next chapter is management, in your opinion has management in your organization set very and sometimes unreasonable expectations of projects that you are working on?

R: Always, the intend is not to. I mean we are a consulting business; I remember often we are not in control of the timelines because those are set by the clients. We do have a chance to say to clients that things are not possible, but we live at the beast of clients' needs. So, we try to manage that but sometimes they are beyond our control, from the company point it's not how we intend it's just so-, I mean if we use the fattening role as an example. Notwithstanding the abnormal effort that you guys put on and so on, but the company can afford you some token of appreciation, not saying all of that. Before that I've got a call from the safety officer of the company that I picked up that you guys are working so many hours and so on. So you know if I had to run through the discussion that it's not ideal but t's what we need to do, and yes we are trying our best to make it as little acceptable as possible and yes we are impacting on people's lives and yes this is what we are trying to do we would never be able to give people back that lost time but we hope that there are times that would be on the other foot ad there is something that we need from the company and the company would not be legit in its dance to say this is black and white. And you can't operate in that sort of environment, and my view is in as much as you've got rules and processing systems and they meant to be completely applied across in a dogmatic way, you need to have some latitude that you give because we work with people. So yeah, my view is we try not to be unreasonable but at times it's dictated by our clients.

I: Ok uhm do you believe that in your organization or other similar organizations within the industry that you are operating it's committed to develop and implement effective plans and resources to support and manage the implementation of lean construction principles?

R: I don't agree on going out at people and specifically saying 'listen we are going out and we are going now to get a lean methodology ' and punting that and offer that in our clients, so the moment the state of the industry is such and the people are just trying to so act. So to be very honest I think lean or processes like that would only come to the fore when you have certain challenges and right now the challenge in terms of finding work I don't think in a company I can-, I think you'll get to a point where you've got too much work and you just don't have enough resources to be able to manage and execute. Then people would say what is the methodology to do this to make sure that we retain quality and so on, and so on at the moment I don't think we face that problem.

I: Ok, ok uhm so your experience and the projects that stand out for you, you find out which projects do. Do you believe that level or higher management could have added more value to improve the success of some projects that could have ended up bad or successful projects that have more opportunity to be more successful?

R: Yeah, I think setting up a project correctly is the most important thing, we often get so swayed by a methodology that we believe that if its successful in 1 area it has to be successful in the other. [Inaudible, recorder disrupted] every project has a different requirement and you need to match the methodology with the deliverables, with the project and so on.

I: Ok.

R: So it can't be a 1 size fits all, and I think as management we make that mistake that we get fixated on this way of doing things and-, I think we can have a framework and an approach, and then these 2 needs to neutralize. But you can't run every single project the same way.

I: Yeah, ok that was managing and education. In your opinion do you feel that bodies like SAC, PNP, or Lean Construction South Africa creates sufficient knowledge and awareness about the topic?

R: No.

I: Ok.

R: And I remember-

I: It's your point of view?

R: Yeah, I am out of University for a while now and there wasn't something that was spoken about at University, maybe it did because lean I think-

I: It's only about 30, 20 so much years now; mope on euro instruct.

R: Are you aware that the more these things are spoken about in terms of the benefits and so on the more ability we have actually to neutralize them? Uhm I don't think it's been well published, I don't think people are being exposed to it, so yeah.

I: Ok do you think the South African construction industry suffers from a shortage of technical skills and knowledge?

R: Yeah, yeah we have knocked the planish as many people have retired, we have knocked the planish for skills and you can see it, you cans see a decline in number of over 65 year old in terms of that band 60 and 65.

I: Yeah.

R: And you can see there is a big grouping of people that are coming in between 25 to 35, but in terms of that 30 to 45 or 30 to 50 it's gone down and that's as a result as a lot of other issues, people who have left the country, they have left the professing and so on, and so on. So that's that skills gap that's missing, the middle; strangely enough it's not that country thing. It actually is a global issue.

I: It's a global issue, ok.

R: And I think that issues stems from the fact that I don't think that what we do is understood in the context of our contribution to society, and my view is that we are burning ourselves to death. And I am not saying that stand at the top of the building and scream to everybody how important you are, but we really need to do something top-, you know.

I: So there is a big gap of skills transfer from the 50 game to the 65 gap below or was it just individuals not willing to learn or-?

R: I think we have failed as an industry to convince that middle management that this is something worth doing and this is something that's lucrative enough for you to, you might not get extremely rich but you should be comfortable with the result we end up losing a lot of people in that to other industries. Whether it's banking, whether it's management consulting, it's suppliers. So that missing middle it's a global phenomenon, it's an industry, it's an industry issue.

I: Ok, ok has there be any-, it's just a simple yes or no answers; has there been any formal lean construction training in organizations you worked in?

R: No, not at all.

I: Ok and has management been for any lean construction training?

R: Not that I am aware of.

I: Ok do you think that training tin this regard could improve awareness and successful implementation in organizations or in other important stuff?

R: Yeah I mean if you demonstrate why something is good and why it can works then you demonstrate how it can be done, and if you do that from the perspective of choice I think it would expose people to better as opposed to try and embed it as compliance. The minute you have other compliance of it your rules of success and your ability to succeed in terms of using it would diminish.

I: Ok I see what you are saying.

R: So, my view is that you need to demonstrate to people that this is-

I: Before we make it a policy, yeah.

R: And it's-, it comes down to being it's the best way to do something or it's the right way to do something as opposed to 'it's the only way', I am telling you because we are the company and we can. If you go down that compliance with it then you would either get interests about it, people would do it or they'll just do it to protect this.

I: Ok uhm now we are moving to investments and financial issues regarding the topic, in your opinion do you think that consultants, contractors and clients invest enough to educate and implement lean construction on their projects?

R: No we don't spend enough on training, so regardless of whether it's on lean we don't spend enough on training and my view is that we are so busy cutting each other's throats in terms of competing for work because there is so little around that the first thing that goes out the window is training. Whereas that's the first thing you should be investing in, and that should be the element of our fee, that should be a non-measurable. In fact, it almost should be-

I: A blanket for all?

R: Yeah it almost should be choosing people on the basis of harsh training they are going to get as opposed to what else.

I: Ok I think you have answered the next 2 questions, do you think they should invest more in educating and implementing?

R: Yeah.

I: Ok.

R: My view is from a country point of view, I think the entire state we are in, the fact that we have not knuckled down and said education is key we made a mistake.

I: Ok and the other one was, do you think they can in terms of commercial affordability, do you think that companies can afford to do that?

R: Yeah, I think so, I think they can, and I think the pipeline and consistency of work exists you won't find companies losing, you won't find companies refusing to train, you won't find companies refusing to recruit. So, because people react to risk, companies take risk, I don't see the outlook for this type of service, I don't see why I would keep a tip of those skills? Is it because I like them, yeah that might hold for a couple of months but beyond that it's hard decision in terms of how we pay the bills, how they make the company work, how we keep on doing it and do on?

I: Ok, so we are down to the last 5 questions. The next chapter is human attitude or people's culture in our industry; do you feel there is a misconception or lack of understanding or lack of knowledge or what lean construction is?

R: There is lack of understanding and knowledge and I think there is that lack because you need to demonstrate its value, you need to demonstrate its purpose, you need to demonstrate why would someone want to do this. And I don't think that is being done adequately, I think we have almost said ok this is the outcomes of using lean, you will do it or you won't do it.

I: So it's sort of back to the other question of like the bodies, showing the benefit of it, it's not enough of that being joined.

R: Yeah

I: Ok, uh now you know our industry and people that we work in specifically in construction, not really in design and consulting, do you feel that there is resistance, do you need this thing to change first of all and then secondly to learn about lean and implement it or are you guys fixated on your ways, they do things and stuff like that?

R: Human being generally resist change.

I: Ok.

R: That's a grant-

I: Not just this industry?

R: It's not just this industry, I think in this industry the few people that we do have in this industry are very irrational, even speaking to people that are not rational. You train the projects and people understand what they are doing and have certain level of competence, if

you can demonstrate the value in terms of how it can benefit them, how it to benefit their client they are not going to pick you out, and until you get to that point, no.

I: People would resist.

R: Yeah, people would just say no.

I: Ok and do you feel that our industry requires a culture change to improve our industry from government all the way down to us?

R: Selfishly I don't think-, I don't think we have forgotten he profession, I think we slightly have faced less profession. You know everybody worried about the contract, so that is the big element, everybody worries about the financial, that's the financial element in terms of how you are going to afford to do this. Number, construction is seen as anybody who has got a bakkie and a barrel can be a contractor, and number 2 as consultants and back room team that makes all this possible no one knows what's made of us. And my view is I think we have done that ourselves, we made ourselves that faceless profession and one of the things that we are sort of trying to do is to look at almost an awareness campaign that if you don't employ technically competent people to do certain things then you will have service delivery issues, you will have buildings that would collapse, you would have disasters, you would have roads that would be washed away and people won't be able to go to work or they won't be able to access facilities and so on. So, from the CESA point of view that's one of our big initiatives that we plan on to embark on next year, because at the moment as a profession we just don't know.

I: Yeah that's true.

R: People know the contractor because of the contractor's board; you see the contractor bakkie outside all the time.

I: That's true; people always associate an engineer with a builder, you know.

R: And the other things is that we have been to use to the word 'engineer', the guy that dud computer science is an IT engineer.

I: They call them engineers.

R: Yeah, you know it right? I know it seems tricky, but I think that lax attitude that we have had has let our space become completely invaded.

I: It's sort of like, what can I say? Because we have let that term run free, we have sort of discharacted as a time camper.

R: Yeah.

I: You know like 'yeah take it, call us an engineer'.

R: So, when you are addressing in Africa, most African countries would call you Engineer Priyesh Dowra. So not Mr., not Dr. they would call you engineers, so and so. I mean I called that twice, one in Mali and one in Uganda where I introduced myself that I am *** ***. And they said you are not *** ***, you are engineer *** ***.

I: Ok and you felt good?

R: It does feel good but it's something that we have not acknowledged for ourselves.

I: Yeah.

R: And yeah so, it's a level of respect, before get respect you need to get awareness for people to understand what you are doing for people to understand the value of what you are doing.

I: Mh.

R: You can't keep telling people this is what I do.

I: Yeah, you have to illustrate it.

R: Yeah, so-

I: Ok, ok so the last few questions. So on my literature review, the research that I have done specifically in the UK where lean is quite much more ahead and in some similar countries to such. Let's call it Brazil, some other South American countries.

R: Emerging marks.

I: Yeah, topics relating to government, management, education and technical skills, finances and you know human attitude itself. Those were the issues that resulted in lean not being as implementer more than it currently is. What do you think-, what are other barriers that you strongly believe that affect maybe the implementation before the successful implementation of it?

R: Hm.

I: So maybe-, like I had a discussion with a lady from McKenzie this morning and she is in mining and they have a big lean institute, and they say one of the lack-, and she is an engineer and she was an engineer and she was on site for so many years and

she has moved from McKenzie for about 4 years now. And she said that one of the issues that she found is the way that we set up our contracts, actually seems like attacking that environment like 'I will make money through claims other than' as you said the project is for the community, not for the client, not for the contractor and it's sort of like a competitive environment rather than working together environment.

R: She is probably right because the end objective is to make sure that the project is delivered, that is the end objective. Everybody is going to get there, we have set up the framework again by not having the right skills and framework and ability to make decisions. We have got contracts that manage every single intimacy, and what happens when we have contracts people enforce just that contract. So, she is probably right in terms of, there is-, that's just environment created. But I also think that in terms of-, also from an industry point of view I think we allowed those contracts to be formulated around us, we are not taking time to understand that. I mean we are just all as engineers 'this is what we are doing' we make sure that we take care of all of that, just leave us to down hat we are doing.

I: Ok.

R: So I think by virtue of not getting familiar with politics we are not being familiar with finance, we are not begin familiar with construction law, contracts and legalities. We have left ourselves outside of that circle and they have moved on, so we are having been left behind. We are standing and that begs the problem that brings these methodologies, bringing in these tools that could have assisted us.

I: Mh, that's what she said. She said she has very successful implementation of lean in certain projects, so she said they may not contract us. They get called in, when it's so far down and they said we told you to implement these tools, try to but you didn't listen, but it would help you anyway. So yeah, because I don't have the issue anyway; so how would you suggest overcoming this barrier that you do have the knowledge that you do have, how would you suggest?

R: Hm-

I: Do you think government needs to play a bit more role in it or us as the industry make some eyes to the occasion and-?

R: I think first and foremost we need to accept that there is a place for everything, so there is a place for different catch of contracts, there is a place for different contract methodologies, and there is a place for different contract tools.

I: Ok.

R: We need to accept that; we can't standardize everything.

I: Mh.

R: So from a lean point of view you can't expect that you can apply lean to everything and it's going to be successful everywhere, so we need to have the understanding that sometimes it's actually not going to be able to do it you know, it's that supposed to. The second thing is I think by creating an understanding and awareness of what are the lean principles, where is lean applied, where does it work?

I: Yes.

R: Not to knock off all the other things and how, when you look at the project delivery and what government has to roar out, what clients have to roar out. You might have a couple of different contracts here and there, you might have PPPs as methodologies, you might have design and construction as a methodology, you might have forms of contracts being any seen in this environment or-

I: GCC.

R: GCC or Firicle [Unsure of the name], one of that maybe it's taking into consideration that the first thing as client buddies we can't adopt the one size fits all mentality, and the only way you can have that mindset or mentality or ability if you have a basic understanding and based skillset. Firstly of what you do, people should understand that environment and secondly expose them to what is out there in terms of what is possible, and give them the latitude you use. The appropriate tools, the appropriate project, so the moment we all try to cannibalize each other, the more of Foodic [Unsure of the name] I have, better for Foodic. The more of NEC contracts I have, better for them. I think they are best high best people in it, so my view is creating awareness and make it available to all of decision makers and allow them choice in term of what is appropriate.

I: Ok, the last question. What strategies if any could contribute to improve our delivery and quality of projects in South Africa? We have a very broad sector, prospector.

R: Yes, it's more obvious, clients need to be clients. Clients can't be engineers; they must know their roles that everybody performs in delivering projects.

I: So, clients are basically not knowledgeable enough?

R: No, no, no they might be, in fact they might be the most knowledgeable people, but they must understand their role ad their purpose in the delivery chain.

I: Ok.

R: So, the most important thing is all of the players in the delivery chain need to understand their role, the client might be the best person to be the engineer but if he is not the engineer then he must stay out of the engineering.

I: Ok.

R: The client might be having the most amount of experience in construction but if he is not the contractor then he must stay out of construction, that I think is the fundamental issue here. Is understanding all the roles plays, their responsibilities and-

I: That's important obviously.

