A framework to implement lean six sigma in selected large non-manufacturing South African companies

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DECLARATION

I, Lotshi Dube, declare that this research report is my own unaided work, except as indicated in the requirements, the text and the references. It is being submitted in partial fulfillment of the requirements for the degree *Doctor Philosophiae* in Business Administration at the Potchefstroom Campus of the North-West University, Potchefstroom, South Africa. It has not been submitted before, in whole, or part for any degree or examination at any other institute.

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ABSTRACT

Baring some limited exceptions, all large non-manufacturing organisations want to improve quality together with reducing costs, and the deployment and implementation of continuous improvement methodologies is commonly viewed as a daunting and sometimes even an impossible undertaking. Many organisations and their leadership fail to properly structure or support continuous improvement initiatives incorporating customer centricity, which ultimately doom them to failure. Business performance excellence programmes enables firms to provide a mechanism to identify and eliminate operational waste; enhance customer experience; and systematically increase profits. Thus, performance excellence has become a key indicator of a firm's ability to achieve sustained profitability and competitiveness.

This study has led to the development of a theoretical framework for effectively implementing and deploying an appropriately adapted Lean Six Sigma (LSS) in large non-manufacturing companies. It also creates a better understanding of the impact that an adopted Lean Six Sigma can have on the success of large non-manufacturing companies, and establish how effectively such organisations can implement the revised methodology, as measured against the said theoretical framework, thus to be able to make recommendations on how they can reduce cost, optimise their performance and become customer centric.

A literature survey was done on Lean, Six-sigma and Lean Six Sigma to evaluate the history, benefits, and challenges during implementation, applicability to services oriented industries and the defining of the critical success factors required for effective implementation.The conceptual background from the literature review identified the research gap on which a theoretical framework for non-manufacturing companies was developed. Field-based interviews were conducted with the relevant senior personnel of four large non-manufacturing companies in order to complete the structured questionnaires to provide the data for understanding the mechanisms by which Lean Six Sigma deployment is addressed in the organisations. Fieldwork consisted of interviews with directors, senior executives, line managers and other staff that have in-depth knowledge of their organisation's Lean Six Sigma deployment activities. These personnel members were selected on the basis of their direct decision-making and

long-term involvement in their organisations' continuous improvement activities throughout the assessment, negotiation and implementation phases.

Detailed research on each organisation's Lean Six Sigma activities preceded every interview. The interviews themselves were highly structured, and focused on the specific organisation's Lean Six Sigma challenges on implementation and deployment of the method. The questionnaire was designed around the key factors needed in order to successfully manage Lean Six Sigma deployment challenges, as identified by theory and case studies and to test the degree of conformance to these theories by the four non-manufacturing companies. The findings in this study proves that, South African non-manufacturing companies are not adopting Lean Six Sigma to the point where it is going to make any sort of significant difference to the bottom line over a significantly meaningful period of time, judging from the statistical analysis from the survey results presented.

The proposed framework provides for clearly defining the project infrastructure and methodology before the Lean Six Sigma project begins. This clearly helps to gain funding to embark on the projects, and will be helpful in any non-manufacturing company that must justify, as most do, how they spend the capital budget. The detailed cost/benefit analysis created during the implementation phase provides for the ability to gain funding for the implementation activities.

People used to think of customer-centricity programmes mostly in terms of Customer Relations Management systems. Therefore, this research proposed a framework for management, supported by technology to become customer centric in a holistic manner. Many projects need not begin with any major technical investments. What matters more is a sustained focus on the financial goal and the transformation effort required to achieve that goal. Profitable Lean Six Sigma companies focus not only on integrating customer centricity into the organisation, but on ensuring that the entire "ecosystem" of the business - stakeholders, along with organisational processes, and structures - are aligned in ways that support Lean Six Sigma and customer-centric growth strategy.

Key words: Six sigma, non-manufacturing, Lean Six Sigma, CRM

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ABBREVIATIONS

5S	Sort, Straighten, Shine, Standardise, Sustain.
6Ms	Machines, Methods, Materials, Measurements, Manpower, Mother Nature.
AQL	Acceptable Quality Level
BB	Black Belt
BPO & O	Business Process Outsourcing & off-shoring
CEO	Chief Executive Officer
CI	Continuous Improvement
CRM	Customer Relations Management
CTQ	Critical To Quality
DFLSS	Design for Lean Six Sigma
DMAIC	Define Measure Analyse Improve Control
DPU	Defects Per Unit
DTI	Department of Trade and Industry
GB	Green Belt
GE	General Electrics
JIT	Just In Time
KPIs	Key Performance Indicators
LSS	Lean Six Sigma
MSA	Measurement System Analysis
PBB	Personal Business Banking
PDSA	Plan Do Study Act
PFMEA	Process Failure Mode Effects Analysis
RBC	Royal Bank of Canada
RPN	Risk Priority Number
SITE MAP	Service Improvement for Transactional based Entities MAP
SPC	Statistical Process Control
SPSS	Statistical Package for the Social Science
SS	Six Sigma
TQM	Total Quality Management
TRIZ	Theory of Inventive Problem Solving
UK	United Kingdom

US	United States
VoC	Voice of the Customer

CHAPTER 1

OBJECTIVES AND SCOPE OF THE STUDY

1.1 INTRODUCTION

In today's 21st century marketplace, increased globalisation, constant technological advances and other competitive pressures are accelerating the pace of change that organisational leadership face to remain in business. Managing systems, procedures and processes do not only require effective managerial skills, but also leadership adept at dealing with complexity. Initiating and successfully establishing organisation-wide change requires the sponsorship (inclusive of the acts of taking responsibility and being held accountable) by the leadership.

Organisation-wide change is often associated with the establishment of new or revised processes. The very act of managing a process can bring about improvement. In many instances processes are designed so that most employees can oversee them without management intervention (Knowles, 2012). However, without the support of leadership, the best designed and most improved processes can be meaningless.

It does not take a leader to design processes; small improvements can be made by any individual; however, significant improvements that positively affect organisation-wide performance require higher levels of understanding skills and accountability level. Therefore, managing is a keystone determinant of organisation-wide change. Long cycle times are a symptom of poor manufacturing performance or poor service delivery and high non-value added costs. Manufacturers and non-manufacturing companies such as professional service firms within the call centre industry need to focus on the continuous reduction of all cycle times. Achieving success requires a specific management style that focuses on proactive problem solving, rather than "fire-fighting". In this process, management takes on a coaching role, bringing all their people into the process and supporting them in their efforts to improve productivity, customer satisfaction and profitability. In the contemporary world of manufacturing or professional services, due to enormous competitive forces,

different companies have started to cast about different approaches and practices to improve the quality of their products or services at a reduced cost, create a safe or harmonious and rewarding workplace, and achieve higher levels of customer satisfaction in support of improved financial performance (De Mast, 2006).

During the early ages of manufacturing in the 1900s, manufacturers in the United States of America (US) relied on the practices of mass production and final stage inspection. These practices resulted in increased levels of inventory and rework; the consequence was loss of time and money (Cross & Weiss, 2007). Their Japanese counterparts started introducing low cost products with higher quality. Faced with competition, the US manufacturers had to change their manufacturing strategies to maintain market share. In the 1980s Motorola launched a process improvement methodology and named it Six Sigma. They enjoyed increased customer experience, increased sales, stock valuation rates and more profits. Later, General Electric and Allied Signals followed the footsteps of Motorola and also improved their businesses. On the other hand, the Japanese were practicing Lean manufacturing, concentrating on delivering a high quality product in a reduced lead-time. So, General Electric started using Lean manufacturing concepts to overcome lead-time related problems (Cross & Weiss, 2007).

The integrated approach of Lean and Six Sigma explains the connection between shareholder value establishment and precise advancement in the business and therefore its basic dimension is also applicable to large non-manufacturing companies. Lean Six Sigma supports the realisation of an improved competitive edge than what could be achieved by either Lean or Six Sigma individually (De Mast, 2006). The practice of organising and managing operations has experienced an increased application of universal, systematic patterns of Lean and Six Sigma joint implementation in many organisations. Lean and Six Sigma are recent developments in continuous improvement methodology that have been popularised by several high profile companies such as General Electric in the US and SABMiller in South Africa in the early 2000s.

Leadership in today's organisations face mounting pressure to innovate; yet finding ways to actually enable innovation remains a challenge for most senior management. Top companies with successful track records of innovation, however,

have discovered one possible solution to this challenge. Lean Six Sigma, a relatively well known approach for achieving operational excellence, can, as it turns out, do more than just simply improve processes. Although there is considerable literature available and many blue chip consultant firms like Bain and Co. are involved with Lean Six Sigma, very little authoritative research addresses the practical experiences of companies that have implemented Lean Six Sigma (Guarraia & Schwedel, 2008). Even less information exists on the experiences and practices relating to non-manufacturing companies. The companies which have adopted this approach towards their own organisational excellence such as Toyota and General Electric, have proven that it can help leaders discover opportunities for innovation beyond current operations, to enhance financial performance and create organisations that have an inherent inclination towards continuous innovation and improvement.

The role of continuous improvement within organisations from the first improvement made through the invention of machines that speed up production to empirical or statistical methods to analyse processes, individuals and organisations have pursued improved operating methods which have changed and matured throughout history (Cross & Weiss, 2007). Certain industries, such as hospitality, healthcare and pharmaceuticals, focus the majority of their continuous improvement efforts on maximising the quality of their products and services whilst, on the other hand, for others such as paper and pulp industries continuous improvement is viewed as a mechanism of cutting down costs on which cutting costs and improving quality, successful continuous improvement initiatives ultimately change the culture of an organisation.

Cultural change focuses on the motivation and desire of individuals within the organisation to improve business processes and policies. Deployment and implementation of Lean Six Sigma methodologies are inclusive of both process and polices by leadership on all hierarchical levels of an organisation remains a major challenge which needs investigation and analysis for companies that seek to emulate the success stories of well-respected and ranked companies like Toyota and General Electric. This study seeks to identify which key issues must be incorporated by large non-manufacturing companies in South Africa to successfully

manage or eliminate the barriers and challenges of implementing continuous innovation and improvement initiatives.

Lean Six Sigma which is referred to by its official abbreviation that of LSS throughout this study, has been proved to be successful in large industrial conglomerates that span almost all economic functions such as manufacturing and non-manufacturing divisions of sales, financial services and integrated logistics chains, there remain some misconceptions about LSSs applicable to non-manufacturing companies. Some companies believe that only manufacturing organisations can benefit from LSS initiatives. Therefore part of the unique contribution of this study is derived from a systematic literature study that examines how the implementation of LSS could bring value to large non-manufacturing organisations and make a specific contribution through various recommendations to enhancing their operational excellence incorporating the customer experience and emotions.

Different organisational factors which have importance in the implementation process are thoroughly analysed. The study also considers some critical points that impede the implementation of LSS enhancement required within the non-manufacturing environment and the conclusions are drawn upon considering an adopted LSS as a business system, which ultimately change the way these organisations operate in order to achieve and maintain competitive advantage.

1.2 BACKGROUND TO THE STUDY

Key competitive business strategies include both achieving lower cost and adding value through differentiation (Porter, 1980). One important way in which competitive performance may be achieved is through the combination of Lean and Six Sigma. The strategy can be used both to differentiate products and services and to obtain lower costs through enhanced productivity and the elimination of waste. An important question for leadership in non-manufacturing organisations is-: 'What are the most appropriate way and method to improve taking into consideration the customer experience and emotions?' Both incremental improvement and innovation are valuable operational strategies to gain and maintain competitive advantage in the global market (Hammer, 2005; Prajogo & Sohal, 2001; Hamel, 2001).