R: There is a lot of studies that are being done on that, caller the role of the client and clients are meant to facilitate projects to make sure that projects run smooth. They are not going to deliver the projects and so on; I think a lot of what we experience right now in South Africa that's the heart of it.

END

8.6.3 Interviewee C

START

I: First question is can you give me a brief outline of your work experience and how many years work experience do you have?

R: Uhm just try-, starting from how many years, before that.

I: Sorry?

R: What is the questions again?

I: What is your work experience in terms of from the times you started working with the different organizations that you were part of, and how many years of experience do you have in the professional industry?

R: Ok I've got probably about 32 years' experience.

I: Ok.

R: I am a qualified civil engineer and I just met lean along the way, and I have worker in civil and building. Civil as we know it's building, mechanical, electrical, up and cost mining. In other ways I have worked in various countries around the world.

I: Mh.

R: I have been in Africa, I the Caribbean and I have spent a bit of time in Sierra. And I have filled the roles of project manager, construction manager, and general manager of a construction business unit, I have been a managing director of a construction business unit and I have been CEO, I think I have been CFO a different times for construction companies in the Johannesburg stock exchange.

I: Ok uhm what is your current responsibility, if you are still in the business what is your latest responsibility in the business that you worked in?

R: I am currently working for myself in property development.

I: Ok uhm what type would you give that position?

R: Uhm Chip, cook and bottle washer.

[Laughter]

R: I do, I mean I suppose you can call me the managing director of the company that I own, [unclear name]

I: Ok and if you don't mind you can either give me a figure or a brac, what is your current age?

R: I am 58.

I: Ok thank you, so those were general questions and now I am moving on to your knowledge of the topic at hand. Are you familiar with lean construction concepts ad ideas and if so which concepts have you used or are you familiar with?

R: Yes I am very familiar with is, from about 2006 of was it before 2006? 2005 / 2006 up to about 2011 I met a lean initiative in construction, which utilize the principles of lean and took then; particularly in construction construction because at that time it was a big debate as to whether it is applicable to construction by also utilizing the principles that are seen in Sigma.

I: Ok.

R: So that could be a bit more specific.

I: Yeah.

R: I mean the one that we used, we put together our own complex and vast planner and implemented vast planner and then we used the [inaudible 00:04:59] principle and then we used the resource balancing principles and things like-, I can't remember the exact names but the principles that's including the work force in solutions, some of them in tinsivity and then driving responsibility and accountability down to the work place, yeah. I can give examples for particular initiatives that we used.

I: Ok I think I know what you are talking about, I also can't get the name as well.

R: Yeah.

I: Uhm I want to know if you have to rate your knowledge of lean construction 1 being you have no knowledge at all in the concept and 10 being fully knowledgeable, this is a sort of throw in the ocean type of question, it's your job and it's your feeling, how would you rate yourself in terms of lean construction and knowledge of the topic?

R: Well i would say it would be 8 or 9.

I: Ok, ok uhm the following questions in this topic is throughout your experience, your professional work experience would you say that the colleagues you have worked with or people within your industry were familiar with these concepts of lean? I am basically trying to engage other than you, were people around you enthusiastic about the topic of lean or was it just a small group of people in your organization?

R: No, it was a very small group in the organization that had any interest in it at all, you know it was one of the first things that we have to-, by my expertise we were actually trained management.

I: Ok.

R: Uhm probably over and above me, and then I kind of end up implementing in this sense. And initially now we would have any idea what we want.

I: Yes.

R: That means educational process can try and get people on board, but in principle it was not known at all for that matter.

I: Ok uhm the next set of questions are not specifically relating to lean, but they are relating to the construction industry I South Africa, in your opinion how would you describe the current state of the South African Industry?

R: It's a complete mess.

I: Yeah.

R: Totally it's a mess; I mean I am actually writing an article which I might end up have published. There is no focus at all on skills and skills development and some of the simple stuff like planning and programming, you know I drive around the country and I look at whether it's a building project or brick project and I could see things getting more and more untidy, that was one of my shocks. I don't know if they've got demo, pictures and aware but you know this thing about it's such a waste. There is a place for everything and there is everything is this place.

I: Yes.

R: Then there was tight ways to talk, I used to be able to-, I still can walk on to a building site and straight away I can tell you whether that construction is losing money based on how their site and premises.

I: Just by looking at the site itself.

R: Just, yeah and then you know some people accuse you of being arrogant if you say that and that you are wrong.

I: Yeah.

R: And I think now I am focusing on just-, sometimes people call lean, you know they refer to lean as some sort of matric chick or some sort of entangled nonsense, to me now that is common sense. Now I am not focusing on anything, the grass root level, the site levels, just the normal skills and understanding of something simple like how our country is like. I mean you can't tell that anymore, you understand.

I: Yeah.

R: Show compassion, whether it's municipality or whether it's some of the parasitals or whether it's a construction company I said in all sides.

I: Yeah I think-

R: And now that it would be changed to anyone else.

I: Yeah that's true, I think one of the key laws that we just sent through last week I also had an interview with a lean construction guide from McKenzie and he also alluded to the fact that no one seems to be using just normal human common sense anymore and that is what lean is about, and no one is using it

R: Yeah it's amazing how they are not using it.

I: Uhm next question is in your opinion how would you describe the perception of the productivity of our construction projects in South Africa? So mainly focusing on productivity what is your perception or opinion on it?

R: Our construction in South Africa?

I: Yes.

R: Yeah it's very inefficient, that is how I would describe it. It's very inefficient and there is no intend to be a-, yeah cool, this is cool yeah.

I: Ok.

R: Yeah it's so inefficient.

I: Uhm do you feel that implementation of lean construction principles could improve our productivity in our projects?

R: I do but not on its own, I do but I sense that they were going to ask lean in a construction company and construction sites then we were going to go.

I: Mh, mh.

R: But it's a vast implementation, it would help.

I: Ok, ok.

R: Do you understand?

I: I couldn't hear what you said at the end, the 2 examples that you gave are-?

R: What I am saying is implementing lean would help but there is even a lot of support staff done before that, but simple implementing lean would help.

I: Yeah I understand, I understand. Ok uhm what occurrences or issues do you feel negatively affect the delivery of our construction projects in South Africa? So just to

apply, you could describe further what issues do you think we need to understand earlier you said that I would clean this as a mess; what resulted in this being a mess?

R: It has not resulted in being a mess, I am not 100% sure but I said what has happened is that we were being focused either on management from this thing called strategy.

I: Yes.

R: And we are doing a lot of papers sitting around talking about are we going to work in Africa or not, are we going to Europe or we are going to build roads or are we going to go broad ways, there is a whole lot of concentration on that.

I: Mh.

R: We are gentle on the operation and looking at the operation we have now got to a point where people in senior management positions do not understand operations the way operations were understood 20 years ago, uhm and so there hasn't been a 5 years on this tool and priority hasn't been given to developing fundamental skills and people haven't been rewarded for that and they are focusing on other important things and now we are left with-. I know of lots of people in this country who advertise and understanding, all thanks to the night they are all sitting down and doing nothing.

I: Ok there is a lot of people who have left our country to go and work abroad as well.

R: Sure, lots of people are gone. You know I have been out of the main stream, corporate construction for 4 years.

I: Yes.

R: And when I left I could have given you a 100 guys, I can probably give you 2.

I: Yeah I know when I was based on a construction project in KZN along the N3 we were doing a road project there, I was an ALP and they contracted me and the main contractor was LLE, and I was a sub-contractor for SL production was a vain. And within 18 months the main contractor, the actual work's engineer from drive within 2 guys left the country to go in Newzeland to go and work abroad because they said things are not working out here for them.

R: Yeah and when was that?

I: It was 2017 / 2018.

R: Yeah that's, as for me that was my friend, he used to be called vain red rose.

I: Ok, ok yes yeah the logos has vain red rose or something.

R: Yeah, it was one of the units than I implemented you in.

I: Ok.

R: And I mean someone can talk and [inaudible 00:17:14]

I: Mh, what did you say at the end?

R: Someone can ad it was one of the first units that we were implementing regionally in 2009 / 2010 and then there was a sudden loss in Africa of operational value and they stopped all operations and then it went down from them.

I: Ok.

R: That client is no more, I mean.

I: Yeah, eventually that project got shut down because that was in the whole project rescue and it got to road works to complete the works.

R: Yeah very said.

I: Yeah that's said, and the next set of questions it's just 2 questions relating to government issues in South Africa. In your opinion what role has the South African government played in either developing or deterring-, in your opinion the current state of the construction industry?

R: Yoh that's a complicated question, uhm because i-, personally I believe that the construction industry was in South Africa, it was protected under apartheid.

I: Ok.

R: With efficiency, right then with the demise of the apartheid the construction industry, the traditional construction industry either the big 5 or the big 6 basically realized that they needed to work differently with the government instead of working in their old fashion.

I: Mh.

R: And as such there was a distance growing between government and private.

I: Ok.

R: And I think that my guy, the one who was in construction is still doing construction so I think it has been replaced to tender and I think that the government is to blame and

corporate, they need to blame it because it's the same problem. Although I said that when the government training program was shut down, there were some programs that should have continued but they were shut down and there is no reason the private sector couldn't have picked them up.

I: Mh.

R: And then I think recently the-, I don't understand and I don't know enough about things like [Unclear] but certainly in my last 2 years in construction there was a trap like [unsure of the word] unqualified people were getting projects to a city, uhm and that's the whole-, they did bribe the way in somehow and then you went to get the project. And then once you had the project you still had to bribe people in order to get paid, so you could get paid on poor quality. So the mechanism of making money was a change completely, so the government was to blame for that. Uhm the government is to blame for that but you know if I would be giving everybody bribed, to pay the bribe is equally responsible. I chose to tender, I am out of business and I have never seen anything like that and I have chosen to travel areas and we just stopped working there.

I: Ok.

R: Which is where I think everybody should be then, yeah.

I: Ok would you say that-, I mean you have mentioned the word bribery. Would you say that there is definitely corruption happening in our construction industry?

R: Absolutely.

I: Ok, ok.

R: Without a doubt.

I: Ok and the next question is do you think the South African government has developed sufficient policies and correct protocols to support the implementation of lea construction?

R: No, no I don't even know where that came from. To my opinion no, I don't know that.

I: Ok the next set of questions, we are almost halfway through the questions, earlier on you have mentioned issues where management is now focusing in operations in the topic of discussion. In your opinion is management in the organizations that you have worked in set very high sometimes unreasonable expectations due to whatever

reason that is, lack of knowledge or XO, whatever it is; do you think that the management might have set unreasonable expectations of the project?

R: No.

I: Ok.

R: Not at all, sometimes the reverse actually.

I: Ok uh in your opinion do you believe that your organization in the industry are committed to implement an effective plan and resources to support and manage the implementation of lean construction?

R: Absolutely no.

I: Ok uh throughout your professional experience and the projects that specifically stand out for you, do you believe that middle or higher management could have added more value to improve the success of the projects?

R: Absolutely, I think if you are saying what is the better symbols saying that prevents-, for lean to be implemented understanding and support at senior management, they don't understand it, they believe vast operations. They don't give it the time required and cut the budget, so those are the people that should be chappling the chatter by not doing something else, I am not sure what it is.

I: Ok uhm the next set of questions relate to imitational topics and technical competencies and skills in our industry, uhm do you feel that SACPNP, and lean Construction Institute creates sufficient knowledge and awareness about lean construction?

R: SACPNP not, I must say I haven't really paid attention to SACPNP over the last 3 years because I believe they were an organization with nothing when I was in construction. I have to access it today in order to believe in, but I do subscribe to the Lean institute newspapers and I am, am being part of that website because I am [Inaudible 00:27:54]

I: Ok so would you say SACPNP obviously doesn't create enough awareness and obviously LCI

R: Uhm say that again?

I: I am saying just to summarize what you said on this question I am going to state that SACPNP do not create enough awareness and you feel that the organization do

nothing and LCI you said you follow them but do you feel that they create enough awareness about the topic or do you think they can do more, or you are not sure?

R: No I think they can do more, I do think that the can do more.

I: Ok do you think that the South African construction industry suffers from a shortage of technical skills and knowledge regarding construction as a whole and lean construction?

R: Yes I do.

I: Ok do you want to possibly explain a bit more though?

R: Uhm so I have a particular opinion on lean, lean for me when one studies it a bit more you study lots of the structures, a lot of the [Inaudible 00:29:56] thing.

I: Yeah.

R: And when one is assigned to put it into construction, the principles into construction it starts to become common sense but it's not so-, there is a problem in selling an improvement in operation to senior management because they have a perception that is not important, not important than the other thing. And so there is a lot of emphasis on lean and what we can do, on specifics of lean [Inaudible 00:31:08] principle, or the mark planner or something like that. But what is needed first is an understanding of the culture that is required in order to acquire this. You cannot try and achieve lean in an extremely hierarchical organization, uhm such as construction the way traditionally it has been.

I: Mh.

R: Uhm you know and that needs to be filled to-, that needs to be filled to the relevant stakeholders, like if you are talking about a construction company, any one of the listed construction companies they are extremely hierarchical, their structure looks very much like a bulleting structure.

I: Yeah.

R: And none of that conduces to the environment you need in order for lean to float.

I: Yeah ok.

R: Yeah and I think I have blown my head off trying to explain that to people.

I: Uhm just a simple yes or no, has there been any formal lean construction training in your organization that you worked in?

R: Yes.

I: Ok uhm has your organization's management committee or team been for this formal training?

R: Uhm-, no.

I: Ok uhm ok do you feel that training would have improved awareness and successful implementation of lean? Just a yes or no.

R: Yes.

I: Ok uhm now the next section-, we are coming close to the end, the next section is in your option-, well the next section is actually focusing on financial issues. In your opinion do consultants, contractors and clients adequately invest in terms of financial investment, educate and implement lean construction?

R: No, not at all.

I: Ok and do you think they should invest more in educating and implementing lean?

R: Yes I do.

I: Ok and the last question in this, considering the economy in our country and the state that it's in-, I know the previous question invest more? Do you think consultants and clients and contractors have the financial capability to invest more or do you think they are wasting their money on other stuff, etcetera?

R: I think there is a problem, so if you want to say construction in South Africa I mean you don't have to look far to see a disaster. You know to see Medupi it's just one of the many disasters around the country, and so everyone is talking about the money involved, implementing lean and promoting lean requires a very, very little investment in terms of money. It does require investment in terms of the commitment of the senior management and the leaders of the industry, clients, consultants and contractors.

I: Yeah.