Much of today's emphasis is on breakthrough improvement:- through developing and using new technology (Sower & Fair, 2005), however, incremental innovation, providing improvement from existing technology, is still the main improvement activity for many companies. In order to retain a leading position in the current competitive global environment, any company which aspires to achieve world-class performance must continuously improve key performance objectives such as cost, quality, productivity, flexibility, innovation and the customer experience (Slack & Lewis, 2002). Both incremental improvement and radical innovation must be undertaken simultaneously in the current fast moving era (Conti *et al*., 2003; Hamel, 2001; Brown *et al*., 2000). Key elements within a continuous improvement suggest a possible framework for Lean Six Sigma to incorporate four elements as follows:

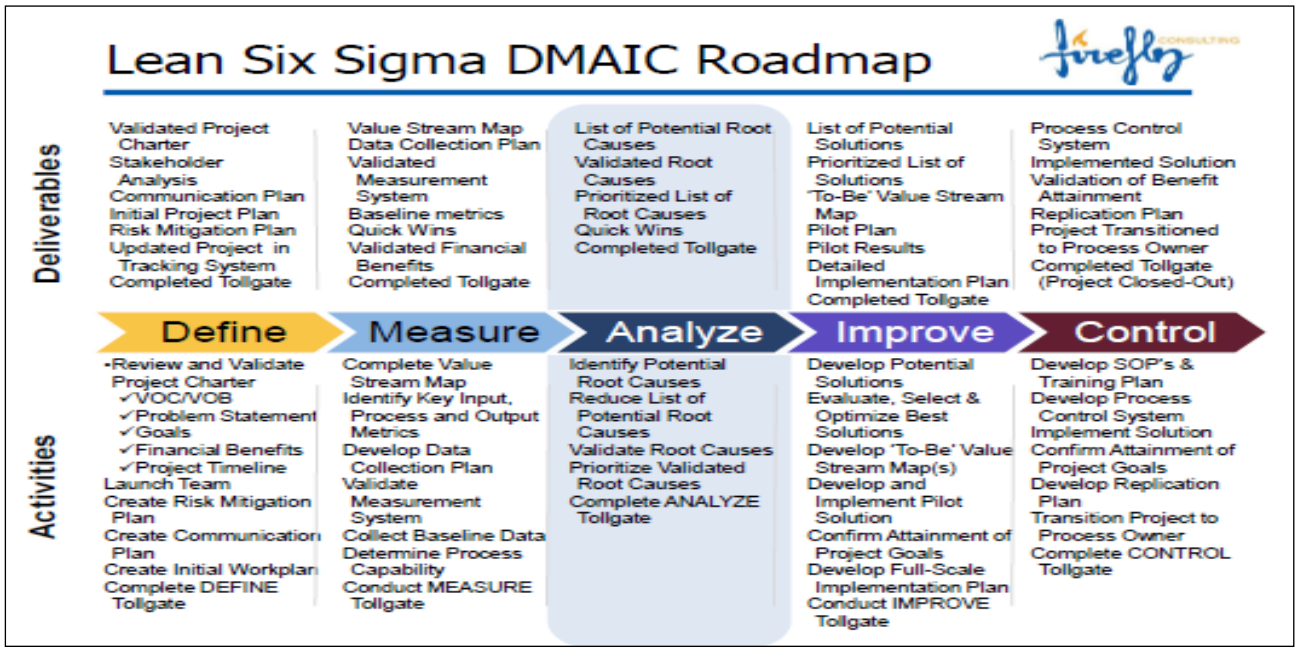
1. *Organisation structure:* – The organisational infrastructure is based on Six Sigma. This means that Lean Six Sigma uses a project organisation consisting of BBs, GBs and Champions. Moreover, the Lean Six Sigma initiative is managed as a program and the project training and training program are also copied from the Six Sigma approach.

2. *Methodology:* – The stepwise strategy for the projects of Six Sigma is used, containing the DMAIC (Define, Measure, Analyse, Improve, and Control) model in phases (Figure 1.1). Each of the DMAIC phases is broken down in two steps. For each step, a list of the end terms (the deliverable of the step) is defined and a prescription in which format these should be documented is provided (De Mast, 2006). Note that this Lean Six Sigma methodology contains only eight steps instead of the traditional 12 steps of the Six Sigma methodology. The reason for selecting the eight steps is mainly due to the fact that some steps do not add substantive value in a non-manufacturing environment. The Lean analysis tools and standard improvement models are embedded in this project approach, which offers an analysis of the project goals (Define and Measure phases), a diagnosis of the current process (Measure phase) and a good anchoring of the solutions (Control phase).

3. *Tools and techniques:* – In Lean Six Sigma, the toolboxes of both Six Sigma and Lean are combined. Lean typically offers simple tools without much mathematical refinement. These tools are easy to apply and are effective in solving commonly encountered problems in the processes. The tools and techniques are incorporated in the stepwise strategy and help the BBs and GBs to attain intermediate results. Thus, one will find the value stream map as one of the tools used in DMAIC 3 (Diagnose the current process) and many of the standard solutions that Lean offers, in DMAIC 6 (Design improvement actions) and DMAIC 7 (Improve process control) (De Koning & De Mast, 2006).

4. *Concepts and classifications:* – The concepts and classifications of both approaches are combined. From Six Sigma, terms such as CTQ and influence factors are taken, whereas Lean provides concepts such as take time, critical path and waste.

Figure 1.1: DMAIC model



Source: Firefly consulting (2011)

Moreover, these elements do not address the challenges within the non-manufacturing environment completely and requires the addition of a fifth element as follows:

5. *Customer experience and emotions (customer centricity):-* Customers are now expecting offerings and communications to be aligned to their needs, preferences and lifestyles. Customers, because of the ever changing environment, are now aware that they can get what they want. These changes are creating challenges as customers are made to adapt to changing conditions. This will definitely impact customer preferences, as they are bound to react to the value added offerings from other service providers within the same industry. Customers have become demanding and their loyalties are diffused. Companies interested in earning their customers' loyalty through delightful customer experiences should focus on delivering a customised and value added solution first before attempting to delight their customers with bells and whistles. To meet customer expectations, you have to be able to see what you have and know exactly where it is located across all supply chain channels. When a customer buys an item online and wants to pick it up in the store, or wants it shipped for next day delivery, system wide visibility is critical.

Once organisations achieve a level of success with Lean Six Sigma, it is not unusual to want to expand the benefits to include the other departments and/or processes and procedures with, for example, the development of new products and services. The solution for many companies is to augment the improvement program with Design for Lean Six Sigma (DFLSS). This methodology focuses on designing products correctly from its inception. With DFLSS, design teams get the correct information they need to make good decisions early that lead to big savings later. By benchmarking multiple organisations that have continuous improvement programs, it is possible to discover best practices as well as common pitfalls. For many senior managers it is surprisingly difficult to implement a lean system (Holweg, 2007). The explanation for this paradox is that lean and quality approaches require a fundamentally different philosophy of management than the traditional mass production approach.

According to Womack and Jones (2003), to transform into a lean organisation, a company needs three types of leaders as follows.

1. Someone who is committed to the business for the long run and can be the anchor that will provide stability and continuity – someone who is also considered an experienced employee with a long history within the organisation.
2. Someone with deep knowledge about lean techniques that is, a lean specialist.
3. Someone who can be considered the "champion" and be held accountable, also who will be senior enough and has the requisite qualities to challenge the status quo in order to establish dramatic change in the organisational operations.

In this regard, it is important to consider the study undertaken by Czabke, Hansen and Doolen (2008) which reports the results of "lean leaders" in four cases of Lean Sigma investigated across the US and Germany – secondary wood industries. A multiple case study design approach was performed in order to identify the challenges of implementation processes as well as the subsequent successes thereof. The key challenge faced by the leaders of these four companies with implementation of "lean" methods was reported to be with the communication of the vision and values of lean thinking to all of their employees. This underscores some of the challenges faced by organisations with the implementation and the importance of the role of effective leadership from the onset.

In addition hereto, because of the unique environment of non-manufacturing organisations, a fourth type of leader can be identified as essential for the successful implementation of an adopted LSS.

4. According to Northouse (2004) and Botha (2009), a transformational leader is able to leave their imprint on entire organisations, and even impact on an entire culture. DuBrin (2004) tasks the transformational leader with the immense responsibility of completely overhauling the culture of a business and states that a leader has eight roles to play as the transformation-agent:
    i. Raising awareness of individuals
    ii. Assisting individuals to look beyond self-interest
    iii. Helping people understand the need for change
    iv. Creating a sense of urgency amongst managers
    v. Committing to greatness

vi. Assisting individuals in their search for self-fulfilment
vii. Adopting a long-range perspective and simultaneously observing organisational issues from a broader perspective
viii. Establishing trust

In support of the attainment of the primary objective, these eight steps can be used as an analytical tool to determine whether the organisation under study, can motivate its workforce to “move the organisation to the next S-curve” (Botha, 2009).

1.3 PROBLEM STATEMENT

Baring some limited exceptions, all large non-manufacturing organisations want to improve quality together with reducing costs, and the deployment and implementation of continuous improvement methodologies is commonly viewed as a daunting and sometimes even an impossible undertaking. Many organisations and their leadership fail to properly structure or support continuous improvement initiatives incorporating the customer centricity, which ultimately doom them to failure. Business performance excellence programs enable firms to provide a mechanism to identify and eliminate operational waste; enhance customer experience; and systematically increase profits. Thus, performance excellence has become a key indicator of a firm’s ability to achieve sustained profitability and competitiveness. However, while the prevalence of such programs is increasing in today’s marketplace over two thirds of such programs fail to succeed (Cross & Weiss, 2007). Successful design and deployment of a new program requires a comprehensive understanding of where the program will be active; how these activities will be completed; what differentiators will be leveraged; and what staging and pacing will be utilised. These program facets represent five key elements of strategy, commonly referred to as the Business Strategy Diamond (Carpenter & Sanders, 2009).

Without a clear understanding of the program strategy, a firm is at risk for not having the required infrastructure to support the new program. Additional risk includes the

inability to communicate the program's mission; prioritise program tasks; and marshal resources appropriately.

Meaningful impact from processes can only be realised when end-to-end processes are taken up for improvement. Given the size and complexity of processes, this is often not easy in a non-manufacturing organisation. For example, there could be processes in non-manufacturing companies that not only cut across functional silos but also geographies. Managing such a large process for improvements is not easy because it not only requires integrating a large number of improvements across all the sub-processes but also engaging teams in various functional silos. This study seeks to identify which key issues must be incorporated to successfully manage or eliminate the barriers and challenges of implementing continuous improvement initiatives with the establishment of a framework that can be adopted by non-manufacturing organisations.

1.4 EXPECTED OUTPUTS AND BENEFITS OF THE STUDY

The main aim of the study is to develop a theoretical framework for effectively implementing and deploying an appropriately adopted Lean Six Sigma (LSS) in large non-manufacturing companies.

A secondary aim is to realise a better understanding of the impact that an adopted Lean Six Sigma can have on the success of large non-manufacturing companies, and to establish how effectively such organisations can implement the revised methodology, as measured against the said theoretical framework, thus to be able to make recommendations on how organisations can reduce cost and optimise its performance.

The study will provide the following three benefits.

- The formulation of a theoretical framework for implementing and deployment of an appropriately adopted Lean Six Sigma that incorporates the most recent theory and research suitable for this environment.
- Provision of empirical evidence on how a selected number of large non-manufacturing companies in South Africa are currently implementing continuous improvement initiatives.

- Provision of recommendations for non-manufacturing companies in order to successfully improve performance by utilising the ideal theoretical framework which incorporates the latest research suitable for this environment.

1.5 RESEARCH OBJECTIVES

One primary and five secondary research objectives have been identified for this study.

1.5.1 Primary objective

The primary objective of the study is to investigate and develop a theoretical framework for implementation of an adopted Lean Six Sigma in large non-manufacturing companies in South Africa.

1.5.2 Secondary objectives

The following five secondary objectives will support the researcher in the attainment of the primary objective.

1. Discussion from literature, on the high failure rate and problems associated with implementation of Lean Six Sigma.
2. Delineating Lean Six Sigma and analysing various methods and approaches that have been developed by leading scholars on the subject.
3. Identification of the reasons for Lean Six Sigma implementation failure and analysing the importance of effective implementation in order to understand the impact it has on organisational and financial effectiveness on non-manufacturing companies.
4. Investigating the current methods being implemented by non-manufacturing organisations and evaluating its respective compliance or adherence with an ideal theoretical framework.
5. Making recommendations regarding methodology required, in order to maximise their performance by complying with an ideal theoretical framework for effectively implementing an adopted Lean Six Sigma by non-manufacturing companies.

1.6 HYPOTHESIS

The research problem was translated into hypotheses. Hypotheses assist the researcher in providing answers to the research problem. In this study a hypothesis is set to test the relevance and necessity of large non-manufacturing companies to augment their current continuous improvement methodologies, to meet the criteria of the ideal theoretical framework to be developed.

The hypotheses for this study are the following:

Ho (Null hypothesis). Current continuous improvement methods within non-manufacturing companies do not incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are not performing optimally.

Ha (Alternative hypothesis). Current continuous improvement methods within large non-manufacturing companies incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are performing optimally.

1.7 RESEARCH METHODOLOGY

In this study the following research methods will be followed:

A literature study was completed and thereafter an empirical study, by utilising questionnaires completed through personal interviews.

The research is divided into three phases as follows.

Phase 1

Identifying and developing a theoretical framework for implementation and deployment of an adopted Lean Six Sigma in four preselected large non-manufacturing companies in South Africa, based on the most authoritative theory and recent research.

Phase 2

Undertaking qualitative, in-depth interviews to identify the respondents and complete the questionnaire for data collection. The empirical study consists of a structured questionnaire, as the basis for interviews with relevant personnel only within these selected large non-manufacturing companies; hence the sample size is limited to 100 respondents. Phase two will investigate and identify the four non-manufacturing companies' philosophy and current Lean Six Sigma models for continuous improvement.

Phase 3

This phase will analyse and discuss the research findings and make recommendations regarding the steps required towards implementing the theoretical framework. The objective is to formulate specific change leadership or transformation management tasks to be performed so as to ultimately comply with the ideal theoretical framework. The empirical study consists of a questionnaire, as the basis for interviews with relevant personnel only within these selected non-manufacturing companies; hence the sample size is limited to 100 respondents. The research study will utilise the descriptive method. A descriptive research intends to present facts concerning the nature and status of a situation, as it exists at the time of the study and to describe present conditions, events or systems based on the impressions or reactions of the respondents of the research and the questionnaire will have a 5-point Likert Scale, as well as ranking questions. A chi-square hypothesis testing method tested the relevance and necessity of non-manufacturing companies to augment their current continuous improvement methodologies, to meet the criteria of the ideal theoretical framework to be developed.

1.7.1 Empirical research

The empirical investigation was conducted to gather information and data on the current Lean Six Sigma initiatives and shortcomings in place for continuous improvement within the selected four large non-manufacturing companies. Large companies, defined by the Department of Trade and Industry (DTI) as those with

annual turnover exceeding R35 million. The business can either be privately or publicly held.

Field-based interviews were conducted with the relevant senior personnel of four large non-manufacturing companies in order to complete the structured questionnaires to provide the data for understanding the mechanisms by which Lean Six Sigma deployment is addressed in the organisations. Fieldwork consisted of interviews with directors, senior executives, line managers and other staff that have in-depth knowledge of their organisation's Lean Six Sigma deployment activities. These personnel members were selected on the basis of their direct decision-making and long-term involvement in their organisations' continuous improvement activities throughout the assessment, negotiation and implementation phases.

Detailed research on each organisation's existing Lean Six Sigma activities preceded every interview. The interviews per se were highly structured, and focused on the specific organisation's Lean Six Sigma challenges on implementation and deployment of the method. Questions in the questionnaire were designed around the key factors needed in order to successfully manage Lean Six Sigma deployment challenges, as identified by theory and case studies and to test the degree of conformance to these theories by the four non-manufacturing companies.

In this study, no independent variables would be introduced (Hair *et al.*, 2000:289). The respondents' level of knowledge, exposure and experience of current Lean Six Sigma management practices in the four non-manufacturing companies would be the only dependent variables in the data. Variables in this study were therefore not of any significance and the one-way tabulation technique was judged most appropriate (Hair *et al.*, 2000:504).

The hypothesis testing was solved by using the Chi Square Testing technique. This is a statistical test which consists of three different types of analysis 1) Goodness of fit, 2) Test for Homogeneity, 3) Test of Independence.

The Test for Goodness of fit determines if the sample under analysis was drawn from a population that follows some specified distribution.

The Test for Homogeneity answers the proposition that several populations are homogeneous with respect to some characteristic.

The Test for Independence (one of the most frequent uses of Chi Square) is for testing the null hypothesis that two criteria of classification, when applied to a population of subjects, are independent. If these are not independent then there is an association between the two criteria.

1.7.2 Literature study

A comprehensive study was undertaken to identify the most important sources. These sources have been carefully studied, evaluated and compared in order to determine the true meanings and values of the relevant information of the sources. A literature study was also compiled on the relevant subject of study, so as to provide a better insight into the research problem and the necessary background to guide the empirical part of the study. Apart from the information obtained from textbooks, other sources were consulted in order to obtain the information needed for this particular study. Sources such as journal articles, magazines and the internet were consulted. Statistics and other relevant information were also used during the study.

1.8 DEMARCATIONS AND LIMITATIONS OF THE STUDY

This study specifically focuses on the challenges leading to failure of implementation and deployment of Lean Six Sigma methodologies and associated shortcomings by the four preselected large non-manufacturing companies. The empirical portion of this study specifically focuses on these non-manufacturing companies' specific environments and their philosophy and approach to managing Lean Six Sigma implementation and deployment. The empirical study consists of a structured questionnaire, as the basis for interviews with relevant senior personnel only within these selected non-manufacturing companies; hence the sample size is limited to 100 respondents thus not necessarily allowing the data and recommendations to be extrapolated to encompass all firms. However, the important contribution made by this study is the provision of a theoretical framework to advance the knowledge of

LSS approaches within non-manufacturing environments and provide opportunities for further empirical testing and research.

1.9 SUMMARY

Continuous improvement has benefited from the contributions and inventions of both academia and industry. Lean and Six Sigma are recent developments in continuous improvement methodology and have been popularised by several high-profile companies. The success and complementary nature of these methodologies has led to their combination into a single methodology, commonly called Lean Six Sigma or Lean Sigma. Many companies are now turning to Lean Six Sigma to satisfy their need for a structured continuous improvement program to perform optimally. The main research goal is to identify the barriers and challenges that non-manufacturing companies' face during Lean Six Sigma implementation and its shortcomings to develop a theoretical framework for these companies to utilize for implementation to realise optimal results. This research study also contributes to the existing knowledge and understanding of how the non-manufacturing organisations plan and execute Lean Six Sigma initiatives incorporating customer experience. The purpose of the study is to assist the non-manufacturing companies structure a continuous improvement program that mitigates or eliminates the negative effects caused by deployment barriers and implementation challenges with the use of an ideal theoretical framework.

1.10 REFERENCE TECHNIQUES

The Harvard method of source referencing and acknowledgement was used. Footnotes will not appear at the bottom of each page; quotations and references are specified directly after the particular quotation or reference.

1.11 LAYOUT OF THE STUDY

Chapter 1 Overview and structure of the study

This thesis is divided into seven chapters, described as follows:

This chapter one introduces the reader to the research background and defines the research aims and objectives.

Chapter 2 Lean, Six Sigma, and Lean Six Sigma literature study

This chapter reviews the most authoritative literature on LSS (such as the approaches to LSS together with its development and background). It also provides a theoretical background to the research including a study of theories of ideas adoption, operations strategy, and multi-criteria decision-making as espoused in the most recent and authoritative literature.

Chapter 3 Quantitative literature analysis

This chapter reports on the results of a detailed quantitative literature analysis which establishes a conceptual background of a proposed theoretical framework.

Chapter 4 Empirical research design

This chapter analyses the empirical research design and methodology discussed. A set of questionnaires was listed and the theory behind the development discussed. Moreover, it explains the selected case companies and its background.

Chapter 5 Analysis on literature study and the empirical study

This chapter summarises the conceptual background based on the literature study and analysis in chapter four. It further provides an in-depth empirical study of continuous improvement management practices in the different case companies, and explores the reasons and motivations for the adoption, which leads to the development of the decision-aid framework.

Chapter 6 Data analysis and interpretation

In this chapter the results and findings of the empirical research were analysed and discussed. The empirical study consists of a questionnaire, as the basis for interviews with relevant personnel only within these selected non-manufacturing companies; hence the sample size is limited to 100 respondents. The research study utilized the descriptive method. A descriptive research study intends to present facts concerning the nature and status of a situation, as it exists at the time of the study and to describe present conditions, events or systems based on the impressions or reactions of the respondents of the research, and the questionnaire will have a 5-point Likert Scale, as well as ranking questions. A chi-square hypothesis testing technique tested the relevance and necessity of large non-manufacturing companies to augment its current continuous improvement methodologies, to meet the criteria of the ideal theoretical framework to be developed.

Chapter 7 Conclusions and recommendations

From the findings of the empirical study, recommendations were made on how to incorporate the theoretical framework into the current Lean Six Sigma methods by the selected four non-manufacturing companies. Chapter seven concludes the thesis, by discussing the outcome of the research and the contribution to field of knowledge. The limitations of the research are addressed and some suggestions for future research are provided.

CHAPTER 2

LITERATURE STUDY

2.1 CHAPTER OVERVIEW

Chapter one gives an overview of the research study. It provides a history and background to the identified problem; outlines the objectives of the study; provides some key definitions and the delimitation of the study; and, the importance of the study. This chapter forms the foundation of the research effort by reviewing literature on Lean and Six Sigma, respectively. The chapter then reviews the literature on the integrated Lean Six Sigma methodology and customer centricity on which a framework for implementing Lean Six Sigma was developed for the non-manufacturing companies. The non-manufacturing companies use Lean and Six Sigma to cut cost and improve the quality of their products and services. These companies are also using customer centricity initiatives separately from their Lean Six Sigma initiatives to focus on the user experience combined with relevant variety. The complementary nature of Lean and Six Sigma principles has led these companies to merge the two into a single process and quality improvement method. The current focus of the literature is centred on why these two should be integrated. Little research has been done developing, critiquing, or comparing actually deployed and implemented Lean Six Sigma efforts.

2.2 LEAN AND SIX SIGMA DEFINED

Six Sigma – Is both a quality management philosophy and a methodology that focuses on reducing variation, measuring defects and improving the quality of products, processes and services (Furterer, 2011). The concept of Six Sigma was developed by Motorola in the 1980s and popularised by General Electric in the 1990s—refers to a method and set of tools that utilize statistical analysis to measure and improve an organisation's performance, practices, and systems with a prime goal of identifying and eliminating variation to improve quality. Six Sigma became popularized in the late 1990s by General Electric Corporation (hereafter referred to as GE) and their former CEO Jack Welch.

According to Knowles (2012), Six Sigma focuses on quality as a strategic initiative, perhaps most famously in the person of Jack Welch who not only declared that Six Sigma was central to the way he expected GE to do business and based 40% of senior management bonuses on achievement of Six Sigma targets but also required that (as he did) senior management:

- Personally spend time in each Six Sigma training wave talking to candidates and answering their questions.
- Drop in on Six Sigma reviews (held weekly and monthly).
- Make site visits to observe first-hand the integration of Six Sigma into business culture and operations.
- Monitor progress through weekly summary reports and reviews with the Six Sigma implementation team.

By talking in the language of senior management (money) and by requiring hands-on commitment and direct involvement Six Sigma creates a much stronger cultural impact. By creating a governance system that links projects' definitions to strategic goals (rather than just doing what helps in the short term) and by assigning a senior management 'champion' to every project a good Six Sigma initiative ensures that benefits are long-term and strategic rather than short-term and tactical (Knowles, 2012).

The Six Sigma method recognises the value of customers to the organisation and focuses on creating value for the customer (Furterer, 2011). Six Sigma initiatives which focus on cost reduction miss the point that:- what delivers long-term profitability is happy customers, even more so than lower costs. A good Six Sigma project focuses long-term rather than just short-term financial gain (Anderson et al., 2006).

One of the key aspects of Six Sigma is that it moves an organisation towards managing with facts and data; too often in the past things have been done on the whim of a leader. The heart of Six Sigma is in the scientific method as exemplified by

the practical model, provided by Process Management International (Gillet & Seddon, 2009).

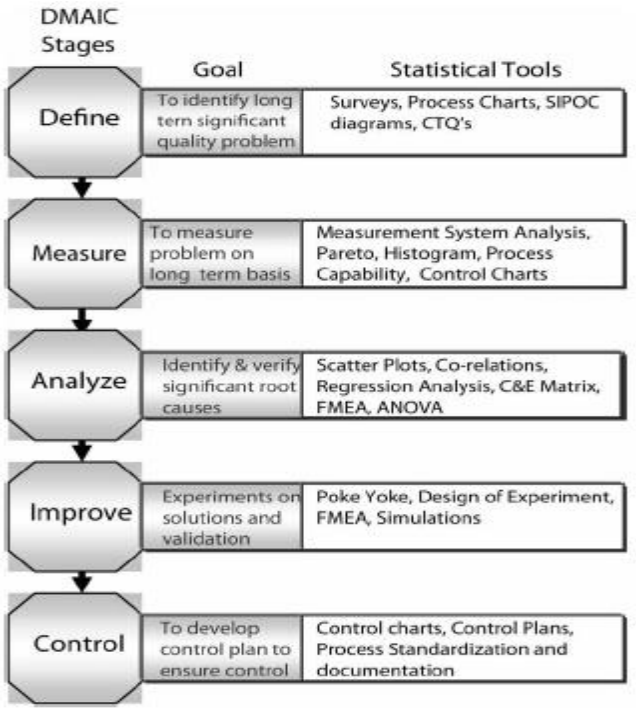
Gillet and Seddon (2009) elaborate that we need to begin a goal and have a clear understanding of how it can be achieved; then develop a plan as to how the goal might be achieved; the plan needs to be enacted and the results (good and bad) observed. The analysis of these results (and our understanding of these causes) then leads us to act to modify our original plan, which brings us back to the start of the cycle and a test to see if we have achieved our goal before restarting the wheel if required. Six Sigma works under two data-driven methodologies and one deployment approach (Nonthaleerak & Hendry, 2006) and they are well known as DMAIC and DFSS.

DMAIC is an acronym covering five phases of the implementation process: Define, Measure, Analyze, Improve, and Control, and is applied for a current process or an existing product/service performance. Meanwhile, Design for Six Sigma (DFSS) is used to develop a new product or process. These methods rely on the use of approximately 140 statistical tools and concepts to achieve particular tasks/targets in each phase of a Six Sigma project (Bendell, 2006).