R: And government together, and they need to be a world-, for example, I need to give you an example. I don't know a contract in South Africa that would insist on the principles associated with vast planner, I mean the vast planner it's even a completely correlates to

trademark or something extortion. But the principles that are done here, I don't know how familiar you are with vast planner but the principle behind vast planner for me is fundamental to a critic in successful project at the moment. If we don't have projects that insist that the clients, the consultants and the contractor are equally accountable for the spat then you are going to leave-, I have done enough work from contractor to inspector on fights where the supervisor and consultants his job is very specific and none of it is to ensure overall efficiency of the project.

I: Yeah.

R: And you now just some of the corporate principles that exist such as shareholders debark in a return on something, and in such a short space of time and it's unreasonable. You know they need to understand that if you started implementing lean in an organization today somebody needs to commit to that for 10 years, it's not going to be fixed by next week.

I: Yeah.

R: And [Inaudible 00:38:12] is considering it fixed by next year, they have been saying that for the last 10 / 20 years, that they are going to fix it by next year and it's still not fixed. So you know if they would have done that 20 years ago it would have been fixed 10 years ago.

I: Yeah.

R: And yeah so-, yeah I think you understand what I am saying.

I: Yeah.

R: We can't work together if everybody is sitting on their own high horse, well this is just going to carry on being a mess.

I: Yeah I think I keen on that to mention that I also spoke to somebody else from another organization, and they said-, we'll come to the question just now, one of their suggestion was basically in order to-, one of the many suggestion is in order to improve the industry as you said is maybe we need to start selling out our contracts differently in order for everyone to have similar risks and similar responsibilities and accountability. And one of the things they mentioned is that the consultant needs to have the same accountability if there is delays, you need to assist your contractor and etcetera, etcetera. She also said that the way we set up our contracts is quite vicious and is not really helpful to one another. It's more around the line that how can we turn against you, etcetera.

R: Yeah and I am telling you it's a huge exercise, it's not just as simple as changing the contract to a form of contract because you have to move away from the tradition of tendering system as well. Why are you sitting with the lowest tender when everything has been cut?

I: Yeah, your quality is being cut and everything.

R: Yeah.

I: Ok, ok the next section is related to human attitude or people's attitude towards the topic in the industry. In your opinion do you feel that there is a misconception or a lack of understanding in the industry of what lean is?

R: Absolutely, the biggest-, not one of the biggest hurdles but one of the biggest hurdle in our value history was this thing of 'we have always done it this way'. So you hear this, we have always done it this way otherwise it's not going to work and then people persist to prove that lean won't work.

I: Ok.

R: They go all the way to prove that it won't work and then they are supporting evidence that it won't work and then when things starts getting a little bit tricky and some losses around the place, then implementation of lean gets drained first. And then they sustain that people said-, the biggest thing I have ever heard is 'we are not a factory, we don't produce multi-cars'.

I: Ok.

R: That kind of a thing works in a factory environment but it would not work in a construction site, I mean and then it was like people cut it off and they don't talk anymore after that. There might be a point and you know that's definitely not going to work here and it won't, there are corporate examples that the industry is going down and those are proper examples of how it works in the industry if you lay yourself open to [Inaudible 00:42:23] work.

I: Yes I think I think the next question is more related to one point that you said that people are like 'this is the way we have always done it and this is the way we will continue to do it' do you feel that there is resistance in the industry to implement lean?

R: Definitely, I mean if any-, you know construction has been around for a very long time and there is way in much view, it starts on lean construction. It's just like the car manufacturing today, a car is a car nower days.

I: Yeah.

R: it won't cost the same and look the same, and that should be the same in construction but the only thing that I believe construction they need to improve in themselves is operation. The push back of 'we are not going to do it, definitely' and I can give you results if you want.

I: Yes.

R: I have had some research and it's happening, you get locked outside of the board room if you say we must do it different and the board room isn't bought in, it's not happy man.

I: Yeah that's true, well this is not really one of our questions. Do you think a lot of resistance comes from older guys in the industry or more senior maybe? Maybe 40s and 50s, do you think more resistance comes from those guys on projects?

R: Uhm I find it to be mixed, they start resisting from-, it's quite a complicated topic on its own because resistance from the youth as well but possibly for different reasons from resistance from the older guys. The older guys is 'we have always done it this way' whereas the youth one the resistance is 'it's not my job'.

I: Ok, ok I see what you are saying.

R: So I didn't study that in University, it's not my job. It's a run and rock into that.

I: Yeah, ok uhm-

R: But the younger guys are really into it than the older guys, you know.

I: Yeah, yeah do you feel that-, well I think you have mentioned this earlier but just to document it. In opening do you feel that the industry requires a culture change in order to improve the industry?

R: Very much so.

I: Ok.

R: Very much so.

I: Ok these are the last few questions, we've got 3 questions remaining and this is basically in my literature and some of the articles that I have read and stuff I think you may have been part of these articles because I got your contact details from Cat Roeland, I am sure you know him?

R: Yeah I know.

I: Yeah one of the topics I have picked up from one of those articles I have read is the issues related to successful implementation of lean is, human attitude issues, financial, government, educational issues, management issues, but in your opinion are there any barriers that you strongly believe that affect the implementation of lean in our industry?

R: Uhm I think-, you know I used to have an argument with some guys in the management consulting and one of them being Cat.

I: Mh.

R: And the difference with Cat is that he used to take long and hard to listen to me because when I would say, I used to say things that people didn't really like. But in time value I would say how people [Inaudible 00:47:27] and one of the things that I debate is the lean operations were not strategic. Uhm and to the extent that they are paired to the conductors in businesses to the strategic thinker.

I: Ok.

R: And so the operational senses were not-, they are not rewarded and you bring the young guys in and the young guys have got ambition to get to the top and what I see is that the reward is not in operation, the reward is somewhere else. So there is not enough-, you know operational, I can use the words how we need to be more, externally focused and we are only internally focused. Or he's very operational, you can't give him that job he is too operational.

I: Mh.

R: You know they make such negative statements that revolve around operation.

I: Mh.

R: And like they exist in [Inaudible 00:48:47] uhm and it's open, in South Africa. I get mine to cover one of your headings.

I: Yeah, ok.

R: I mean just in general you know I have made a note before and you have mentioned the stamen that counterfeits that, that the hierarchical mindset is inherent in construction and it needs to change. You know everybody is trying to be opposite of operation vulgar.

I: Yeah ok.

R: And when I was studying I-, because I was an accounting man, when I was in accounting a construction company in Japan and they built a high rise building and their top project managers were all Ex CEOs of that company.

I: Ok.

R: If you worked in that company, the time Inaudible 00:50:10] you were allowed to be the project manager.

I: Ok, so you get invested interest into your company to always do your best sort of thing.

R: Yeah.

I: Ok you have mentioned 2 issues such as operations and hierarchy in construction, what are your general suggestions as to how we can overcome these barriers?

R: You know there has to be a real lean designers for someone to overcome these barriers and making-, the situation for me it's just a bit like legislation BEE. You rectify one of these things, all these other things start to rise around everything, anything in legislation. So for government to try and legislate something I don't think it's going to work, I think that the senior leaders of the organization that exist they need to drop as leaders and understand they need to understand that this is imperative to not only survival of their business but to survival of construction in South Africa, and ultimately it ads to survival of South Africa as a whole as leader of the African continent. And if they can do that and meet and talk about, and understand this thing on where it's really heading to the organization they would become a bit more humbled and talk to people who've got that stone age and give people examples of how we think it could work the maybe we can-, maybe that could be the catch to the far thing. The leadership has to become more humbled, I don't know what type of leadership in the world because it all looks like rubbish. And I don't-, yeah we need the distance, we aren't power hungry and things like that.

I: Ok.

R: Uhm we need that thing to implement this thing, to see that thing as a normal human image we are building on a project instead of feeling that they've got more power than us and we can't associate with them .

I: Yes I understand what you are saying, the last question that I have is in order to improve our quality and delivery of construction projects in South Africa what strategies do you think need to be implemented?

R: I think the -, you know I have worked in both years, I could see the power shift a little bit.

I: Mh.

R: I remember when I was running a construction company I hired a commercial manager to handle the clients that we are dealing with.

I: Mh.

R: And he wanted to know from me what success would look like from his point of view, and I said to him unfortunately we have absolutely no time against the clock and that is success. And he got quite expecting that I had to tell him about the job and said 'are you going to give me my part of the job?' and I said no I am not, my job is to make sure that the client knows every in and out of the problem that we are putting on the table, in front of them. The moment that the contractor is contracted, the moment the client puts the contract on the table it's 'now we are going to make money out of this' you know, you know everybody is going to benefit from this, everybody is going to make money out of it and how we are going to finish the project on time.

I: Mh.

R: And how we are going to do it in budget, you know whether they shift months or a year of planning before, everybody sticks his hands in the grant and I am telling you at the end of the day it would be no bars financially.

I: Ok.

R: But collaboration is the idea [Inaudible 00:55:41] collaboration on the accountability and inclusivity and non-hierarchical of the word and how we put in the strategy.

END

8.6.4 Interviewee D

START

I: Ok, uhm the first question is just general questions. What is your work experience and how many years of experience do you have?

R: Uhm I have 15 years' experience in the construction industry.

I: Mh.

R: Yes and I work as a-, I run a private firm under quantity survey.

I: Ok.

R: And I also make sure to invest in, and over 10 years' experience as a lecturer.

I: Ok, uhm Mr. Monyane can I call you back in a few minutes. My laptop just froze, I can't record anymore. I'll call you back in 2 minutes.

R: No problem.

I: Sorry.

R: It's ok.

I: Ok, let's begin and continue to the next question. What is your current responsibility in your business or the projects or the environment that you work in?

R: I am the director of the company.

I: Ok

R: Yes, that is the business I own personally. I basically oversee the entire operation of the business; I also make contact with clients and do all the business management, entire business management including obviously operations, QS which is in constriction, procurement. We do that as well for the clients and I actually do the entire scope of a quantity surveyor.

I: Ok, ok.

R: Yeah that's what I do, yeah.

I: Uhm I am not sure if you are going to be comfortable with the next question, you can either give me a range or you can give me the exact number. I just want to know what is your age?

R: My age?

I: Yeah.

R: No I won't tell you that, it's unknown.

I: Ok that's ok, thank you and now we are moving on to another section. I want to know are you familiar with lean construction concepts and ideas? If so which concepts are you familiar with?

R: I am familiar with lean construction concepts and we are surely familiar with the entire lean concepts including to-, like how we mean by efficiency and how to improve efficient counterfeits of delivering projects.

I: Mh.

R: This includes like last level system, target manage design, respect for people and especially the official spectrum of lean if you want to look at things like just in time.

I: Ok.

R: And yes.

I: Ok.

R: Actually it's the entire lean, also looking at IPB.

I: Ok.

R: Uh timing problem, my PHD was also on construction, so-

I: Ok, ok.

R: Uhm yes, yes.

I: Ok it seems you are quite knowledgeable on the topic. So if you had to rate your knowledge, this is an open question so it's up to you. If you had to rate your knowledge of the concepts of lean, I have principles 1 being you have no knowledge at all and 10 being you are fully knowledgeable of the concepts how would you rate yourself?

R: Well I would say 9.

I: 9.

R: There are other ones which are not necessarily-, they are lean concept but they are not lean construction, they are not really familiar in the lean construction lexicon you know.

I: Mh.

R: Lean is actually a very broad area.

I: Yes.

R: But they are the ones that are specifically based more on lean construction. You know there are those that you take in the entire lean lexicon apply them in small parts not to the lean construction but I am fully aware of the ones that are mainly operating in the construction.

I: Ok, ok so I wanted to know about lean construction specifically, so that's good.

R: Ok then then in lean construction I am fully aware with the ones that are useful in lean construction.

I: Ok, ok uhm the next question would you say that the colleagues you have worked with are also familiar with lean construction concepts and principles?

R: There are people who are applying some of the lean concepts.

I: Mh.

R: But they are not aware that they are lean concepts, you know when people are trying to improve efficiency they use some of them.

I: Yes.

R: But they are not really-, they have heard of the word but they don't know how it works. Some of what they do you can relate it to some of the lean concepts.

I: Ok.

R: There is little knowledge but it's not entirely, fully recognized as lean concepts.

I: Yeah, I think just to add to that some of the lean concepts are just applying normal logic and some people don't know when they apply it that it's lean.

R: Yeah, they cannot associate it with the terms but it's something that they do.

I: Yes, yes, yeah. Ok so those questions were related specifically to knowledge of lean and the topic, the next set of question is related to the state of the current industry in South Africa. So in your opinion how would describe the current state of the South African construction industry?

R: Well it's not a good picture; we have a lot of problems with regards to construction performance.

I: Yes.

R: And we also have a problem in terms of-, the industry is going through a slum at this point and there is a lot of poor performance out there which I believe it needs to be more in order to sensitize the entire industry in South Africa. The industry right now is not in a good state of issue compared with other developing nations which are growing well in terms of developing the status of the construction settler. Ours is not in a good condition at this point

ad again the economy is also not helping because if the economy goes down it means there is also less construction happening, that also affects a lot of things.

I: So what would you say has led to our construction industry not looking so good?

R: There is a lot mistakes that are happening in the industry, we have not been very innovative in what we do. We are basically just been doing in whatever we do.

I: Mh.

R: And there is no urgency to try and improve the status quo.

I: Ok.

R: We talk a lot about what needs to be done in order to improve the industry but there is less that is being done physically to make the change.

I: Mh.

R: We are transforming from our old traditional ways of doing things, it's happening but at a very slow pace.

I: Ok.

R: We are not using-, we are not even fully up to date in technology but-, In fact I am but people have got a different view of what we are having. They think using a 3D model you are fully applying lean.

I: Mh.

R: But if you use a 3D model you are just adding the difference of what it used to be before in 2D and then you are just using a 3D, there is no new information. You must now-, if you do a 3D without the information data then you are just wasting your time. You are just helping your individual but you are not fully using what is being termed off alike, you know so that you take it to something like 6D where a facility manager can be able to take and understand. If a geyser has busted you know he can get full information about where the geyser is located, what type of geyser it is so that he can obviously send somebody out to go and fix it you know.

I: Yeah.

R: By the click of a mouse you can see the full information, full spec, how many liters it is and if it's a solar panel one or whatever. Then that information can be able to commission

work for a plumber to go and fix it, do you understand? But people think that thing is just hanging in model layer.

I: Yeah.

R: You apply the bits.

I: Yeah I understand.

R: You need information to help you, you don't just do half done work and things that you apply in technology because you are using a computer.

I: Yes, yes I understand where you are coming from. The company that I work for in the last 2 years we have probably been in the initiative in the entire business globally. And as you said it's not just using a computer and think that you are doing well, it's incorporating information, sustainability, looking at a whole life cycle of whatever you are doing and how it can be improved technologically.

R: Exactly, that you have less information but you can move at any time.

I: Yes, yeah.

R: You know, people think you start applying-, when you use a computer then you are technologically inclined.