The Six Sigma program is deployed through a project-by-project basis by the introduction of a structured/hierarchical system of improvement specialists with various roles (Bendell, 2006). For example, the title of “Champion” is given to the top senior leader who is responsible for success of whole Six Sigma projects. Each Six Sigma project is led by full-time improvement engineers or managers titled “Master Black Belts”, “Black Belts” or part-time improvers who often work as technical analysts and supervisors referred to as “Green Belts”. Each belt level is given appropriate training that provides a level of knowledge and skills, given the scope of that belt’s level or responsibility, scope of work, and specific targets. Six Sigma provides statistical and other analytical tools to process complex problems with the help of DMAIC Methodology (Figure 2.1). It usually requires sophisticated software like Minitab or SPSS (Furterer, 2011). However, if these tools are not properly learnt by all concerned, the abilities to solve and analyse problems remain limited. This

means the core competence of managers needs to be upgraded on statistical and analytical tools, as well as abilities to use statistical software (Furterer, 2011).

Figure 2.1: DMAIC process, goals and usual tools



Source: (Moosa & Sajid, 2010)

Schroeder, Linderman, Liedtke and Choo (2008) and Zu, Fredendall and Douglas (2008) support the contention that Six Sigma uses a structured method. Schroeder et al. (2008) suggest this approach is one of the four elements of the Six Sigma definition. Zu et al. (2008) identify and empirically verify that Six Sigma's structured improvement procedure is one of the key three practices which are critical for implementing Six Sigma in organisations. The structured method, DMAIC, provides companies with a *Meta routine* to follow in order to solve problems and improve processes (Schroeder et al., 2008). In alignment with these ideas, Zu et al. (2008) argue that the Six Sigma structured improvement procedures provide teams with a methodological framework to guide them in the conduct of improvement projects**.**

Six Sigma places emphasis on integrating specific tools into each step of the method, which makes Six Sigma unique (Schroeder et al., 2008). Further, DMAIC involves different specialists and organisational members at different steps in the

method. Schroeder et al. (2008) emphasise that there is greater clarity regarding the role and scope of work in each step with DMAIC than within the structures of other quality management methods.

Typical areas for improvement in the new product development process include communication, resource allocation and prioritisation, change of priorities and objectives, quality assurance, and cost management (Hemphill & Bradley, 2010).

DFLSS offers an opportunity to evaluate the existing process, streamline areas of redundancy and add a stronger toolkit where needed. DFLSS also drives value by making the design of the product itself Lean (Hemphill & Bradley, 2010). DFLSS techniques include:

- Using mistake-proofing concepts to make a product impossible to misuse.
- Minimising the complexity of the product's bill of materials.
- Replicating design concepts to minimise product complexity across the product portfolio.
- Using customisation techniques to lock in design options late in the process.
- *Target costing*, a method for aligning product costs with the functions that provides the most value to the customer.

Finally, the product should be designed so that when it transitions to production, it can be produced with Lean best practices. DFLSS emphasises Design for Manufacture and Assembly, a series of tools for designing a product that is easy to manufacture. A significant percentage of the overall life cycle costs of the products are locked in early in development, so having the right tools to design products that are less expensive to manufacture is critical (Hemphill & Bradley, 2010). Design for Manufacture and Assembly compares costs of different materials and manufacturing methods, estimates difficulty of assembly, and eliminates unnecessary parts and tooling.

Statistics in this process will involve collecting, processing, and then presenting data in an understandable form. Statistical analysis provides techniques and tools for studying variation and patterns by examining data samples to estimate

characteristics of the phenomena. More often, managers are not even trained on the application of basic statistics resulting in their insufficient capabilities to analyse and infer data effectively (Moosa & Sajid, 2010).Those who adopt Six Sigma, generate a data-driven management style and make use of elementary to medium level applied statistics in all business function units. Green belts are those who are trained to a basic level of techniques while black belts are trained on the advance level of applied statistics (Moosa & Sajid, 2010). Two types of statistics are addressed in problem solving: (1) descriptive statistics; (2) inferential statistics.

Descriptive statistics is used for summarising and characterising data. It provides quantitative measure of the characteristics (such as the average and standard deviation) of sample data. It has useful application in almost all areas where quantitative data are collected. It can provide information about the product, process or some other aspect of the QMS, and may be used in management reviews, for example summarising key measures of product specs, describing process performance, characterising delivery time or response rate, and displaying distribution. It usually includes the use of mean, median, mode, variance, standard deviation, process capability index, different types of distributions and control charts.

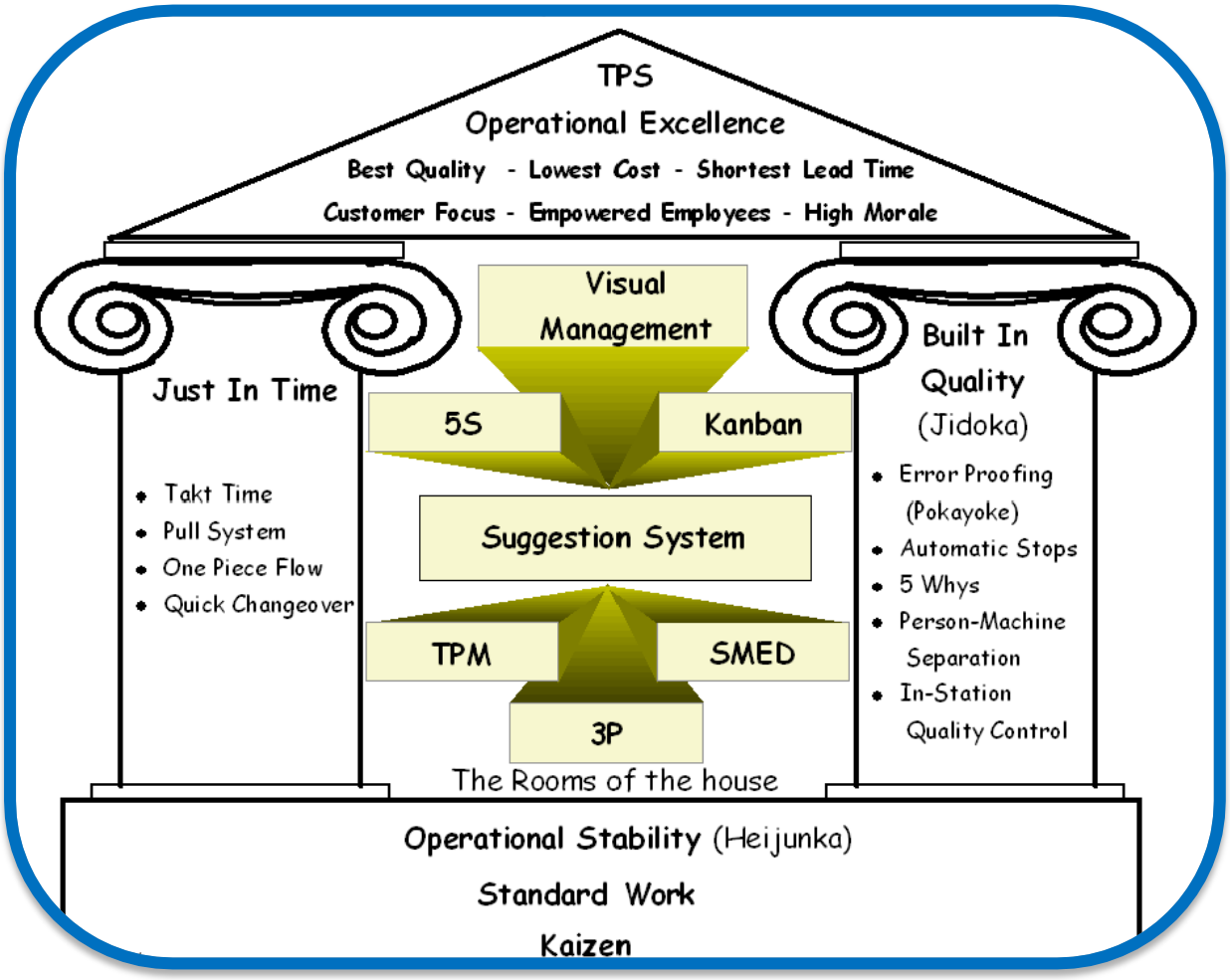
On the other hand, inferential statistics is about studying the sample (customer feedback, employees' feedback, process data, experimental data) and then interpreting results about the whole phenomenon or data (long-term process). It also aims to explore the relationships (associations), especially causal relations, followed by their validation (Moosa & Sajid, 2010). Six Sigma extensively utilises these techniques, such as sampling techniques, probabilities, test of hypothesis, analysis of variance, correlation, regression analysis, and design of experiments. These techniques, if taught to managers, raise the level of their analytical capabilities tremendously. Six Sigma includes the investigation of causal relations in complex systems through the use of these statistical techniques.

Lean—historically referred to as Lean manufacturing—refers to the principles and methods of the Toyota Production System (TPS). Lean methods focus on the systematic identification and elimination of non-value added activity (called "waste").The major difference between Ford's production model and TPS was the

shift in focus from individual machines and their operation, to how production flowed across each machine throughout the entire process. By making adjustments, including right-sizing machines for volume, lining them up in process sequence, pioneering small steps to produce small amounts of different part numbers and implementing excellent communication at every handoff, Toyota was able to lower costs, increase variety and improve delivery speed and quality. Over the following decades this system, with various refinements, was adopted by many other Japanese organisations (Duggan, 2013).

In a lean system the emphasis is basically on reducing waste of all types. The emphasis on elimination of waste as well as continuous improvement is combined with a strategic focus of the company over the quality ensuring that the reduction of defects will always be at first place. To accomplish this goal employees are trained into using different methods of hypothetical testing of how to identify problems and search the appropriate solutions for them. They look for sources of variation and wastes; develop ways to eliminate them. Another lean belief (Mefford, 2009) is that the process can be improved further no matter how good it is. Management encourages the workers to think in this direction of continuously searching for better ways of doing things. Lean activities are part of a system, an integrated series of parts with a clearly defined goal with each activity with a clearly defined objective (figure 2.2). These activities are interdependent and each activity fits into the operating system while interacting with each other.

Figure 2.2: House of Lean 1



Source: www.systems2win.com (2014)

The value of the system is without a question for the manufacturing companies having the example of Toyota. Lean was always associated with reduction of cost, eliminating waste, just-in-time (JIT) delivery (The term 'lean' is also regarded 'as the previous name of just-in-time manufacturing (Holweg, 2007).The LEAN approach is intended to have the enterprise think first and foremost about maximising the value that its products and services can bring to the client.

The products and services that are offered must therefore answer to the requirements of the client, be provided at a lower cost, with a higher level of quality and in the shortest delay possible. And to reach this objective, the enterprise must be the most flexible and efficient possible in its operations (Holweg, 2007). This is,

indeed, the ultimate goal of the LEAN approach, a systematic approach consisting in:

- Modelling the enterprise as value streams, eliminating any barrier between departments (the silo effect);
- Identifying and eliminating the waste and inefficiencies in the operations, to maximise the added value;
- Ensuring a continuous flow in the production of products, services and the related information;
    - Produce on demand, in a Just-in-time mode;
    - Standardise and level the workloads;
    - Reduce the lot sizes, and strive for an ideal one-piece flow;
    - Reduce inventories, and strive for an ideal zero inventory and zero WIP (Work-In-Process);
- Make the operations visible, to quickly react and bring the proper corrective actions as may be required by a given situation;
- And lastly, transforming the business culture and aiming at continuous improvement, so that optimising the value provided to the client remains at the heart of each and everyone's concerns.

A certain number of tools have been developed to eliminate Kanbans, 5S and simple visual controls). At the origin of LEAN, the approach has mainly been applied to Manufacturing (Lean Manufacturing). But nowadays, this approach is being diffused to the enterprise as a whole (Lean Enterprise). We then talk, amongst other things, of Lean Office, and, of course, of Lean Engineering and Lean Development.

A clear segregation of duties is essential for successful completion of the desired outcomes of a Lean assessment and capacity model. The following tables summarise tasks, accountabilities and outcomes for a Lean assessment (Table 2.1) and capacity modeling (Table 2.2).

Table 2.1: Lean assessment tasks 1

Lean Assessment Tasks	Responsible Party	Desired Outcome
Identify key business processes Process manager and/or supervisor to complete Review summary for completeness	Process manager	Key business process summary
Identify staff responsibilities Review organisation chart Document staff locations Document key business processes performed by each staff member	Process manager	Staff responsibilities matrix
Identify staff for one-on-one interviews Ensure coverage for key business processes High/low performers Shift coverage	Process manager	Staff responsibilities matrix
Inform staff of the project, its purpose and that they will be contacted for interviews	Process manager or supervisor	Memo or other communication media
Schedule half- or full-day interviews Document schedule Send meeting invitation to interviewees FYI (CC) supervisor and process manager	Project leader	Interview schedule table
Conduct interviews at staff location(s) Document observations and initial recommendations for improvement based on 7 wastes, 5S, best practices and benchmarking Document and validate process steps	Project leader	Walkthrough observations report, capacity model template

Review and validate observations with supervisor, process manager, process owner and sponsor	Project leader	Lean assessment presentation

Source: www.isixsigma.com (2013)

Table 2.2: Capacity modelling tasks 1

Capacity Modelling Tasks	Responsible Party	Desired Outcome
Modify time-study data-collection table as required	Project leader	Time-study data-collection table
Inform staff of purpose for time studies and schedule half- or full-day sessions with the same individuals interviewed during the Lean assessment	Project leader	Interview schedule
Obtain cycle times by task. Obtain 30 samples for each task, if possible	Project leader	Time-study data-collection table
Use statistical tools to determine whether the cycle time data is normal. If normal, use the mean for cycle time, otherwise use the median	Project leader	Statistical software output
Enter the appropriate cycle times into the capacity model template. Create a separate model for each process	Project leader	Capacity model template(s)

Source: www.isixsigma.com (2013)

Shah and Ward (2007) suggest that Lean is not simply just these concepts: waste elimination, continuous improvement, JIT, pull production, Kanban, TQM and employee involvement, but more than this. The authors state that, "*Lean Production is an integrated system composed of highly inter-related elements*" (Shah & Ward,

2007). In addition to this argument, the authors also highlight that implementation of Lean represents itself in multiple facets.
In an attempt to clarify the confusion surrounding the complicated concept of Lean, Shah and Ward (2007) track its historical evolution and developed a conceptual definition.