I: Yes.

R: No, we are moving towards a the [Inaudible 00:11:37] it's about data.

I: Yes, yeah.

R: A model without data for me it's still like we are lying to ourselves that we are using technology.

I: Yes, ok, ok. The next question is in your opinion how would you describe your perception of productivity in our industry?

R: Look there are parts of the private sector that is doing very well in terms of productivity but those are big projects where you uphest for completions and you now you work like your private commercial projects. You know there it's about profit and when you are putting profit in front of what you do then you demand performance, you know. There are deadlines that needs to be met, there are some good performances that are happening there but those are projects that are profit inclined, for clients. When you look at projects that part of the project

revenue of the organization, so it's a performance difference, it's a very, very low. I mean sometimes I can say it works in the public sector.

I: Mh.

R: But in private sector you have some good performance, that can be identified but not so much for the public sector.

I: Yes.

R: And again the types of contractors that you employ in the public sector is not the same as those that you would employ for the private sector.

I: Yes, yeah.

R: Yeah.

I: Ok, ok in your opinion could or how has the implementation of lean con9struction principles improve or improved productivity in construction projects?

R: I beg your pardon, you said the occupation of lean by what?

I: In your opinion has the implementation of lean construction principles improved productivity, like have you seen the implementation of lean and could you have noticed the productivity increase thereafter in your opinion?

R: Well the truth is we don't have to have a lean that is out there for anyone to know, not that I know of. But I do a lot of work in the public sector and people are reluctant to change, so the only lean aspects that have been used are the ones that would help me not necessarily improve them on other people but-, because it has to be something that is industry driven you know for people to be able to buy in. lean is a hard fell, it's a hard fell product. You know it's not a lean that you need to go and sell to someone because people are used to their old way of doing things, it's a mindset. Like I said it's a philosophy and if people don't believe in that philosophy it's a hard fell for you to convince them otherwise unless they can see the benefits. You know even sometimes when they can see the benefits they want something that they can see the benefits much quicker and lean doesn't provide you with the luxury of time. You know there is a time factor to fully get people's mindset to change towards lean, but we are doing something because now we are trying to get the industry to understand the lean concept. We called chairman of the non-profit organization, some of my partners that we have opened a Lean Building Environment Africa, it's an organization that is trying to sensitize the industry to try and make them see. We are running workshops and we have a

few companies that have come on board but we were keen to help them. So people like Aurecon, is on board and we have had several workshops with them and they like the idea.

I: Yes.

R: And then we just need to actually move forward and get them to fully know and use, we've got some other companies as well that have joined in. Property Company like CITITU, IT paranoum CITITU, Indlu, and we've got Empire development solutions. So we are trying to get developers advising into the concept, so once we can get those clients moving and able to bridge this gap of what the industry may or may not fully embrace lane but we are making head waves in that aspect. Property developers of course they can see the benefits in the long run, so they are buying to it. So they just took the initiative because they want to be the first to implement because they are very innovative companies and they really value innovation, so they are fully on board with everything.

I: Ok that sounds good, I know you have mentioned that we never really seen the implementation of lean to measure success but in our feeling and you knowledge do you feel that implementing lean could improve productivity in our projects?

R: Definitely, that is a no brainer. We have seen a case by these-, Brazil ,Peru, Norway and Chile.

I: Yes.

R: So those are developing countries but they have already embraced the concept and they are seeing good results, and we just need to get Africa to also believe into the concept. Once we start going then people would start really to understand what it's about because lean is not really about amid a change in the process but actually about amid a change in human beings.

I: Yes.

R: That's all because we won't really have to apply lean-, if you can get the attitude to change then you are half way there because they always say don't change the contract, change the behavior. You see if we can if we can get the behavior of people to change then we are half way through what lean is about.

I: Yeah.

R: But people must think of many ways of doing this, there are smaller things we can do that are lean and once we can be able to understand the concept and use it in everyday life then we don't have to do much when it comes to processes, they'll understand, it would be easier.

I: Yeah that's true.

R: Like a simple thing like respect for people, you know it's a behavioral thing and we are moving a lot of productivity because we depend on people to push productivity. But without respectful people then it means we are working against resistance because you are getting people to your production but people are not fully buying into your vision yet because they see that as just a normal task rather than something that is productive for them to try and help you achieve your vision.

I: Yes.

R: Because once you can convince people what your means, if then buy into your vision then it means your productivity has already improved, do you understand?

I: Yes.

R: But we do lack of that, these people pass in instead of making them part of the plan and that's what lean wants. That you respect people and you make them part of what you want to achieve rather than a top down management sort of thing.

I: Ok, the next question is in your opinion what occurrences or issues negatively impact our delivery of construction impacts in South Africa?

R: Frankly our contracts is are collaborative and doesn't have the imperatives to try and-, or maybe it's performance based, you know to try and encourage performance. And without improving our contracts, without improving the integrated project developments then we are saying that we have 2 sides to a construction project where we have clients and then we shift to the contractor, we shift that contractor. You know if we can fix our contracts and move to an integrated project development then at least we are realizing the fact that we are all one when it comes to what the client requires. But then what we are now doing is that we are trying to score points, you know the other side is trying to show the other side how they are not performing and the other side is only profit driven as well. So we are not supine in what we do, the contractor is trying to maximize his profit and the agents are there to make sure that he doesn't maximize or get what is due to him.so you see there in no mutual trust between what is happening in our contract, so that is already a problem and our procurement system as well. You know they are not performance driven, from the start we

don’t need to have what we call Owner project requirements. The objective is not clear, we are going to a project with less and actually hat happens is that the consultant takes over the objective of what the client wants.

I: Mh.

R: And then they interpret according to what they think the client wants.

I: Yes, yes.

R: So the client sees his objective in requirements through what the consultant has convinced him this is what he wants.

I: Ok.

R: Do you understand?

I: Yes.

R: We also have less informed clients you know, you tell them this is what I need and then the architect is the first person that is brought in and then from there everybody else takes cue from the architect.

I: Yeah.

R: So he has whatever he wants and everybody else [Inaudible 00:24:47] so how can we improve our processes when we the objective of the project through one person?

I: Yeah, yeah.

R: Because he knows what everybody knows.

I: Yes.

R: So we are not collaborators but followers in the construction process, if you understand what I mean.

I: Yes I understand, I had a similar discussion with another lady from McKenzie and she is part of the Lean Construction Institute South Africa and she mentioned the very same thing that our contracts are being set up in a very vicious way that the consultant is trying-

R: It’s isolated.

I: Yes.

R: It's isolated.

I: It's showing how the consultant can show that the contractor is not doing his job and lay penalties against him and it's a claim sort of business, there is no collaboration to work together and to achieve the end goal. There is also very eye informed clients, they don't even know their full scope of work before they are put to work and it's basically it's a lot of people who are trying to screw each other over who think they know more than that they know.

You see that is the other problem with what is happening, lean is happening in isolated areas McKenzie had mine a lot on lean but they would tell you that those are confidential, do you understand? So you would never get the industry fully aware of what is happening because the main think about lean is to show your experience to other people so you can improve the industry. But with what is happening now there is no way that we can be able to achieve the objective, the way it's happening in isolation like the way it's happening now. That's why we are told to do it outward, you know invite people to come and be part of the whole thing.

I: Yeah, ok uhm-

R: Because we spoke to the institute before but it looks like they were not so coordinated, you know they are doing very little to lean. One or 2 things they do and we have some agreement on to long term and things like that but they kept quiet because I think he-, in McKenzie he left and he went and joined another firm I think.

I: Ok.

R: So there is nothing right now but I know that he told me that McKenzie was very keen on pushing that concept, I can say but I don't know.

I: Ok, the next set of question specifically speaks to-, it's just a few questions specifically speaks to our government in South Africa. So in your opinion what role has our government played in developing or determining our current state of our industry?

R: They are not really managing whatsoever to try and contribute or deter like you said, they are not doing anything whatsoever. They are even worse because anything they do still gets published; there is a lot of democracy in terms of their processes. It would be very difficult to bridge the government for now, I think if the private sector pushes the lean then the government will sort of try and join later but the public sector provided a lip service into

improving processes but in action there is no way they are providing action. What they do is just to provide lip service into efficiencies, there is a lot of inefficiencies and they are not going to change anytime soon.

I: Ok, do you think that the South African government has developed correct policies and protocols to support the implementation of lean? Or from your previous answer it seem as if your answer is a no.

R: No, they have definitely not. I don't think they are aware what it is and you must understand why I am saying this, the public sector doesn't have capacity to actually do lean.

I: Yes.

R: Yeah.

I: Ok, ok.

R: Even that if you tried to come with innovative ideas you would be shut down; like you see it won't be seeing the light very soon, it would never happen.

I: Ok, the next set of questions is specifically related to management. So in your opinion and in your experience in the construction industry, has management in the organizations that you have worked with set very high sometimes and unreasonable expectations and project goals?

R: Yeah, it does happen especially in projects where there is headlines that cannot be missed, then it's unreasonable implication for you to perform a miracle. Things are done at the speed of light and that's where a lot of things go wrong because you are in such a hurry that you need to get things going.

I: Yes, yes.

R: So sometimes you get to a point where they tell you that this project needs to go out in Ithemba like yesterday.

I: Yeah.

R: So you see everything is rushed and the quality gets affected by such urgency, you know.

I: Mh.

R: It happens a lot actually to tell you the truth, it happens a lot.

I: Ok, do you believe that your organizations or other similar organizations in the industry are committed to develop and implement an effective plan and resources to support and manage the implementation of lean?

R: No like I said the visibility of lean is very low.

I: Mh.

R: Even the project that I have told you before, that are practicing lean they are confidential. So if you are doing something that is good for the industry and you are taking it as confidential then how are you supposed to improve the entire industry with that the of person? I am aware that in Eskom there are some lean companies from the US that have been appointed to try and improve the construction of power stations, as well like I say Eskom projects are very confidential as well and there is very little that they are sharing with you. So it's still difficult to get to have people expose the concept.

I: Yes, yes.

R: They are keeping it under rights, it's not assisting anyone if it's. Any kind of knowledge in order to make a difference it needs to be shared with you.

I: Yeah.

R: If you keep it then it can't work because you are keeping it to the few, even the International book for construction I think they did the same thing when they-, I think they wanted to keep lean amongst a certain group of people.

I: Mh.

R: It took them 24 years to realize that you know what; we should have made this things as wide as to the whole world you know instead of keeping it to the selected few.

I: Yes, uhm-

R: You know and it was difficult even to try and send to other people, even after 24 years. It was not as wide as it was supposed to be, they needed to get the concept from the weird go to everyone but at the time they kept to a few countries in the US and few countries in Europe. So it's only now that they realize that they should have just introduced it to everyone.

I: Why do you think they had it secret for so long though?

R: You know when you think you found the pot of gold.

I: Yeah.

R: So you keep it amongst yourself first and I think firstly they said let's see where it goes first before we can share it to the rest of the world.

I: I think they wanted to measure the success of it first before they started to get it to everyone else.

R: Yes, yes that's what was happening. They wanted to be fore first of its success before they can-, you know they were not confident as yet.

I: Yes, yes.

R: You know they were still trying and there is a lot of trying error and they took all of the experiences and shared all the experiences with the select few, and then from there they perfected it a little bit and they started putting in other people and then it grew. And then you know other people try something else, so then after that they realized the more people we involve it's actually the better results we can get. So that is how.

I: Ok, throughout your experience and the projects that stand out for you specifically do you believe that middle that middle or higher management could have added value to improve the success of these proje9cts?

R: Definitely, lean would not work if the clients are not on board. You know it needs everyone; all stakeholders, the whole value chain and everybody has to be involved. You know it's not like Simon Tyson confidenity or only selected few. It has to involve everyone and everyone has to have a buy in and get to contribute. And that is not happening and you are about to change.

I: Yeah, yeah ok. Uhm the next set of questions specifically speaks to education of the topic and awareness of ethical ability in South Africa, in your opinion do you feel that bodies like SACPNP or Lean Construction Institute or any other body creates sufficient knowledge and awareness of lean construction?

R: No I am not even sure how well knowledgeable SACPNP is on the topic; people are not willing to learn. People are not willing to learn anything, the company is what they have and even at that people might-, you know just have basic knowledge of what lean is but have no intention or whatsoever what it's holding. So that's a different issue altogether.

I: Ok, do you think that the South African Construction Industry suffer from shortage of skills and knowledge regarding lean or just in totality?

R: I don't think so, we have a lot of technical people here we just need to get them to embrace the lean concept. And it's not like a rocket time to get people to understand what lean can do.

I: Yes.

R: You just need to get the mindset changed and show them the difference between the traditional way of doing things and how the lean differs from that, so that is all you have to do. We have presented papers that talks about lean but people make an excuse on what it could not work.

I: Yes, yes.

R: Yeah, people are like that. If they don't know something it's difficult for them to picture them in it, so they would rather shut it down rather than try it. Even if you can show them the manifest, that is the same thing that happened to me. In 2014 I presented first lean project paper at the SACTSD conference and people were saying 'no that thing would never work here' you know.

I: Mh.

R: But now everyone is going on about being-, that is what everyone in construction is talking about now, it's about it now like 5 years after the fact, you know.

I: Yes, yes.

R: But back then when I was talking that no it would never work here, let's teach you what we know and stop adopting things that we don't know. What I am saying is that people are reluctant to change, people are reluctant to get to something they don't know than to be open minded about it.

I: Yeah, yeah.

R: Because they feel like you want them to change and they don't want to, they would rather do what they have been doing and not learn anything.

I: That's very true, sometimes people rather doubt the ability and they are very resistant to change especially in our industry.

R: Yeah, you see you are challenging their comfort zone and you see if you do that then everyone would be resistant.

I: Yes, yes.

R: We need to be gradual in information means you know, gradual change and we need to at least implement it to the young generation. You know the young generation can embrace this new technology in voce of this and render all these people who are not ready to change redundant then they would see that they have to work on themselves, it's all about them. Because lean is not about the individual, it's about what you can offer, efficiency you know.

I: Yes.

R: And if you are happy with not achieving maximum efficiency in your projects then it means you shouldn't be there in the first place because it's not your money to start with, so if you are not respecting the client then you are about to just bring out the data.

I: Yes, yes.

R: We work with client.

I: Yeah that's true.

R: The sooner the people realize that the better, that it's not your money so you should go out of the way to make sure that the client is happy. So we need to go past the fact that we think we know everything as consultants and we don't, we don't know anything.

I: Yes.

R: And we don't know what is best for the client, the client knows what is best for him it's just that we are not giving them the platform to fully tell us what they want. We are not working with them they working-, they are not even working with us, we sort of taken over what the client wants and we think that we can deliver what the client wants.

I: Yeah that's true, the next question is has there been any formal training in your organization around lean?

R: I am doing it in my company, I am working on the behavior and respect for people. That's what I am doing before I can actually go into post, we are trying to change the behavior or people. Work on that and then train and then show them how they can improve their attitude and see things differently. And it's working, people are seeing a difference in something that they took for granted and how they apply some lean concepts and they see the difference in how productive they are, you know. The productivity has changed also the attitude has changed, so that is where I am starting right now that the biggest title that we had to overcome is behaviors.

I: Yes, yes and the organizations that you have worked for previously or currently as a management other than yourself being to any formal training, any?

R: Well my core channels that we do, that we work for their organization is with Build Environment Africa. We have done level 2 Lean certification from the Lea n Construction Institute of Canada.

I: Ok.

R: That's in Canada and we have done that over a 5 week course which is a level 2 certification, all 3 of us had that level 2 including the 2 other people who are assisting because we have collaboration with LCI Canada and LCI Texas.

I: Ok, ok.

R: Yes we work with those 2.

I: Ok, do you feel that more training or start training would actually improve awareness and successful implementation of lean?

R: Yeah, definitely we need to provide more frame.

I: Yeah, ok.

R: The more training we provide the more-, you know we need to hold workshops with those people to send the target and make them aware of lean and the more awareness we create the more people will start embracing it. So it's like a big sort of bribe to create lean champion.

I: Yes.

R: For the whole country so that we can get people to understand what lean is and what it can do, so and that is what our companies are trying to do, our councils we call them lean councils. We are trying to create-, actually we are trying to lead the whole Africa and not just South Africa and we are trying to get some people from Africa that can partner with us then we can also run, planning some workshops with them as well.

I: Ok.

R: That's our entire plan.

I: Ok I hope it works.

R: Yeah we are trying to get some people to join in, we have done workshops already here in South Africa.

I: Yes.

R: And the reception is quite well, it's just that we have to squeeze everything in a day which is difficult to run many concepts in a day because now you do some theory and then vacations where you do all those training exercises but sensitize people. So it's difficult but what is done so far has got to be good reception from the training that we have provided so far.

I: Ok no that's good, the next set of questions specifically resonated to finances and investing into the concept. In your opinion do consultants, contractors and clients invest adequately financially to educate and implement lean?

R: No I don't think so, like I said it seems the visibility is very low, the awareness is very low so contractors are not really boarding on board. Contractors are money coaches and if they did like with the economy now it would be a huge challenge for them to fully invest in lean unless the economy is doing very well, we might get somewhere. But the consultants are for me key, they are key and developers are key. Those are people who have long term goals on where they want their company to be, so they obviously have the capacity to do that now but contractors don't have consistent business and that makes it difficult for them to invest in lean.

I: Yes, yes uhm do you think they should? I am speaking about contractors, consultants and planners, do you think they should invest more in this theory of lean and implementing its principles?

R: Of course, without a doubt they have to. In long run they would see the benefit, you can sell lean as a competitive wedge you know and the biggest hurdle we have to overcome is convincing clients to buy into it. So the more clients we can convince the better chances of us having it implemented because it would be demanded from consultants, as consultants we only consider investing in such because the client demanded. But if the client does not demand it they stick to what we have been using along.

I: Yeah that's true, do you think that considering our economy and the cost of lean-, I know us do you think they should burn out, do you think they can invest more financially into this concept?

R: Yes, yes, yes you know lean doesn't really define in saying they don't cost that much to the construction companies. There is very little that they need to invest and I just want to say it's a bit abstract for now considering how much we work hard on.

I: Mh, mh.

R: But we'll get there eventually.

I: Ok, I want to know-, I am coming to the end and it would probably be in the next 10 minutes or so, I have a few more questions remaining. And you have touched on this topic before quite a few times and it's related to human attitude, in your opinion do you feel there is misconception or lack of understanding of what lean is or lean construction is?

R: Definitely yes, there is a lack of consensus on-, I don't call it consensus. There is lack of understanding or what it is or what it can do, people hate terminology. You know when it comes to terminology people become defensive, you know they might be doing that but they don't like it when you call it whatever you call it.

I: Mh, mh.

R: Why do you have to give it a term and things like that, but we have to obviously understand the definition. Do you understand? Without the consensus on the defin9iton then we wouldn't have knowledge of what we are talking about.

I: Yeah, yeah.

R: Yes.

I: Do you feel that-, you have mentioned it before. Do you feel that here is resistance in the industry, contractors on how they like to do things and even some consultants applied, do you think there is some resistance in the company to implement lean construction?

R: I think so, I think so, there is a lot of resistance and especially when it comes to money. You know money creates problems. When you start fiddling with money people get uncomfortable. And this is a lot more in private sector, you don't want processes that are going to obviously stop the way they do things. You know especially when it comes-, with corruption and all those things, they are heart felt and nobody can sign up on lean if they see that it's in favorite of corruption.

I: Yes, yes.

R: Uhm d you think that our industry requires a culture change to improve our industry?

I: Oh definitely, our culture is so out dated.

R: Mh, mh ok.

I: But we can't go on doing what we are doing, it would get us nowhere. Already if you look at the news yesterday Minister of Finances showed us a pretty gluey picture of where we are heading and we talk about efficiency, and this is where lean should be a priority.

R: Mh.

I: Yeah.

R: Lean should be a priority to get where we want the country to go and if we don't consider lean to be part of construction to improve our efficiency, we can't keep spending money on projects where you are not seeing value.

I: yeah.

R: We need value and lean can provide that, value for money.

I: Yeah.

R: And if you don't value for money then I am afraid we are still going to remain the same in a sense that we are now, so processes and concepts like lean would work best in this situation.

I: Yes, ok. Ok we've got just 3 more questions to get through, are there any other barriers that you stringy believe that affect the successful implementation of lean?

R: Yeah our policies like legislation; legislation is one big factor because it forces us to do our supply chain in bringing the contractor late. You know with lean we need any contractor involvement for us to be able to realize the value, you cannot be sitting and dividing a project which with whoever is going to be in it is not part of the results, and this is where we are exactly. Lean finds procuring a system that mainly the contractor is in, and the only thing that would get us to that point is to do debt procurement where we can the contractor heading.

I: Yeah.

R: Then we know that we can pull plan and divide, pull plan in prognation meeting where we can iron out all the deliverable and we want the contractor to pull and divide any, so that the

contractor can obviously provide the input on what we work and we could leave where we are all on the same platform and we can collaborate in real time.

I: Mh.

R: We can obviously hold take off meetings where we can try to understand the team, you know we go and in takeoff meetings in introduction of other like a camp, a boot cap. In America what they do is that they bought the tin staff, they go on a boot camp to understand the team and the people that are going to me in the process and talk about how they would love to-, or find out how they would provide efficient services. How they would provide efficiency in the project, you so that we can be with each other, do that we can work with each other when the projects kick off. But with us we just go to a meeting and we meet each other for the first time, and one person is in charge and telling us exactly what everyone needs to do and dive us the time line and that documentation makes everything. And we don't really engage in what the project is about but each and every one of the deliverables and that's it, so we are not engaging with the project but having individual tasks.

I: Mh, mh.

R: And that is the problem.

I: Ok, what strategies could contribute in improving the delivery and quality of our construction projects in South Africa?

R: We need to share the contract, we need to have the greatest part of development sort of form of agreement and we need to introduce incentives again for people buying in. We have to use target costing, target value in line and let's talk about target cost and what are their level costs, what are their market costs and let's show them to all of the participants. And let's not have one side, 2 sides, let everyone contribute to the deliverable at one. If you don't get to out everyone into one, you know one sort of contract that say we are all working for that, you know that consultants are not in hierarchy but higher than the contractor is. You know let there be a performance that includes performance contractors and sub-contractors and let's grow in this you know, where everyone who is involved in the project is there whether as part of the programing session. We can not only bring the sub-contractors the time when we feel that they should come and do their part, you know they need to understand the bigger scope of the project. But at this point we need to eradicate the seldom mentality that everybody is just responsible for what they have to do.

I: Yes, yes.

R: That is the biggest issue, that everyone is just doing what is their role in the project rather than all of us doing this thing together in collaborative way. And collaborative is a problem and everyone knows that collaboration is the main problem of construction.

I: Ok.

R: If we could get rid of that we would be much better off.

END

8.6.5 Interviewee E

START

R: Ok, my name is *** *** and I have graduated from university of Pretoria in Architecture, my first professional degree in 2010.

I: Mh.

R: And I'll give you a brief history up until now, and then I went and worked after graduation in Malaysia for about a year. I studied architect, in highest construction and then sometime I got a full bursary scholarship to go and do my PhD n the stated where I did my PhD in environmental design planning. It was a bit mixed disciplinary degree; so I also did economic as part of that. And after that history I was about 3, 4 years conversation later on I took on honors representative role at the US firm again in the city on development route. And that point in time I got honors rate for a developer and that was where I was introduced to lean construction and design on the job. So the project was a lean job and I learned it there, so I spent about 2 / 3 years being on account doing that role and my function was honors rate as well as lean champion. So my job was to bring the practices on to the construction side and supervise team and production engineering ad everything in that conversations. And then around 2017 I came back in South Africa.

I: Ok.

R: Project Stone construction and for various reasons and then in 2017 I also wrote a book with [Inaudible name 00:02:13] called Mastering in leadership which is a book about practices of lean design construction and how to adopt these ideas in the real world, it's not a theoretical book.

I: Ok.

R: And then that was about 2 years ago and I came back o the country and I was operating in my private capacity as an urban strategist, so this is the next blade of project coordination precinct and project planning and strategy as well as design. And parallel to that we started the lean Africa organization in Southern Africa, and it's and NDC Company with explicit function of bringing lean design in construction and areas practices to the continent and now it is a year old and ongoing. So those are the capacities that I operate in, so as of 2010 you can say that I am now about 10 years on the environment and in the spaces.

I: Ok that was quite a comprehensive background which is good for me.

R: Yeah just the way I start when I do it.

I: Yeah, yeah.

R: Oh and acting just to say in understanding my titles, I am the director for region 50 and chairperson for Lean Bolti-manufac.

I: Uhm ok, uhm next question well in your brief-, well in your quite detailed summary you actually answered the 2 questions of mine so I am just on the reformation now. So the next question is if you are comfortable with this question I just want to know what is your current age or could you quickly give an age bracket?

R: Sure, I am 33 at the moment, and I am female white South African.

I: Ok uhm those were just the brief questions about my interviewee, the next questions relate to your knowledge of the topic of lean. So are you familiar with the lean concepts and ideas, if so which specific concepts and ideas are you familiar with?

R: Yes I am very familiar with the concepts and ideas, I know a lot about a lot of things about it so since I have-, I have 2 domains. I have an educational understanding, in other words I am in the business of teaching people about it then the second one is I have application understanding as in the project space. I understand how lean projects are put together and how it's executed.

I: Ok.

R: So yeah I don't know if that help your answer?

I: Yeah that's fine.

R: I won't be able to say-, I think it would be able to fit both in this particular topic because I am comprehensive in it.

I: So would you say you like the concepts of last planner or just in time you are familiar with all of those?

R: I have a personal experience in all of them.

I: Ok the next question is sort of your perception and understanding, if you had to rate your understanding of lean concepts and principles 1 being no knowledge at all and 10 being fully knowledgeable how would you rate yourself?

R: Uh I would rate myself very high, the reason I wouldn't give myself 9 or 10 is because I am young and there is a lot to learn so I am 7 to 8 on the scale of knowledge. Yeah maybe-, yeah I would say 8, 8 out of 10 on knowledge.

I: Ok, ok.

R: Yeah that would be where I place myself.

I: Ok, throughout your experience would you say that the people around you and the colleagues you have worked with are familiar with lean construction concepts? So I am just trying to gage other than yourself, in an environment that you have worked with were the people around you familiar with the topics of lean?

R: In my US experience I was surrounded by lots of knowledgeable people, in my African experience I am starting to build that capacity. I have colleagues in that space but they are usually South Africans with experience of 5 out of 10 for knowledge about lean. So I would say the colleagues that I work with in this continent that understand lean are people who are interested but then don't have a particular practical history in it, and then but my colleagues in the states are usually Industrial engineers or industrial managers with that kind of history. They have application history in other domains, so a lot of my peers have applied lean in for example in financial sector or a specific component or manufacturing off shoring aspects.

I: Mh.

R: It's not necessarily comprehensive design and construction focuses.

I: Ok.

R: Does that make sense?

I: Yeah, yeah I understand. So the next set of questions is specifically relating to the construction industry in South Africa particularly, in your opinion how would you describe the current state of our industry in South Africa?

R: I would say it's broken, it's broken and it's high inefficient and it's also not profitable at the moment for most companies in most practitioners. So it is usually very customary, in other words I have no reason to believe that if innovation is taking place intentionally.

I: Ok.

R: Compared to the rest of the world we are on par with developing regions in the industry but we are not that far behind the top of foremost either, because the top of foremost globally are still a small group of people relatively speaking.

I: Ok, and how would you describe-

R: We are at par probably with everyone else.

I: Yeah, yeah ad how would you describe your perception of productivity in South African in our construction projects in South Africa?

R: Productivity as in executing and building a building?

I: Yeah.

R: Ok executing and building I think our productivity is very low and I do think there is a lot of resources drawn on jobs but I don't think it's used effectively, so I believe that productivity can at least be doubled if we adopt different ways of working one of which is with lean and Africa can gain a lot of territory if the work on this aspect.

I: Ok, and well you have touched on that and the next question is do you think in your experience could or has depending on the review that you have seen it, has the implementation of lean construction principles improved productivity in some of the projects that you have worked on? Or if you haven't do you think it would?

R: Ok so from the design side of the conversation not in the construction I am applying it in my own private capacity, so I have a bias towards seeing that works. I see it work for us if you are practicing it however we have practiced it in ratio time, so time will tell how well it is.

I: Yeah.

R: On the construction side of the network I have not engaged with any of my network, I have not seen anyone apply lean intentionally yet. And so I don't think you'll find a lot of evidence for it at this point in time I 2019, however with the engagements in Africa that it has evolved with information that comes to light as we work with our clients in our network.

I: Ok but if you have to think of the concepts and how it has assisted you do you think that formally implementing it in construction could actually benefit these projects in terms of improving production?

R: Absolutely, absolutely.

I: Ok, ok.

R: And I am convinced of that.

I: And the next question is what occurrences or issues negatively impact-, this is your opinion again, negatively impact the delivery and performance of our projects in South Africa?

R: Sure, this would be my personal impressions?

I: Yeah.