*"Lean Production is an integrated socio-technical system of which the main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability." (*Shah & Ward*, 2007).*
A multiple case study by Czabke, Hansen & Doolen, 2008) reports results of four case studies of secondary wood manufacturers from Germany and the United States. The results outline three main factors with great importance for the successful Lean implementation.

These are:
1. Communicating the vision of the new initiative at every organisational level
2. Necessary change in the organisational culture
3. Consequently following the new practices and principles.

Most successful change efforts begin when some individuals or some groups start to look hard at a company's competitive situation, market position, technological trends, and financial performance (Kotter, 2007). The vision clarifies the direction in which an organisation needs to move. In more successful transformation efforts, executives use all existing communication channels to broadcast the vision.

The following four essential components for successful implementation are identified, which if thoroughly embedded into one continuous system can create value for creating a lean culture (Mefford, 2009):

- Belief in the new program, that it will work – convincing into the success of the Lean concept.
- Commitment for implementing it from managers.
- Involvement of the whole organisation – employees, resources.
- Patience and long-term view for the results.

What is needed most is that managers should essentially change their philosophy of management. The role of the manager as boss needs to be replaced by allowing the responsibility in the lower levels of the organisation.

There are several tangible and significant benefits to the LEAN approach that include:

- reduction in lead time for the delivery of products and services;
- increase in productivity;
- reduction of inventory levels of and Work-In-Process (of material or intellectual nature, such as information);
- improvement of quality (with a reduction of errors, and of the change orders that often result from these errors);
- increased simplicity of the processes (simplified to maximise the added value);
- lightened document management (with a reduction of paperwork and related procedures);
- and, of course, reduced consumption of resources used in production (raw material, energy, and more).

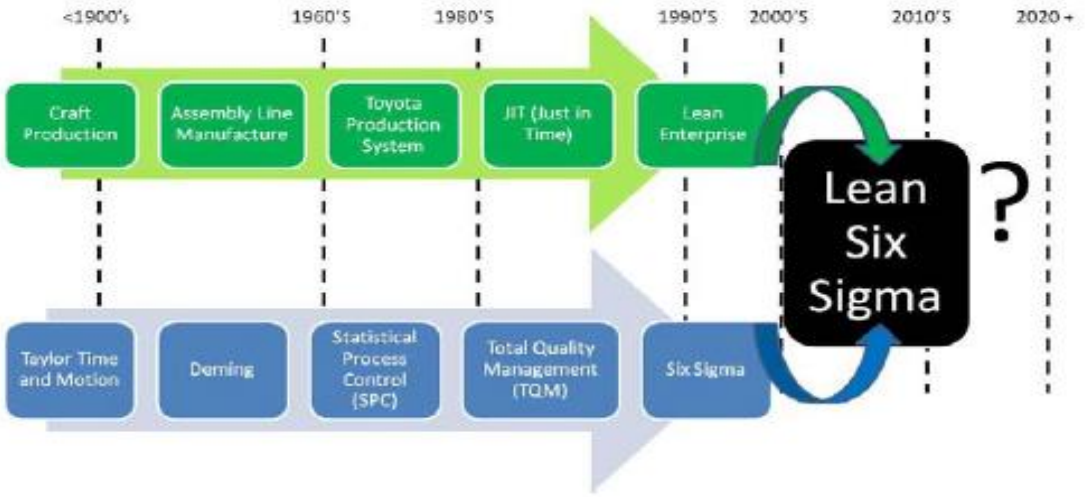
2.3 LEAN SIX SIGMA DEFINED

Lean Six Sigma is an approach focused on improving quality, reducing variation and eliminating waste in an organisation. It is based on the concept of combining two improvement programs, Six Sigma and Lean Enterprise. Mader (2008) is the first peer reviewed article that describes the evolution of Lean Six Sigma in detail, demonstrating and analysing how the separate bodies of knowledge from Six Sigma and Lean are integrated to form Lean Six Sigma. Some commonly used tools include Balanced Scorecard, 5S, AQL, ARL, DPU, FMEA, DMAIC, root cause analysis, Gemba, Theory of Constraints, Total Quality Management, business process reengineering, statistical tools, and innovation tools.

The combination of Lean practices and Six Sigma methodology can lead to superior benefits, including process variation reduction and dramatic business improvement

(Mader, 2008). Lean Six Sigma has evolved during a journey that can be traced back well over a century, according to Antony and Kumar (2011). The family tree, depicted in figure 2.3 clearly demonstrates how Lean Six Sigma followed two completely different paths and only converged in recent years to become what is now the most accepted methodology namely Lean Six Sigma (Antony & Kumar, 2011).

Figure 2.3: Evolution of Lean Six Sigma 1



Source: Antony and Kumar (2011)

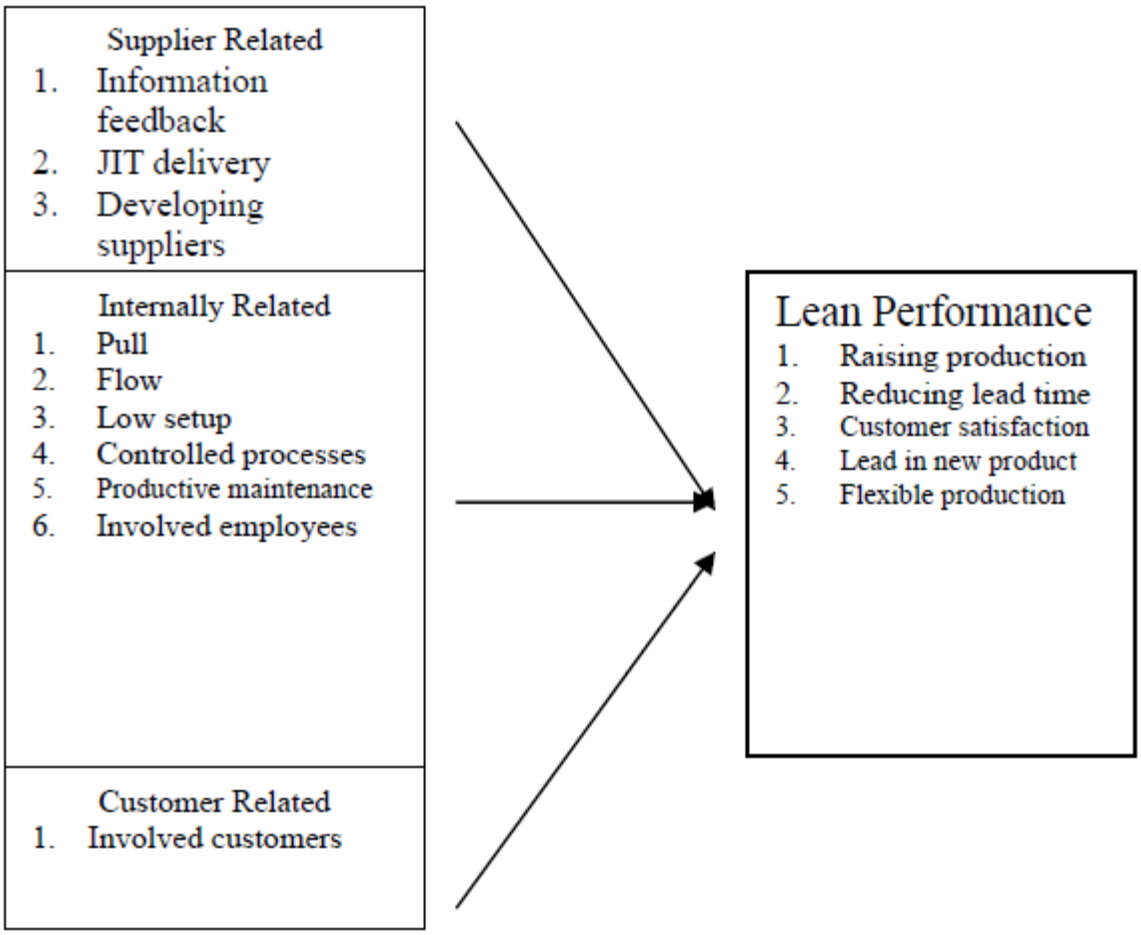
While definitions of Lean and Six Sigma as separate systems are prevalent in academic literature, there is currently a noticeable absence of any theoretically supported definitions of Lean Six Sigma as a distinct approach. Mader (2008) points out that while academics still describe Lean Six Sigma as the underlying key attributes of its two separate components, practitioners perceive Lean Six Sigma as existing in its own right, an integration of the two distinct models (Mader, 2008).

Byrne, Lubowe and Blitz (2007) provide a definition and suggest that both methodologies are more or less equivalent in importance. However, their definition arguably places too much emphasis on the individual characteristics of the two methodologies rather than defining Lean Six Sigma as a synthesis of something that is new.

*“Lean Six Sigma builds on the knowledge, methods and tools derived from decades of operational improvement research and implementation. Lean approaches focus on reducing cost through process optimization. Six Sigma is about meeting customer requirements and stakeholder expectations, and improving quality by measuring and eliminating defects. The Lean Six Sigma approach draws on the philosophies, principles and tools of both. However, Lean Six Sigma’s goal is growth, not just cost-cutting. Its aim is effectiveness, not just efficiency.” (*Bryne et al., 2007).

The research empirically identifies a set of ten main components, which characterise ten distinct, essential dimensions of a Lean system, including *Supplier Feedback, JIT Delivery, Developing Supplier, Involved Customers, Pull, Flow, Low Setup, Controlled Processes, Productive Maintenance,* and *Involved Employees*. The authors also developed a framework (Figure 2.4) to describe the interrelatedness of these ten factors. The components are classified into three main underlying streams of Lean philosophy: supplier, customer related, and internally related construct. The definition involves well-rounded perspectives of Lean systems as including both people and process, both internal and external operational elements.

Figure 2.4: Conceptual and empirical map



Source: Shah and Ward (2007)

The impressive results companies such as Toyota, General Electric, Motorola, and many others have accomplished using either one of the quality systems have inspired many other firms to follow their example. As a result, most companies have either a Lean or Six Sigma program in place. However, using either one of them alone has limitations: Six Sigma will eliminate defects but it will not address the question of how to optimise process flow; and the Lean principles exclude the advanced statistical tools often required to achieve the process capabilities needed to be truly 'lean'.

Therefore, most practitioners consider these two methods as complementing each other. And while each approach can result in dramatic improvement, utilizing both methods simultaneously holds the promise of being able to address all types of process problems with the most appropriate toolkit (Bertels, 2010). For example,

inventory reduction not only requires reducing batch sizes and linking operations by using Lean, but also minimising process variation by utilizing Six Sigma tools.

The merger between Six Sigma and Lean results in a powerful Lean Six Sigma tool, because the strengths from each individual method are secured. Therefore, many firms are looking for an approach that allows the combination of both methodologies into an integrated system or improvement roadmap. However, the differences between the Six Sigma and Lean are profound.

Developing an integrated improvement program that incorporates both Lean and Six Sigma tools requires more than including a few Lean principles in a Six Sigma curriculum or training Lean Experts as Black Belts (Bertels, 2010). An integrated improvement strategy has to take into consideration the differences and use these effectively:

- Lean projects are very tangible, visible, and can oftentimes be completed within a few days (whereas Six Sigma projects typically require a few months). An integrated approach should emphasise Lean projects during the initial phase of the deployment to increase momentum.

- Lean emphasises broad principles coupled with practical recommendations to achieve improvements. For example, Lean suggests a technique to analyse and reduce changeover time that does not require sophisticated analysis and tools. However, Lean principles are oftentimes inadequate to solve some of the more complicated problems that require advanced analysis. Therefore, Six Sigma needs to be introduced during the first year of the deployment to ensure that the improvement roadmap includes a generic problem-solving approach.

- An integrated improvement program needs to be fueled by a vision of the future state and by a pipeline of specific projects that will help close the gap between the current and future state. Lean introduced value stream mapping as the central tool to identify the gaps and to develop a list of projects that can be tackled using Lean or Six Sigma methodology.