R: So the first thing is the discrepancy between labor doing the work and management doing the work, there is a large class difference for like I have been work, so in other words regions, the educational labor force on the US is much close to the education of the managerial force. So the closeness I am just speaking educationally is much neither where in in South Africa it's much more higher. The first thing is cultural differences, there is a lot of history in South Africa that has cultural behaviors. Social ways of leaning and those also between people who are doing the work and people planning to work, which means you need to might clear the point. We have a historical approach to finding work, just in our way to innovative. So our planning is from our first plan of perspective all the way down and the structure in how it works it's hierarchical. There's an obstacle and barrier, and the other thing is that we have an identical or skilled view of how we generate jobs.

I: Mh.

R: For example we have the general understanding that it doesn't matter how many people are in sites, if everyone can carry a bucket that means they have a job to do and this is contradicting the functional meaning which is the right people at the right job, at the right time.

I: Yeah.

R: So we have labor unions and laws, things that require as many jobs as we can possibly get and this is getting in the way of being effective. The other practice is that our industry is corrupt, so it's difficult to manage in a way that the developing world regions are using lean and that's an obstacle we need to figure out. However the way lean is applied in construction is a way that it could be mitigating the corruption risk because lean is so transparent.

I: Ok, uhm the last one that you touched on was corruption and that brings me to my next section which is actually about our government in South Africa.

R: Ok.

I: In your opinion what role has the South African government played in either developing or deterring or current status of our industry?

R: Ok so large question, so I'll just try my best.

I: Yeah.

R: I think the public sector has a concern of creating jobs and not focusing on creating good jobs, they are just creating jobs. So in that way it's-, let me just try and rephrase r change.

I: Sure.

R: Uhm in that way that's an obstacle to adopting new things because we just want great jobs without scarring people up. The other thing is the public sector has in general terms a tender process that is very-, it's very hard to understand how they evaluate competency in the tender process whereas in the lean world competency is a driving force for selecting team members. So again in that way the way we practice when we work is inefficient and counterfeit to inadequate work. And the other thing is corruption, we have a long history with bad practices where the government intentionally or unintentionally it's behaving powerlessly.

I: Mh.

R: So that means a lot of things go on that it's unregulated or informal which makes difficult to manage whether you are on the project side or ownership side.

I: Yeah.

R: And then everything is our government in our context fighting fires, they are not able to think of the future in strategic ways so that means they are at low capacity to adopt innovation which means they cannot request that innovation from our sector which our sector spends their energy on innovation.

I: Ok and the next question is do you think that the South African government has developed the correct or sufficient policies and protocols to support the implementation of lean construction?

R: No the South African government isn't educated about anything like that.

I: Ok.

R: Anytime I engage with my metro peers, clients or public sector entities I am usually-, I would say 90% of the time introducing the concept.

I: Ok, ok uhm so the next section is particularly related to management. In your opinion has management in the organizations that you, yourself currently working or previously working set very high or sometimes unreasonable expectations of projects? Basically illustrating poor management or poor sight and planning of the projects?

R: Ok in the design and the projects, scoping side let's say the articulation of projects I think management is-, I didn't think about this questions to clear my way, I don't think management is maliciously doing poor work.

I: Mh.

R: I think they are historically doing poor work, so I think management is following the trajectory that has always been on. Either with the project or the money value is higher or bigger; I don't think they have ever considered changing delivery practices.

I: Ok no I do understand what you are saying.

R: I do think that the current practices are-, and I can back it up with research, they are ineffective themselves. I don't think it's intentional but I just think they just ride on the history that they have or the education that they perceive.

I: Ok, and do you believe-

R: Ok i would say ready for it, in general.

I: Ok and in your opinion do you believe that your organization or similar organization, wither that you currently work in or previously worked in is committed to developing and implementing an effective plan and resources to support and manage the implementation of lean construction?

R: Yes, yes.

I: Ok

R: And that is one of the major activities that I am participating in, is how to adopt and apply lean under construction.

I: Ok.

R: I am fully committed to it.

I: Ok, and throughout your professional experience and the projects that stand out for you in the past or currently do you believe that middle and higher management could have added more value to improve the success of projects?

R: Yes.

I: Ok, do you want to just briefly explain why you say yes?

R: Sure uhm sorry I forgot what I was saying, uhm so how management could support this is proving behavioral change, we are obviously saying technical change. Uhm a lot about lean design construction is about the current behaviors; however management in general sense to believe through technology. So it is common that lots of influence is placed on technological innovation, whatever the perceive that to be as opposed to doing what they are ought to do which is develop people. So yes I think management in general it's doing us a dis-service because there are some technical points, and then what happens is that work environment is not ready to receive technical-, the learning curve of technical application and that is where management is failing us. They can be further out coming in new tools and technical sense if they were to focus on technical development than get much for is. So that is where the biggest breaking point is.

I: Ok, ok thanks for that. The next section is related to education and technical incompetency, in your opinion do you feel that bodies in South Africa such as SACPNP or Lean Construction Institute or even the organization that you are part of in construction environment creates sufficient knowledge and awareness in lean construction? Do you think these organizations could do more to raise awareness?

R: Uhm so I am not the expert in lean institute.

I: Ok.

R: It appear to me that the lean institute or whatever they are calling themselves is a manufacturing fact and that's the reason that we establish lean in North Environment Africa because the lean institute is practicing lean and it's factory and laboratory and anywhere else but design and constructions. So I don't-, up until now there is no educational vehicle besides lean both America and Africa which is where we are having this conversation to our institutes.

I: Ok.

R: Every time I engage with an Institute in design and building phase it is the first time that they have herd of lean design construction.

I: Ok, and well it might be a bit biased but do you think that the organization that you are part of could raise more awareness or do you think that the guys are doing what they can in their capacity, or do you feel that more awareness should be brought up?

R: Yes, the answer is yes and the answer is yes because we are accurately doing that.

I: Ok, ok and in your opinion do you think that the South African Construction Industry suffers from a shortage of technical skills and knowledge in construction and engineering or lean construction principles?

R: Uhm I have to stratify the route for you, I think the upper issue in my knowledge is design engineering and white color work. Over there, what was the question again?

I: Uhm do you think that we suffer from a shortage of technical skills and knowledge?

R: Ok, so in the-, I think we have the engineering professional service sites, technical capacity there is fine but the gap is that they have no domain knowledge of lean.

I: Ok.

R: On the technic, on the scale on the construction side of it I don't think there is-, I don't think there is-, I think it/s 0 scales for effectively planning and other than tradition of foreign and traditional.

I: Mh.

R: I think our construction side we have 0 technical competency in effective management.

I: Ok, uhm-

R: I may mean broad.

I: Yeah, yeah uhm in the-, obviously in the current organization and previously has there been any formal lean construction training throughout the organization that you have worked in and currently working?

R: Yes, yes in my history yes.

I: Ok.

R: I have formally being on the job training, so we would have experts coming in to educate us on topics and tools and that's how we know.

I: Ok and particular in your time in South Africa has there been formal training in lean?

R: No I have never received formal training in South Africa; I have brought it to Universities myself. I have been offering classes and I have been offering training in whatever my environment is and what they need, for example I am introducing lean design and construction as part of course work at Department of Construction in Pretoria in the subject under sustainable development.

I: Mh.

R: I am doing those kinds of things, there isn't a formal way yet that we can educate people either through-, besides me giving talks, workshops but the function of Lean Building Environment Africa is to be able to give formal education as soon as we can.

I: Ok and in these organizations that you have worked in or currently work in is management in those organizations being full lean construction training and in particularly in South Africa?

R: Yes, lean building environment is a bit about a year old here and we are just signed our office training program for 3 months.

I: Ok uhm do you-

R: The adoption is beginning, yes.

I: Ok and do you feel that any training would actually improve awareness and successful implementation of lean construction principles?

R: Yes it's the only way, it's very hard for-, ok so an individual can go very far on his own but that does not construct as organizations. Se we have to formally get organization on the same page and then we must have formal wise learning.

I: Mh.

R: And formal doesn't really mean through educational institute at university or whatever, but structured learning is absolutely necessary if you want groups of people to behave and adopt things together.

I: Ok, ok the next section is relating to the financial implementation of lean. In your opinion do consultants, contractors, clients / owners adequately invest financially to educate, train and implement lean construction principles?

R: In South Africa the answer is obviously no because they are aren't weary, and in the US the answer is yes. My experience is US and Canadian based, so there resources are really put to work to skill people up in this. It's not upcoming for project to undergo root clamps and training and bringing consultants on board and label out people in this South Africa that's similar. I foresee that the conversation is bigger but the money will follow the conversation, just like we are seeing with Lean Building Africa it is. It isn't a product that our industry is desperate for because our industry is always stuck there and they don't know where else to turn. They know that they existing diaphysis are killing their office and killing their projects, but they have no other conversation to have.

I: Mh, mh.

R: So I think the interest is speedily growing and people are exploring and looking for new things, and with the interest and normal practices I think a line atom would be generated in private sector work or dysfunction more often.

I: Ok, and do you think that-, well as above stated, do you think they should invest more in implementing and educating lean construction?

R: Yes, yes lean is not a single player game.

I: Yes.

R: So I think if you want to be successful the projects are also long, longer in duration and if you don't invest in your people and don't give in the support to motivate things, there are peers that-, the likely of succeeding if very low if you don't support it. So uhm yes, companies and the equivalent must invest in this if they want to reap the benefits through to the base.

I: Ok, and my previous question-, well this question particularly related to, do you think they should invest but-; my next question is considering the state of the industry and how many companies are liquidated, just basically having said about the economy. Do you think that these companies can actually invest in educating and implementing lean construction principles?

R: Yes because the opposite of the reward can pay for the learning, the function of lean is to generate value in different ways.

I: Yes.

R: So even if you do 1 or 2, you don't have to have full lean to be a lean operator.

I: Yes.

R: So if you would focus on simple things like the moving ways you can pay for that education through the ways that you can move, so it is a fallacy for companies to believe that this is an additional cost to the job where probably the job can generate the education.

I: Ok, ok yes. I think you have touched on this previously but the next session is relating to human attitude or culture in the industry, do you feel that there is a misconception or lack of understanding of what lean construction is?

R: Yes I do, in most instances it's considered a trend or a fat or a fashion, or the Ice cream of the week.

I: Yeah.

R: The other misconception is that-, so in other words what I mean with the trend is if we are having a conversation about lean it would be-, it would consider the latest trends and whatever and then dismiss it and understand the history. That there is a vast history for it, the second one was-, just repeat the question again.

I: Misconception of what lean is, misconception or lack of understanding.

R: Ok another misconception is that it's a technological tool.

I: Yes.

R: That's completely wrong, completely wrong and it's not a technological tool it's a human and process tool. There is a reflected option is that we don't have money or time to learn a new thing.

I: Yes.

R: And that's just incorrect, and the third misconception is that it does not apply in Africa. It only applies in places with lots of money and higher education, the false-, is that our culture cannot absorb this culture and because it comes from-, a common one is that it comes from Japan, only the Japanees can do it. So that is the major misconception obstacle and it's also completely incorrect because our world regions are doing it everywhere else and including India and South America which is much more key to us.

I: Yes, yes ok and in your opinion again do you feel that there is resistance in the industry to implement lean construction techniques?

R: Uh I think that question would be more-, will reveal itself later on because at the moment there is no conception of lean, so there is no resistance. There is this thing it's actually not about the word lean but about the new thing.

I: Yes, yeah.

R: So I think time would tell if lean as a topic is the thing they are resisting or it's a thing about new things, right now if I have skepticism about it it's usually because it's misunderstood or it is a completely a new idea.

I: Mh.

R: So either you are skeptic or resistance, I don't have resistance.

I: Yeah but considering that in South Africa it is sort of fairly new concept in terms of the age of construction in the country, do you sense any resistance to find out more about it or to educate or do you feel that people are as you said that it's sort of like a trend to talk about it? Do you feel that they are resistant to learn about it or do you feel that-?

R: I don't think they are more or less resistant than the US.

I: Ok.

R: It's usually-, the experience that I have with resistance in the US is probably the same experience that I have here with resistance.

I: Mh.

R: So I don't think it's exclusively South African resistance, there is a general-

I: Global.

R: It's the same thing that there is here and the same contractor against the same answer in the US and even in South Africa.

I: Ok, ok and do you feel that not specifically relating to lean but you can talk about this, do you feel that the industry requires culture change to improve the industry?

R: Yes uhm I don't think there is another way, I don't think more computers and more engineers is going to change the industry. I think we have to change the culture where I also mean in giving an example, we are proud of expensive buildings and lean culture is a change of expensive buildings. So our culture is derived with how many zeros we add to the

project and you know, you can have 50 more engineers and add more zeros and still not be innovating.

I: Yeah.

R: So yes the culture must change if we are looking for new ways features.

I: Ok and I understand what you are saying there.

R: Yeah you are probably right to down there.

I: Yeah, uhm I am actually at the last section now. So throughout the questions that I have asked you I have picked one certain topic which is previously relating to human attitude, financials, education training awareness, management, our government, the current state of our industry. I want to know from you are there any other barriers that you strongly believe that affect the successful implementation of lean construction or actually people being knowledgeable about it? I am just looking to barriers as to why lean construction is-

R: Yeah the one that we haven't discussed is that because we don't have lost of African Application it's hard for people to buy into it because we have so few African stories about lean and they are so far in between, I think that's the major obstacle. We don't need big projects to be successful; it doesn't need more projects to try it.

I: Yes.

R: So if more projects at any scale because that's another comment to resisting, there's people saying that lean only applies on big jobs.

I: Yeah.

R: Uhm and that's a huge fallacy or perception problem, does it make sense?

I: Yeah but I want to know that-, I understand that you are saying that the projects are quite seldom that implementing lean, why do you think that is the case? Why are we not implementing it in more projects?

R: We don't know people who have experienced it.

I: Ok, ok.

R: Very few people who-, ok so this is how lean usually comes across a person's career path, as usual it goes on a project.

I: Yeah.

R: Typically, I mean I am not saying-

I: No for sure.

R: It's almost 100%, a project is being a project just like a how a project is a dream moving. And that's how people get educated on it, so usually when you are learning about this you are typically maybe-, it's into your career and learning about it. So I think that is why people-, we don't have people in the country who can speak from first time experience.

I: Yes.

R: Than operating it in the space, if we have people in the country who have operated in lean they are typically operating at an international level and the product will be on an international continent or somewhere else.

I: Somewhere else in the world, yeah.

R: Yeah so because we don't have practitioners it's not part of our organization.

I: Ok and what are your suggestions to possibly overcome this barrier of-, this barrier that you stated about few and far between projects? How do you think that South Africa as a big industry can actually overcome this barrier?

R: They should-, my recommendation is design experiments and talk about is.

I: Ok.

R: Do experiments on the job and share with your learning, because we don't have a conversation we don't have the experiments we can revert to and work from. So if I were any practitioner or any part of the supply chain would-, I am financing right though the electrician I would say if I lead an experiment ad share it with the industry.

I: Ok and my last question to you is what strategies if any could actually contribute to improving the quality and delivery of our projects in South Africa?

R: Sorry someone just called me, could you please repeat the question.

I: No problem. Uhm the last question is what strategies if any could actually contribute to improving the delivery and quality of our construction projects in South Africa?

R: Yeah so I think on the work force side doing the nominatal things like understanding waste and participating waste in the nation, that's learning improve that anyone can do and anyone can learn about.

I: Yeah.

R: On the project articulation side target cost delivery and target of designing site is a must in, easy to learn easy to learn relatively speaking and they also can be quickly applied and tested. And procurement I think in the private sector there is a lot of experiments that are happening quickly to change procurement practices such as the whole talk every process has competitive dialogue and that's how they select people for a job. So that is-, I mean most allow having fruitiness, the private sector is going through. Another thing is to get really good and proper bin, right South Africa is using them, the information management as a fancier fruity program.

I: Yes.

R: We are really immature and using it's full data of capacity this is a private sector where we are hanging fruits from both financing and project graphic emotion and where to be, end. And the private sector really invests in what Bim can do for them, regardless of lean.

I: Yeah.

R: They'll get much more efficiency in what they can do.

I: So also just to expand on that when I spoke to Mr. Monyane he also mentioned the same thing and I also gave him the same-, well we have discussed an organization which is quite a big international organization. They are having a Bim dry for the past few years and I understand that if you are not fully understanding and implementing the full capability of its data and how to use it, you are just using a fancy tool and bluffing everyone one that-

R: Yeah I see that every day, I walk into my finance office and I see verdicts. And I understand 'oh great are you a Bim company?' and they are like yes we are. And I say ok can you pull, up the Bim report, how is the Bin execution plan and how are you doing?

I: Yeah.

R: And none of that exists in their worlds, I means that's-, I would walk into any office right how and I am sure I am going to see it.

I: Yeah I think some of the guys don't actually understand that it's not actually about the software; it's actually how you can be sustainable and less wasteful and actually at the end of the day you are just trying to prove the efficiency of what you are doing by the full capability of-, from let's say it.

R: Yes the industry right now is using Bim as a production tool for drawing.

I: Yes, yes.

R: And I hardly hear them probably mention instrument.

END

8.6.6 Interviewee F

START

I: What is your work experience and how many years of experience do you have?

R: I have been working as a quantity surveyor in the construction industry as well as in the academic for more than 10 years

I: What is your current responsibility in your business or projects that you work on?

R: Quantity surveyor

I: What is your current position in your company and age (if comfortable with giving age)?

R: Senior Quantity Surveyor / Senior Lecturer

I: Are you familiar with lean construction concepts/ ideas? If so, which concepts are you familiar with?

R: Yes, Just-in-time, visual design construction, document management, etc

I: If you had to rate your knowledge of lean construction concepts and principles (1 = no knowledge and 10 = fully knowledgeable), how would you rate your knowledge on the topic?

R: 8

I: Throughout your experience, would you say that the colleagues you have worked with are familiar with lean construction concepts and principles? Please briefly explain.

R: Yes they are familiar with the practice just that they do not call it lean construction as a practice

I: In your opinion, how would you describe the current state of the South African construction industry?

R: The industry is still developing and as such, a lot of concepts like lean construction are necessary to help improve construction project performance

I: In your opinion, how would you describe your perception of the productivity OF South African construction projects?

R: There has been an increase in the performance and productivity of SA construction industry although some problems like cost overrun, time overrun, still persists

I: In your opinion, could/ has the implementation of lean construction principles improve/d productivity in construction projects? Please briefly explain.

R: Yes, depending on whether they are adopting the principle and the extent of adoption

I: In your opinion, what occurrences/ issues negatively impact the delivery and performance of construction projects in South Africa?

R: Insufficient knowledge of construction professionals, inadequate government legislation to support effective construction, lack of adoption of ICT tools, etc.

I: In your opinion, what role has the South African government played in developing OR deterring the CURRENT state of the construction industry? Please briefly explain.

R: The government has been doing a lot especially through the cidb. There is a need for continuous development of industry experts including the labourers and construction professionals

I: In your opinion, do you think that the South African government has developed policies and protocols to support the implementation of lean construction principles?

R: I do not think so, there are other principles like value management, project management, risk management, etc. and the government can not support all the principles at the same time

I: In your opinion, has management in your organisation set very high, sometimes unreasonable expectations of projects?

R: Yes

I: In your opinion, do you believe that your organisation and other similar organisation in the industry, is committed to develop and implement an effective plan and resources to support and manage the implementation of lean construction principles?

R: Not really, there is still a low level of awareness of the practice and as such, it is difficult to support and manage the implementation

I: Throughout your professional experience and the projects that stand out for you, do you believe that middle and higher management could have added more value to improve the success of projects? Please briefly explain.

R: Yes, since all decisions are ratified and approved by individuals at this level. They are also expected to possess the require knowledge and professional know-how better than the lower management

I: In your opinion, do you feel bodies such as SACPMP and LCI (SA) create sufficient knowledge and awareness about lean construction? Please briefly explain.

R: Not really because there are still a lot of people including construction experts without adequate knowledge of lean management

I: In your opinion, do you think that the South African construction industry suffers from a shortage of technical skills and knowledge regarding lean construction principles? Please briefly explain.

R: Yes, there are few lean experts and most people with lean knowledge are researchers with interest in other areas

I: Has there been any formal lean construction training throughout your organisation?

R: No

I: Has your organisation's management been for any formal lean construction training?

R: No

I: If you answered no to any of the above questions, do you feel that any training would improve awareness and successful implementation of the lean principles in your organisation?

R: Yes

I: In your opinion, do consultants, contractors and clients adequately invest financially to educate and implement lean construction techniques on their projects? Please briefly explain.

R: I do not think so, it is difficult for them to invest when they are not adequately aware of the practice and its benefits. People will only invest if they are sure of return which I doubt they believe lean management can help with

I: Do you think they SHOULD invest more in educating and implementing lean construction principles?

R: Yes

I: Do you think they CAN invest more in educating and implementing lean construction principles?

R: Yes

I: In your opinion, do you feel there is a misconception or lack of understanding of what lean construction is? Please briefly explain.

R: Yes, most just see it another concept concerned with just waste management. Others sees it as a project management exercise while few sees it as part of them management approaches like value management.

I: In your opinion, do you feel that there is a resistance, in industry, to implement lean construction techniques? Please briefly explain.

R: Not really, just that there are so many principles already in use and it will be a bit difficult to implement a new one when the existing ones have not been fully implemented.

I: In your opinion, do you feel that the industry requires a culture change to improve the industry?

R: Yes, but individual, corporate and organisational culture should be improved

I: Are there any other barriers that you strongly believe that affect the successful implementation of lean construction principles?

R: Yes

I: If you answered yes to the above question, what are your suggestions to overcome these barriers?

R: Awareness among construction experts, government legislation backing its implementation, research and training on ways to improve construction performance using lean principles, incorporating lean management to other existing construction management activities, etc.

I: What strategies, if any, could contribute to improve the delivery and quality of construction projects in South Africa?

R: Training and research, linkage and collaboration between town and gown, readiness of clients to adopt same, awareness of the principles by construction stakeholders, etc.

END

8.6.7 Interviewee G

START

I: What is your work experience and how many years of experience do you have?

R: Project Manager Spent 8 year at McKinsey capital projects (minning, oil and gas). more than 20 years' experience. Chemical engineering.

I: What is your current responsibility in your business or projects that you work on?

R: I am a partner, tactical optimisation, lean construction and operations.

I: What is your current position in your company and age (if comfortable with giving age)?

R: 39

I: Are you familiar with lean construction concepts/ ideas? If so, which concepts are you familiar with?

R: Integrated planning, big part of our capital productivity work.

I: If you had to rate your knowledge of lean construction concepts and principles (1 = no knowledge and 10 = fully knowledgeable), how would you rate your knowledge on the topic?

R: 9

I: Throughout your experience, would you say that the colleagues you have worked with are familiar with lean construction concepts and principles? Please briefly explain.

R: Ya, I think the term lean, everyone is familiar with but there isn't a consistent understanding of what it is and how to apply it. So everybody had read about lean in theory but not how to implement.

I: In your opinion, how would you describe the current state of the South African construction industry?

R: Its in a very bad state, you can just look in the news. There are very few construction companies that are profitable in the current environment. There order books are in a very bad shape. There are the very big construction companies who are struggling and there is a mid-tier who are comfortable. This trend is not just South Africa.

I: In your opinion, how would you describe your perception of the productivity OF South African construction projects?

R: Productivity is low, we are definitely under the benchmark of 40%. Sometime under 20%.

I: In your opinion, could/ has the implementation of lean construction principles improve/d productivity in construction projects? Please briefly explain.

R: When we apply consistently and apply it properly, there is massive improvements. One example is when a projects productivity went up by 300%.

I: In your opinion, what occurrences/ issues negatively impact the delivery and performance of construction projects in South Africa?

R: There is a lot of factors. The level of contractors is not always meeting the minimum bar, the level of planning and risk management is not in place, upfront engineering quality Is not done to the correct degree. With the owners, there are the same issues. There is labour challenges. There is a multilayer factors that affect the projects.

I: In your opinion, what role has the South African government played in developing OR deterring the CURRENT state of the construction industry? Please briefly explain.

R: Definitely negative. My reason for that is that there isn't enough focus on creating the right skills with universities, trade skills not doing enough. The whole BEE requirements, a lot of EPC companies can't get government. When we force collaborative contracting, this does not work.

I: In your opinion, do you think that the South African government has developed policies and protocols to support the implementation of lean construction principles?

R: No.

I: In your opinion, has management in your organisation set very high, sometimes unreasonable expectations of projects?

R: There is always unrealistic expectations set. There is not enough investment upfront. The projects are always starting on a back foot.

I: In your opinion, do you believe that your organisation and other similar organisation in the industry, is committed to develop and implement an effective plan and resources to support and manage the implementation of lean construction principles?

R: I don't think the clients we work with are doing enough. You can't do it as a project in the side, its either part of your company or not.

I: Throughout your professional experience and the projects that stand out for you, do you believe that middle and higher management could have added more value to improve the success of projects? Please briefly explain.

R: Yes

I: In your opinion, do you feel bodies such as SACPMP and LCI (SA) create sufficient knowledge and awareness about lean construction? Please briefly explain.

R: First thing, there is a lot of knowledge out there. I don't think there is a lack of knowledge. The problem is how to apply. It doesn't help if the owner doesn't know and the contractor implements. The whole body needs to know. Not sufficient at all if I compare to the UK.

I: In your opinion, do you think that the South African construction industry suffers from a shortage of technical skills and knowledge regarding lean construction principles? Please briefly explain.

R: Yes definitely.

I: Has there been any formal lean construction training throughout your organisation?

R: Most have had some element on training.

Has your organisation's management been for any formal lean construction training?

R: Some ya, most not.

I: If you answered no to any of the above questions, do you feel that any training would improve awareness and successful implementation of the lean principles in your organisation?

R: Quality training is key, application is key. Knowledge is there so implementation is key. Lean is a way of life, its not just a process.

I: In your opinion, do consultants, contractors and clients adequately invest financially to educate and implement lean construction techniques on their projects? Please briefly explain.

R: No, definitely not.

I: Do you think they SHOULD invest more in educating and implementing lean construction principles?

R: Yes definitely. The world is digitalising, so it will be required quite a bit of investment.

I: Do you think they CAN invest more in educating and implementing lean construction principles?

R: The reality is you cannot afford not to invest. Companies need to invest to stay alive.

I: In your opinion, do you feel there is a misconception or lack of understanding of what lean construction is? Please briefly explain.

R: I don't think its misunderstanding of what it is, it's a misunderstanding on how to apply it.

I: In your opinion, do you feel that there is a resistance, in industry, to implement lean construction techniques? Please briefly explain.

R: I think there will always be resistance. You are asking people to change the way they have done things forever and now you are asking them to change.

I: In your opinion, do you feel that the industry requires a culture change to improve the industry?

R: Yes definitely.

I: Are there any other barriers that you strongly believe that affect the successful implementation of lean construction principles?

R: Mindset is critical. If you don't have the right measurement, it's very difficult to apply lean properly and if you don't have the right performance management. The contracts are never clear on exactly what's required in terms of reporting, performance management and progress.

I: If you answered yes to the above question, what are your suggestions to overcome these barriers?

R: It starts with right level of education throughout your contract, from the contractors to the owners. There needs to be a proper procurement process.

I: What strategies, if any, could contribute to improve the delivery and quality of construction projects in South Africa?

R: I think what we have consistently see is that the owners need to take a more active role in their projects.