Whereas the Six Sigma process and tools can be applied to virtually every process and industry, the Lean approach is much more specific and the content needs to be adjusted to industry needs: For example, reducing set-up time in a plant that has lines dedicated to a single product is pointless. Therefore, the Lean curriculum needs to be adjusted to meet the needs of the specific business.

Training is effective but only when combined with application. Lean principles are typically taught as separate workshops, with each workshop combining a short training session on the principle with direct application on the shop floor. Six Sigma training is broken down into the phases of the DMAIC (Define, Measure, Analyze, Improve, Control) process with time between each training session to apply the tools learned to the project. The extensive analysis required for Six Sigma projects suggests that a workshop structure as used for Lean training would not be effective (Bertels, 2010).

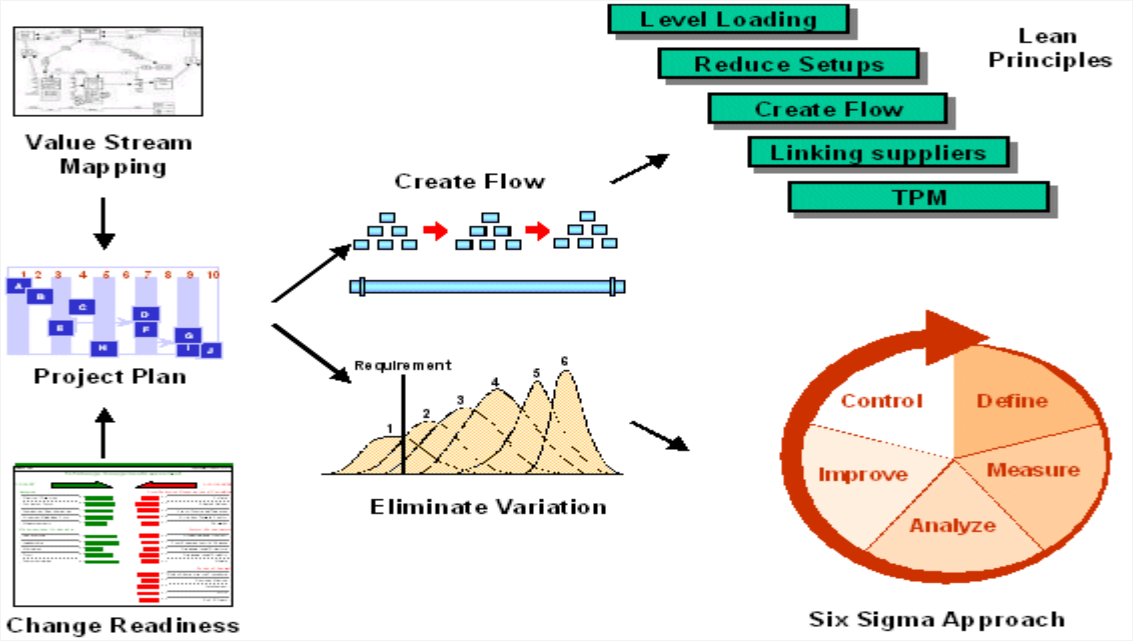
The integrated approach to process improvement (using Lean and Six Sigma) will include:

- Using value stream mapping to develop a pipeline of projects that lend themselves either to applying Six Sigma or Lean tools.
- Teaching Lean principles first to increase momentum, introducing the Six Sigma process later on to tackle the more advanced problems.
- Adjusting the content of the training to the needs of the specific organisation – while some manufacturing locations could benefit from implementing the Lean principles with respect to housekeeping, others will have these basics already in place and will be ready for advanced tools.

The roadmap provides an example for how one could approach the integration of Lean and Six Sigma into a comprehensive roadmap (Figure 2.5).

Figure 2.5: Integrating Lean and Six Sigma

Integrating Lean and Six Sigma Roadmap



Source: Integrating Lean and Six Sigma (Bertels, 2010)

From a training perspective, the Lean principles would be taught first, using the simpler projects identified through the value stream map as training projects for the Lean workshops. A Black Belt therefore would learn how to apply these Lean principles working on a real-life problem. In addition, a Lean Black Belt would complete a large Lean project over the course of the training to become certified. The Six Sigma process will be introduced once the Lean principles have been taught. Again, the training participants would work on one specific project identified by value stream mapping.

As a result, a Lean Black Belt in this example would receive in total 30 days of classroom training, would participate in five Lean workshops, and complete one large Lean and one large Six Sigma project over the course of one year. Such a Black Belt would be capable of applying Lean and Six Sigma tools to a variety of business problems and choosing the appropriate approach to address the problem at hand.

2.4 LEAN SIX SIGMA APPROACHES IN THE LITERATURE

It is evident from the above review that both Lean and Six Sigma can be characterised in terms of its underlying philosophy and a set of practices, tools/techniques, implementation orientation, unit of analysis, and performance measures associated with them. Philosophy is implemented through a set of activities/practices and tools/techniques. The implementation orientation is the focus of how practices and techniques are implemented (Shah, Chandrasekaran & Linderman, 2007).The unit of analysis is where the process improvements take place. And, finally, the performance measures spotlight what is typically improved upon. Both Lean and Six Sigma underscore the value of management and employee involvement to improve performance, but the nature of involvement differs considerably in the two approaches.

Lean is a bottom up approach where management plays a supportive and facilitating role in engaging shop-floor workers to form cross-functional self-directed work teams and apply Lean tools. In Six Sigma management plays a more active role often selecting improvement projects based on financial and strategic goals, and championing and monitoring the improvement projects (Shah et al., 2007). Six Sigma is a deployment approach that uses the improvement specialists and a structured method in its pursuit of variance reduction and achieving higher performance (Schroeder et al., 2008). Lean Six Sigma for non-manufacturing companies is a business improvement methodology that maximises shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital.

The fusion of Lean and Six Sigma improvement methods is required because:

- Lean cannot bring a process under statistical control
- Six Sigma alone cannot dramatically improve process speed or reduce invested capital

George, author of the book, "*Lean Six Sigma for Service*" which was published in 2003, explains that both Lean and Six Sigma enable the reduction of the cost of complexity. Ironically, Six Sigma and Lean have often been regarded as rival

initiatives — Lean enthusiasts noting that Six Sigma pays little attention to anything related to speed and flow, Six Sigma supporters pointing out that Lean fails to address key concepts like customer needs and variation. Both sides are right. Yet these arguments are more often used to advocate choosing one over the other, rather than to support the more logical conclusion that we need to blend Lean and Six Sigma.

Six Sigma:

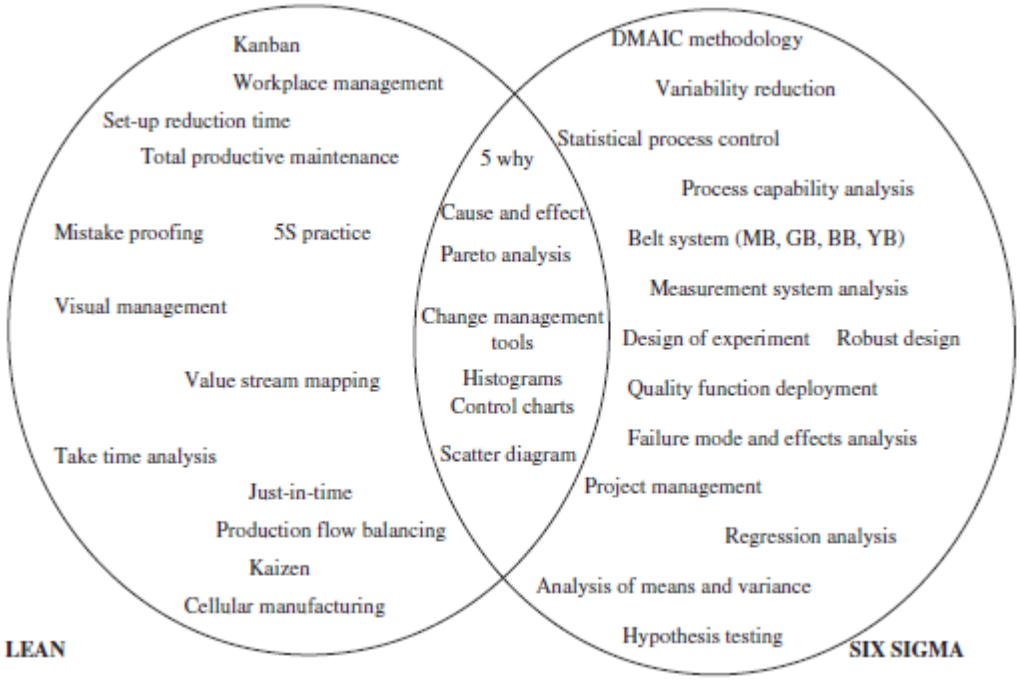
- Emphasises the need to recognise opportunities and eliminate defects as defined by customers
- Recognises that variation hinders our ability to reliably deliver high-quality services
- Requires data-driven decisions and incorporates a comprehensive set of quality tools under a powerful framework for effective problem-solving
- Provides a highly prescriptive cultural infrastructure effective in obtaining sustainable results
- When implemented correctly, promises and delivers $500,000+ of improved operating profit per Black Belt per year (a hard dollar figure many companies consistently achieve)

Lean:

- Focuses on maximising process velocity
- Provides tools for analysing process flow and delay times at each activity in a process
- Centres on the separation of “value-added” from “non-value added”; work with tools to eliminate the root causes of non-value add activities and their cost
- Provides a means for quantifying and eliminating the cost of complexity

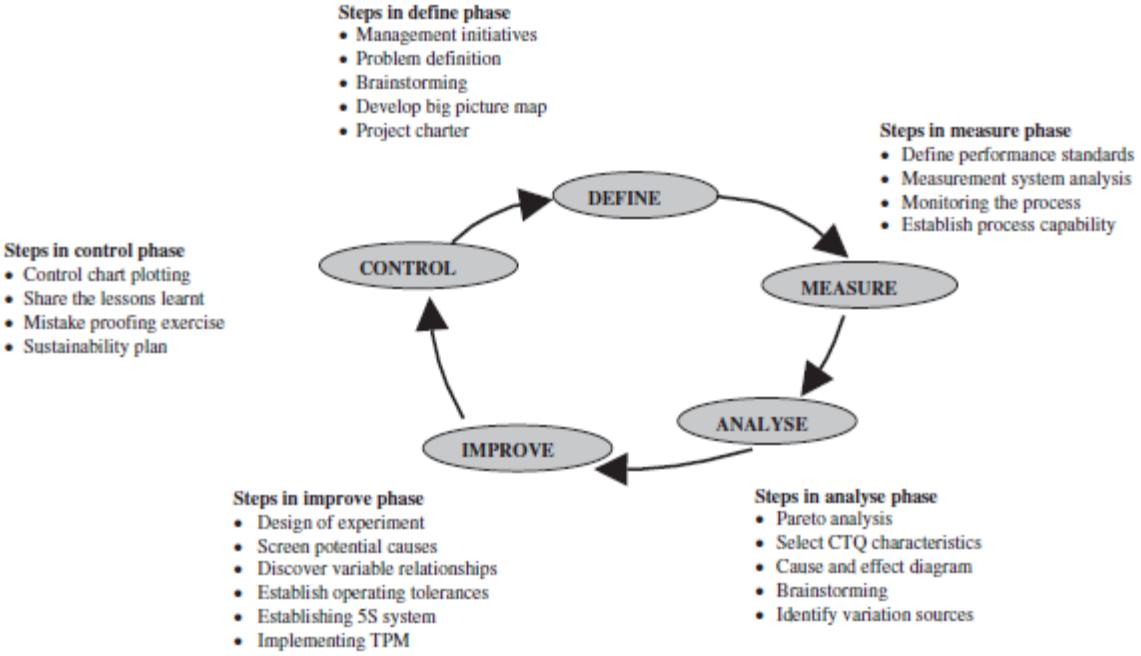
The comprehensive set of tools, techniques and principles that have been employed in the integrated approach of Lean and Six Sigma business strategies are shown in Figure 2.6.

Figure 2.6: Tools and techniques of LSS



Source: Kumar, Antony, Singh, Tiwari & Perry (2006)

Figure 2.7: Lean Six Sigma model



Source: (Kumar, Antony, Singh, Tiwari & Perry, 2006)

The first phase of the LSS model is the ‘define phase’. The purpose of the ‘define phase’ is to clarify the goals and value of a project. The second phase is the ‘measure’ phase where a baseline data is established. The ability to measure the factors critical to customers’ quality and the metrics is also determined (Vinodh, Gautham & Ramiya 2011). These measures are essential to establish the capability and stability of the process. The third phase is the analyse phase in which a thorough data analysis is carried out to narrow down, from the trivial many reasons of a problem occurring to the critical few. The fourth and the most crucial phase is the ‘improve phase’ where upon identifying the root causes, solutions would be generated and tested by piloting it. The last phase is the control phase where the improvements that are identified and implemented would need to be documented and thoroughly captured (Vinodh, Gautham & Ramiya, 2011).

Define phase - The purpose of the define phase is to clarify the goals and value of a project. Teams and champions use those tools necessary to assess the magnitude

of the value opportunity in a given value stream, the resources required and a design of the problem-solving process. In this phase, the main task is to identify who the customer is; select the project area, define the goal, scope and resources of the project, form a project and responsibilities, outline the project objectives, identify the main stakeholders and defines the authority of the project manager. It serves as a reference of authority for the future of the project.

Measure phase - The ability to measure the factors critical to customers' quality and the metrics are also determined. The process in which the problem is occurring or improvement is required would be mapped out in detail and includes time, people and material elements to ensure that the current state is clearly understood. Impact to the factors critical to customers' quality is also established by identifying the key input and output variables. These measures are essential to establish the capability and stability of the process.

Analyze phase- A relationship between the input and output factors is also established. Additionally, activities such as a cause and effect study, Pareto analysis, time and motion analysis and analysis of statistical data will be performed in this stage and the results are expected to assist with the identification of the critical few root causes.

Improve phase - During this phase, team creativity often helps to generate solutions that result in maximum gains. Data collected during this phase are reviewed against the baseline data as a measure of improvement.

Control phase - The improvements that are identified are implemented during the improve phase and needs to be documented and thoroughly captured. A roadmap of solving the problem needs to be established. Implementation plans as well as change management procedures should be developed to ensure the successful transition of the solution to the team that is ultimately responsible for the process. In order to ensure that the action plan is institutionalised, a control plan is worked out.

2.5 APPLICATION OF LEAN SIX SIGMA IN NON-MANUFACTURING COMPANIES

The non-manufacturing corporations mainly deal with customers, suppliers and clients on a routine basis. It encompasses those soft processes that are the driving force behind the production and distribution of every product and service. Part of the soft processes are human centric and each situation is a unique case hence, it requires scientific application to reduce and manage the variances. This necessitates standardisation, as the quantity of automated equipment is less and human resource is greater.

Lean Six Sigma has systematically taken over various sectors of the industry owing to its methodological process variations of working towards achieving targets and eliminating any defects occurring throughout the procedure. Since it aims at providing top class service and works towards being a reliable and valuable enterprise for its customers, it has made an entry into areas such as banking, telecommunications, marketing, insurance, healthcare, software and construction (sixsigmaonline.org).

No matter what the approach is for deploying improvements within the company, having a standard improvement model like DMAIC (Define, Measure, Analyse, Improve, Control) is extremely helpful because it provides the company with an improvement roadmap. There are a lot of resources that describe the DMAIC process. Generally, after the project's definition phase, key process characteristics are identified and benchmarked in the measure and analyse phases; this is then followed by the improve phase where a process is modified for better performance, and the control phase aims at monitoring and sustaining the gains. The basic elements and key tools in LSS DMAIC are as follows.

In the define phase, a team and its sponsors reach agreement on what the project is and what it should accomplish. They should establish some metrics to measure the success of the project, such as customer satisfaction, speed or lead time, sigma level improvement, and financial outcomes. In order to accomplish the objectives of

this step, a tool is used to help in confirming or refining project scope and boundaries.

A common tool is a SIPOC diagram which includes Suppliers, Inputs, Process, Outputs and Customers for creating a high-level map of process:

- Suppliers – the entities that provide whatever is worked on in the process. The supplier may be an outside vendor or another division or a co-worker.
- Inputs – the information or material provided.
- Process – the steps used to transfer (both those that add value and those that do not add value).
- Outputs – the product, service or information being sent to the customer (preferably emphasising critical quality features).
- Customers – the next step in the process, or the final customers. A core principle of LSS is that defects can relate to anything that makes a customer unhappy, such as long lead time, poor quality, or high cost, for instance.

According to Fu-Kwun Wang and Kao-Shan Chen (2010), to address any of these problems, the first step is to take a process view of how the company goes about satisfying a particular customer requirement. In the measure phase, the performance standard of the process is verified and established to obtain a baseline for future improvements. One of the major advances of LSS is its demand for data-driven management. Most other problem-solving methodologies tended to dive from identifying a project into the improve phrase without sufficient data to really understand the underlying causes of the problem (Fu-Kwun Wang & Kao-Shan Chen, 2010). A service that is trying to improve the process will spend a great deal of its time dealing with data problems.

There are a plethora of measure tools that includes everything from data collection to brainstorming methods and prioritising tools. Some of the most common tools are process description tools (value stream maps, process cycle efficiency, and time value analysis), focus/prioritisation tools (FMEA (failure mode and effects analysis), Pareto), data collection, and quantifying and describing variation (control charts).

The purpose of the analyze phase is to make sense of all information and data collection in the measure phase, and to use that data to confirm the source of delays, waste and poor quality.

The most common tools used in the analyze phase are those used to map out and explore cause and effect relationships such as ‘5 Whys’ analysis, cause and effect diagrams, scatter plots, and more. One of the major themes of LSS is that slow processes are expensive processes (Fu-Kwun Wang & Kao-Shan Chen 2010).Value stream mapping analysis is also a key tool for a team to identify the hidden time traps, and to find out the root causes to achieve a substantial increase in value-added time in process.

The purpose of the improve phase is to make changes in a process that will eliminate the defects, waste, costs, and other changes. Common tools are those such as solution matrices that link brainstormed solution alternatives to customer needs and the project purpose (Antony & Kumar, 2011). Many of the Lean tools play their most important role in the improve phase, for instance the pull system, set-up reduction, queuing methods for reducing congestion and delays, and 5s (structurise, systemise, sanitise, standardise and self-discipline). As regards the service industry, in particular the banking service, the above-mentioned tools for the improve phase would be insufficient to solve the problem (Fu-Kwun Wang & Kao-Shan Chen, 2010).

The purpose of the control phase is to make sure that any gains made will be preserved until new knowledge and data show that there is an even better way to operate the process. There are some areas of control that are critical in service environments, such as making sure the improved process is documented, turning results into dollars, ensuring that maintenance of gains is verified down the road, ensuring that an automatic monitoring system is installed which will identify any ‘out of control’ situation, piloting the implementation, and developing a control plan. A control chart is one of the key control tools; mistake prevention and mistake proofing are two other very helpful closely related concepts in the control phase (Fu-Kwun Wang & Kao-Shan Chen, 2010).

However, there are issues with the combined Lean Six Sigma approach which if not resolved can result in unsuccessful implementation (Antony & Kumar, 2011). The first thing to consider, according to the above authors, is the expertise and awareness of the two approaches existing within the organisation and the chosen project team. Personal expertise of Lean Six Sigma implementations has shown that there can be a mix or unbalance of awareness and expertise in Lean and Six Sigma. Therefore there is a possibility that there could be situations where some stakeholders have only used Lean and not Six Sigma and vice versa. This would require a review of the expertise in a given area and additional time and budget may be required to get the team to the same level of knowledge and capability.

Another issue is the lack of clarity of Lean Six Sigma as an approach. Lean has 5 lean principles and Six Sigma has adopted the DMAIC approach, but there is not a specific industry-wide accepted Lean Six Sigma approach (Guarraia, Carey, Corbett & Neuhaus, 2008). What we have in reality is a mix of tailored approaches developed by Lean Six Sigma organisations, consultancy companies or in-house. There is in practice resulting variation in the quality of these bespoke approaches in their principles and application.

Companies that are yielding the biggest gains from Lean Six Sigma are deploying an upfront diagnostic X-ray to help them identify the most critical opportunities, (Guarraia, Carey, Corbett & Neuhaus, 2008). Performed by a small advance team of black belts, the diagnostic X-ray consists of three steps:

Enterprise Value Stream Mapping, in which the X-ray team scans the enterprise and maps its primary processes to identify the biggest opportunities to reduce cost by reducing wasted time and materials.

Benchmarking, in which the performance of processes is measured against internal and external benchmarks to gauge shortcomings and establish improvement targets.

Prioritising, in which the X-ray team determines which process improvements will yield the greatest results when the Lean Six Sigma teams are deployed.

2.6 CUSTOMER CENTRICITY DEFINED

Customer centricity is about understanding the needs of the customer and meeting them or providing an alternative for the customer (Bosworth, 2010). It is an organisation's ability to design products and services based on the needs of a customer. It is when an organisation is customer-focused that issues such as customer dissatisfaction, poor customer service and customer attrition, just to mention a few, are eliminated. According to research done by Interserv Market Research (2010), in South Africa, understanding why customers leave is the first step in building an effective customer retention program. A second step is to identify the customers with a high risk of leaving, which is the task of retention. Predicting customer attrition is challenging work due to the large quantity of data and the difficulty of specifying the right statistical model (Tyrer, 2009). A customer leaving is not caused by a single reason; usually there are multiple reasons and some reasons are:

- Customers no longer need the service
- Migrate to another type of service
- Switch to a competitor for the same service
- Competitor offering a better product or service

Therefore, predicting customer attrition is a challenge hence the need to understand customer-centricity and customer service which form part of understanding what the customer needs and then providing a service or product to meet those needs.

Today's market is characterised by highly competitive markets in all industries that are all vying for customer loyalty (Tyrer, 2009). Strategies are put in place; most of which focus on the customer. Precise understanding of the customer needs can be time consuming as well as difficult. This could involve things like taking a group of customers within the segment and analysing their needs and understanding the trends. It is worth doing for the segment because it enables cost-effective targeting of customers with a product and service offering that matches the needs of the customer.

Royal Bank of Canada (RBC) is one of just a handful international banks that segment customers based on customer needs and not their own. The bank has moved its focus into seeing what opportunities lay in finding what the needs of the customer might be so they can offer them additional products and get them to a point where they are making some return.

Corporate culture and the environment are important in motivating for the organisation to become customer centric (Gulati & Oldroyd, 2010). The culture of an organisation aids in demonstrating how leaders internally demonstrate their commitment to customer centricity, how companies ensure that each contact with the customer is made with warmth and appropriate intimacy and individual responsibility in the different areas in an organisation in resolving customer complaints. Leadership is a critical role in driving the needs of the customer. According to Gulati and Oldroyd (2010), effective leadership is thinking through the organisation's mission and defining it then clearly and visibly establishing it. It is the leader who sets the goals and priorities with total clarity. Likewise it is up to the leader to define and maintain standards. A company must agree on one definition for customer centricity, although consistent characteristics are found among best practise organisations. It is important to understand that top management commitment is such a key aspect of a culture of customer commitment that it needs a great deal of focus.

Organisations are seen to be unaware of human buying behaviour. The main focus is selling and closing deals. Organisations need to step back and realise that their selling process does not provide a positive buying experience. According to Bosworth (2010) in the book titled Customer Centric Selling, positioning of the product to the consumer is a critical factor in ensuring that the right customers are targeted. Customers do not want to be told what they need to buy. It is important to ask the customer questions so as to understand the customer as well as allow the customer to draw their own conclusions about what they need. Features for the benefit of the research are the attributes of the product. Features include size (Bosworth, 2010).

It is critical that customers have a shared mission. Hill, Roche and Allen (2007) in their book titled *Customer Satisfaction* state, "For companies without a shared

mission, CEOs will continue to lose sleep knowing that the forecast consists of the opinions of sellers who each developed their own interpretation of what they are selling rather than selling with a shared mission." (Hill, Roche & Allen, 2007). Amazon's mission is to be "the earth's most customer-centric organisation". Amazon's CEO Bezos says that customer centricity involves "starting with the mind of customers and working backward in the supply chain" (2010).

Every aspect of an offering to a customer is driven by the needs of potential customers. The starting point always has to be the customer. The rationale to the approach that Amazon uses is that there is no point spending research and development funds developing products and services that potential customer will not need. Despite much fanfare about exotic designs of customer experiences, customers are still seeking companies that solve their entire issue rather than just a portion of the problem. Retail is all about the customer experience. For retailers going beyond brick-and-mortar into the virtual world, it's no longer just about the in-store experience, (retailcustomerexperience.com.) It is about an end-to-end experience that begins whenever and wherever the customer orders: in the store, on a smart phone, on the store's e-commerce site. The overlooked—and maybe the most important—part of the experience is flawless fulfilment. Insufficient service will drive away customers. At the same time, adding more service personnel can be costly. The right balance is defined in part by the culture of your organisation (the value placed on quality customer service), the financial impact of turning customers away, and the cost to improve the queuing system and realising consumers' emotions.

According to Tyrer (2009) from Customer Relationship Management at Accenture South Africa, high performance organisations deliver an end-to-end experience that reflects a holistic, multidimensional view of the customer rather than internal systems and organisational complexity – they see their business through the customer's eyes.

- High performance businesses create customer loyalty by delivering a customer experience differentiated (highly relevant) to the needs and intentions of specific customer segments and consistent with the promise of the brand.

- They design experiences that reflect a deep understanding of what satisfies and frustrates specific customer segments and consider multiple customer values – timeliness, reliability and convenience as well as price – rather than focusing on one element such as price at the expense of the others. They execute these experiences consistently across customer channels and touch points.
- High performance businesses understand the full cost of serving the customers they have, acquiring those they want and the lifetime value of these relationships and align their investment in retention and acquisition accordingly.