END

8.7 Appendix G: Analysis

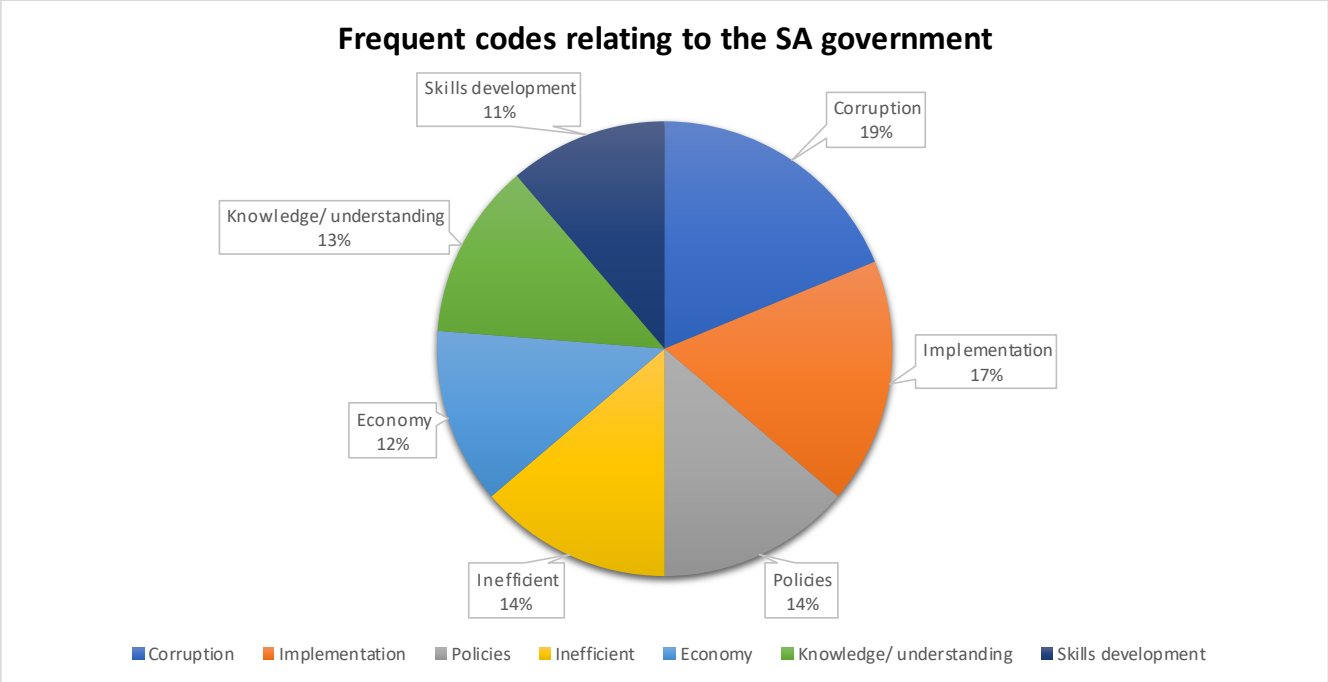
Interviewees colleagues and client's knowledge on lean construction

Yes	3
Partly	1
No	4

Government

Code	A	B	C	D	E	F	G	H	Frequency	Interviewees	Rank
Corruption			6		4	2	1	2	15	5	1
knowledge and understanding	1	2	1	3	2		1		10	6	4
Policies	1	2	2	2	1		1	2	11	6	3
Inefficient	2		1	4	2		2		11	5	3
economy		2		1	2	2	1	2	10	6	4
implementation	2	1		6		3	2		14	6	2
Unqualified		2	1						3	3	
skills development	2	3		1	1	1	1		9	6	5
BEE			1				1		2	2	
Apartheid		2	1		2				5	3	
Social development		3			2				5	2	
Infrastructure development		2			1		1		4	3	
Labour unions/ issues		1			1	1		1	4	3	
Innovation				2	1				3	2	
Procurement				2	4				6	2	

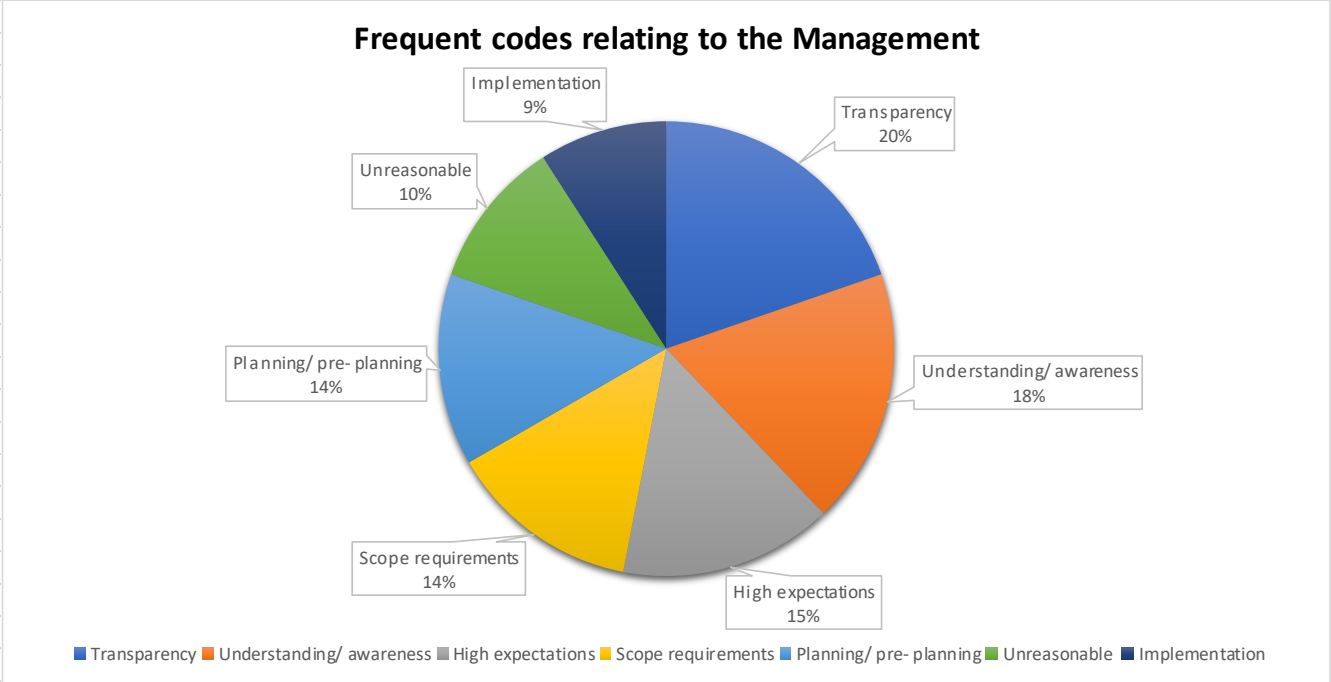
Top 7 codes	Frequency
Corruption	15
Implementation	14
Policies	11
Inefficient	11
Economy	10
Knowledge/ understanding	10
Skills development	9



Management

Code	A	B	C	D	E	F	G	H	Frequency	Interviewees	Rank
High expectations	3	1		2		1	2	1	10	6	3
Excellence/ achievements	3								3	1	
leadership/ responsibility/ accountability	3	1							4	2	
implementation	5					1			6	2	6
understanding and awareness	6	2				2	1	1	12	5	2
margins/ profit/ cost	2		2						4	2	
resources	3								3	1	
value	2								2	1	
transparency	5		1	4			2	1	13	5	1
scope/ requirements		2	2	1		1		3	9	5	4
unreasonable		2		2			2	1	7	4	5
planning/ preplanning		2		2	2		2	1	9	5	4
productivity		2							2	1	
resources		2							2	1	
quality				2					2	1	
technical support					5				5	1	
innovation			2		2				4	2	

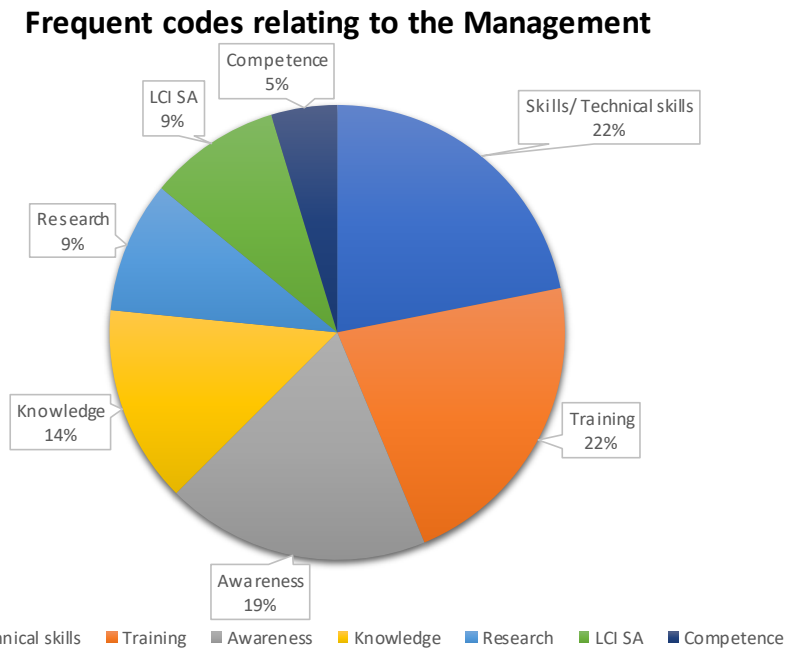
Top 7 codes	Frequency
Transparency	13
Understanding/ awareness	12
High expectations	10
Scope requirements	9
Planning/ pre- planning	9
Unreasonable	7
Implementation	6



Education

Code	A	B	C	D	E	F	G	H	Frequency	Interviewees	Rank
LCI SA	3			2				1	6	3	4
SACPMP	2							1	3	1	
Knowledge	2			1	1	2	2	1	9	6	3
Technical Skills/ Skills	4	2	4	1			2	1	14	6	1
Training		3	2	3	1	2	2	1	14	7	1
Research		1	1			3		1	6	4	4
Competence	2							1	3	2	5
Awarness	2	3		3		3		1	12	5	2

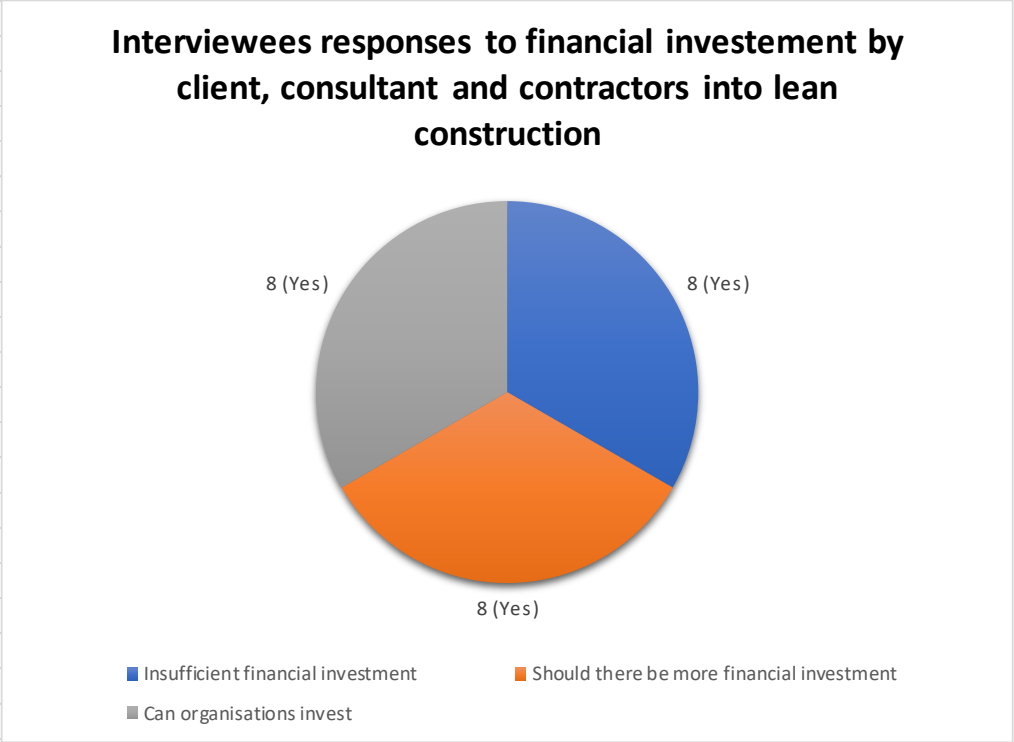
Top 7 codes	Frequency
Skills/ Technical skills	14
Training	14
Awareness	12
Knowledge	9
Research	6
LCI SA	6
Competence	3



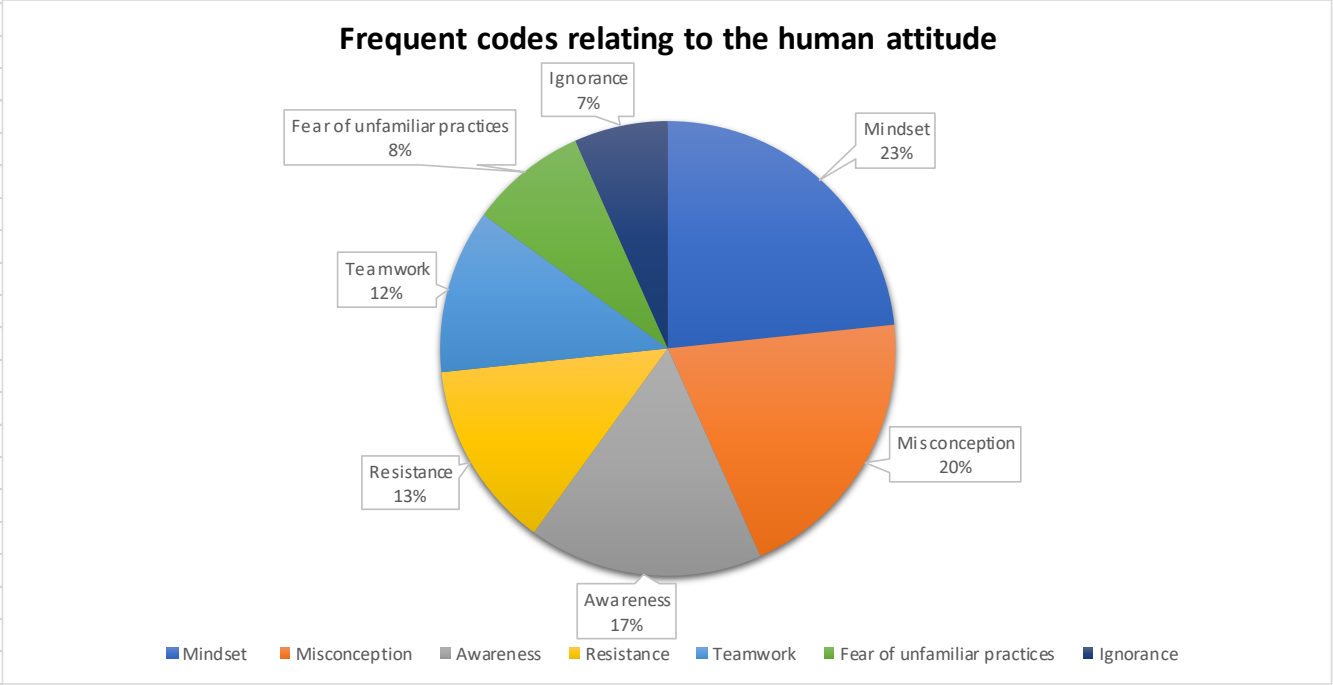
Financial

Interviewee	A	B	C	D	E	F	G	H
Sufficient investment	No	No	No	No	No	No	No	No
Should they	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Can they	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Question	Frequency
Insufficient financial investment	8
Should there be more financial investment	8
Can organisations invest	8



Human attitude

Code	A	B	C	D	E	F	G	H	Frequency	Interviewees	Rank
Mindset	6		2	2			2	2	14	5	1
teamwork/ group work	4	1					2		7	3	5
misconceptions	4		1	1	3	1	1	1	12	7	2
understanding and awareness	6	2	1	1					10	4	3
self-criticism	2								2		
resistance		1	3	2			1	1	8	5	4
irrational		1							1		
fear of unfamiliar practices			1		1	1		2	5	4	6
ignorance			1	1				2	4	3	7

Top 7 codes	Frequency
Mindset	14
Misconception	12
Awareness	10
Resistance	8
Teamwork	7
Fear of unfamiliar practices	5
Ignorance	4