Being customer focused in any organisation is a journey. The attempt by organisations to move from the product-centric view by creating silos based on the products that are offered to the customer, should be relooked and silos should instead be based on the customer needs (Gulati & Oldroyd, 2010). The shift in mindset in seeing the bottom line of an organisation in a different way is a culture change. For organisations that achieve this, there is bound to be a remarkable payoff. However, the critical element in all this is that organisations need to start shifting organisational mindsets in that direction as the environment in which they operate has changed.

2.7 INCORPORATING LEAN SIX SIGMA AND CUSTOMER CENTRICITY

A heightened focus on the customer provides a competitive advantage to small companies, who must continue to nurture this advantage. Large companies, who often are enamoured with creating a one-size-fits-all solution, increasingly find themselves in a never-ending competition to be the low-cost provider (Abilla, 2012). The challenge is that cost advantages are, with few exceptions, not sustainable. In Lean thinking, traditionally not much has been said regarding emotions; except for a bit here around “Voice of the Customer” and a bit there on “Customer Satisfaction”. Other than that, not much else regarding emotion is mentioned. This is unfortunate because, at bottom, if we are to improve how business is done, we must pay attention to the process and the feelings of the customers that interact with those processes. Doing so gives practitioners of continuous improvement a broader picture

of how customers are feeling, as well as the steps they are doing when engaged in a process.

Abilla (2012) laments over the fact that Lean Thinking is typically focused on measures such as volume, productivity, costs, lead time, cycle times, wait time, variations, defects, warranty claims, customer contacts, and the like. But, behind many of these metrics are customers – people that have feelings and experience a process in a qualitative way. Being able to do the mechanical aspects of continuous improvement coupled with an understanding of the delicate and often unarticulated qualitative experience can present a very powerful approach to process improvement. Finally, executives from smaller companies believe that their companies are closer to the customers and are more deserving of both their customers' and employees' loyalties than their larger counterparts, (retailcustomerexperience.com, 2013). This reinforces the fact that size increases the distance between executives and their customers as organisations become more product-centric and focused on operational efficiency.

Customer Centricity is a goal to which most companies aspire and many companies believe they already achieved. The majority of these companies, though, fail to understand that achieving Customer Centricity is not a one-time effort, carried out by a small project team and quickly filed away and forgotten. For a company to be truly Customer Centric, a recurrent validation process needs to be implemented. To better understand this concept, we need to get reacquainted with the definition of Customer Centricity (Marrietti, 2012).

"Customer centricity is a strategy to fundamentally align a company's products and services with the wants and needs of its most valuable customers to maximize profits for the long term. Customer centricity refers to the orientation of a company to the needs and behaviours of its customers, rather than internal drivers (such as the quest for short term profit)" (Marrietti, 2012).

As products and services change, so do the needs and behaviours of people (customers) – in some industries, these needs and behaviours change faster than in others. To become and, most importantly, remain Customer Centric, a company

needs to follow its customers' behaviours, listen to their needs and then re-align its initiatives based on those wants and needs in an iterative and on-going process.

Achieving Customer Centricity with Six Sigma

The following chart describes a high level strategy to achieve and sustain Customer Centricity by following the Six Sigma methodology:

Phase	Six Sigma steps	Customer Centricity steps
Define	• State the problem • Define the project goals • Gather the voice of the customer	The goal of the project will be to achieve and sustain Customer Centricity. • Set up a Customer Experience Board/Committee comprised of a representative for each department involved in driving and developing Customer Centric initiatives in the company (This might include, but is not limited to, Communications, Sales, Marketing, IT, Finance, Product, and more.) • Gather customer satisfaction data (from surveys, focus groups, and so on.)
Measure	• Map the current process • Collect the data available	• Map the Customer Life Cycle (from the moment the prospect becomes a Customer, to the moment he/she leaves the company) • Review customer satisfaction data and locate "pain points". • Obtain list of company-wise on-going initiatives.
Analyze	• Investigate and verify cause-and-effect relationships in the data • Seek out root cause of the defects	• Determine which Moments of Truth*, throughout the Life Cycle, have more impact on the customer. • Map current on-going company-wise initiatives against Customer Life Cycle • Find out any gaps (Are there no initiatives on-going for the top Moments of Truth? Is the company dedicating time and resources to initiatives that will not impact customer satisfaction?)
Improve	• Originate and implement solutions	• Brainstorm and define additional strategic initiatives for each Moment of Truth missing. • Prioritise current and additional initiatives. • Retire unnecessary or secondary initiatives. • Develop an implementation plan including specific goals, primary owner, targets and quality metrics, and possible risks/issues associated with each initiative Launch initiatives.

Control	• Continuously monitor and assure implementations are still valuable and effective	• Review quality metrics once initiatives have been implemented and on a regular basis moving forward. • Continue gathering and analysing customer satisfaction data. • Establish new initiatives as needed.

2.8 FACTORS INFLUENCING LEAN IMPLEMENTATION IN SOUTH AFRICA

The success of the TPS is often associated with the highly efficient and disciplined Japanese work culture (Shook, 2009). Although the Japanese culture definitely plays an important role in Toyota's past and growing success, it is also part of their global philosophy to adjust principles and adapt business strategies and operations to the country in which an organisation is situated (Shook, 2009). The motto "Think globally, act locally" conveys this idea pretty well. It is therefore important to acknowledge certain country-specific elements that could impact the implementation of Lean in South African organisations. Hulamin, Africa's leading producer of semi-finished and fabricated aluminum products, saved about R50 million after implementing the Lean Sigma Six business management training program (Maslen, 2013). The management improvement tool helped to ensure steady growth which led to greater sustainability and profitability (Maslen, 2013).

In his doctoral thesis "Critical Success Factors for the Implementation of Lean Thinking in South African Organisations" Vermaak (2008) lists some aspects specific to South Africa that should be considered when attempting to implement Lean.
These include:

- Culture
- Skills shortage
- Unemployment
- Resistance by Trade Unions
- Distance

The unique South African culture entails a number of factors that could be problematic when trying to implement Lean in an organiation. Vermaak (2008) states that ethnic differences are a big cultural factor that impact on the implementation of Lean. Lean is focused on working in teams, which seems to be problematic when trying to involve members of different ethnicities. While the spirit of “Ubuntu” is prominent in the black culture and people prefer to work in teams, whites are often more comfortable working on their own and getting their work done without interference from other employees (Vermaak, 2008). The spirit of Ubuntu should therefore be encouraged in the attempt of incorporating cultural views with the implementation of Lean.

De Beers affiliate, Element Six, a global leader and innovator in the design and manufacture of such super materials as synthetic diamonds for industrial applications also opted for the Lean Six Sigma Six training program (Maslen, 2013). The company has won the Golden Award for Excellence in the corporate sector, Manufacturing, from Productivity SA and the Department of Trade and Industry (DTI). This company has seven manufacturing plants nationwide. Equipping employees with an understanding of Six Sigma principles throughout a company is the only way one can ensure that everyone works towards the same, key strategic objectives, Maslen (2013). But most importantly, through Lean Six Sigma training, employees on all skill levels learn to comprehend the impact of every one of their actions and buy into the LSS approach (Maslen, 2013).

According to Statistics SA (2012) the official South African unemployment rate is 24.9%. Some experts believe that when including people that have given up looking for jobs the figure would be closer to 40%. Since the philosophy of Lean is to employ the least number of people necessary to do a job, the high unemployment rate is a big obstacle for managers trying to truly implement lean. To lay off a significant number of employees is not only made difficult by labour laws in South Africa, but should also be questioned morally and ethically when considering engineering ethics and professionalism (Vermaak, 2008).

South Africa’s political past has brought about an adversarial relationship between managers and employees, and although the new political situation does not

encourage these adversities anymore, there still seems to be a constant conflict between employers and employees (Vermaak, 2008). In a typical South African scenario, every change that is proposed or introduced by a manager must be approved by the employees and their trade unions. This makes it difficult to implement Lean if the employees are not satisfied with the changes that will affect them and their daily duties. It is therefore particularly important to convince employees of all levels of the benefits of Lean for the company as well as for themselves to keep them and the trade unions satisfied.

Vermaak (2008) mentions that, compared to Japan, where the distances between manufacturers and suppliers are relatively small and manufacturers can practically order the needed parts when they are needed, South Africa faces another challenge. South African manufacturers often use parts or materials that have to be imported from various countries and commonly have to spend a few weeks on a ship to reach their destination. Just-in-Time delivery is extremely difficult to implement in such a scenario which is quite typical for South Africa.

Standard Bank Group, one of the largest financial institutions in South Africa, published a case study (Appendix D) of the implementation of Lean Six Sigma in its institution. In the case study presented by "European independent IT research and analysis firm Bloor", Research and Analysis shows that the bank has saved 438 million rand – the equivalent of $ 64.8 million – over a period of four years through its Lean Six Sigma project ("iSixSigma reports").

Standard Bank implemented a process improvement program in its Personal and Business Banking division which provides financial services to individual customers and small and medium enterprises (Mezouari, Bouaouda & Drissi, 2013). In 2005, the managers had noticed that the division encountered several problems of operational inefficiencies, including product focused structures that revealed a silo of individual operations for each product group, which drives redundant functions and documents, high error rates, rework and waste (Mezouari, Bouaouda & Drissi, 2013). The division had no performance measurement system in place, making it difficult to locate the root causes of the problems facing it and impeded any attempt to find a solution. On that year, the bank has deployed Lean Six Sigma, and focused on

projects that address the reduction of waste and process redesign. Following these gains, the Bank has developed a "scorecard" to track improvement results.

2.9 BARRIERS TO IMPLEMENT LEAN SIX SIGMA

Changing an organisation in developing countries from old habits into new working systems is difficult. Many organisations in developing countries have failed attempts in lean transformation due to a variety of reasons. These reasons can be identified as barriers and roadblocks which may halt the conversion process into lean; therefore, it is essential to address barriers that impede the developing countries' organisations to adopt the Lean philosophy. Barriers to lean implementation vary from one firm to another one based on aims and objectives, and firm types. Desale, Devdharand and Patil (2013) has grouped barriers into four categories only.

a) Technological barriers:

Technologies innovations have the most impacts on the varying process. For example, new construction machinery, network, and activities planning technologies are fundamental factors within production and information generated systems. Technology includes production design and scheduling, and quality and operation measurements (Cheng & Chang, 2012). Updated technologies help organisations to close the gap from the current state to the future (desired) state. On the other hand traditional and old technologies can impede the lean implementation process. Most of the developing countries do not change its traditional technique with the latest technique. The majority of companies in India perform a work by labour (Tenera & Pinto, 2014).

b) Financial barriers:

Tenera and Pinto (2014) emphasised the vital role of the financial capacity within the process of lean implementation. The application of Lean philosophy requires financial resources to cover the implementation expenses such as hiring change agents, and training the people. Most construction organisations in India with limited financial resources may view the changing process as an unnecessary loss of resources. Lean manufacturing aims to develop integrated improvement strategy in order to achieve the top level organisation aims and objectives. For example, lean

implementation results in a reduction of waste and inventories aiming to increase the materials flow through the system; in contrast developing countries are having traditional accounting views inventories reduction as reduction in the income. The traditional financial measures emphasise a sub-optimisation strategy which aims at improving certain parts or activities of the value stream in isolation of the whole system (Cheng & Chang, 2012). The traditional financial measurements are inadequate because:

I. They do not recognise the necessity of a comprehensive integrated strategy to improve the whole system instead of controlling and improving certain areas or activities in isolation, and
II. They provide unrealistic historical information and data.

c) External barriers:

Numerous external factors can influence and impede any lean transforming process. For example, Khoshafian (2014) mentioned that the absence or insufficient integrated communication and cooperation between the firms and their suppliers can prevent the changing process. According to Rever (2010), misunderstanding of customer value is counted as a main factor which may prevent the lean implementation process. Tax laws, competitive instant, trade agreements, and political and economic environments have direct influences on the transmutation process. For example the recent global economic recession situation causes a sharp downturn in market demands which has a negative impact on any improvement process.

d) Internal barriers:

Desale, Devdharand and Patil (2013), have emphasized that Lean is not just a toolkit which is used to reduce the costs and inventories, or about removing wastes and enhancing productivity. Nevertheless lean is about human resources, leadership, management, and culture. Corbett (2011) mentioned the vital role of the commitments of managers and leaders in determining the success of lean implementation. An absence of strong supportive leadership to lean transformation will halt and block any transforming process. The beneficial lean journey starts with fully understanding the lean principles and tools, and identifying the right technique

for a specific sequence. Any misconception of lean concepts will result in failure of lean implementation. The internal barriers can be divided into three main factors such as:

i) Human factor:

The human natural tends to resist change; people resist change and they are more comfortable with the existing working manner. A negative feeling may be developed when lean is introduced within the organisation because of communication lack, and misconception of the real purpose of lean. Any non-cooperative and unsupportive attitude can easily obstruct the lean implementation (Desale et al. (2013). Human-related factors in the construction industry are very vital in order to realise new concepts and innovation. That is why; the study emphasised the importance of human-related resistance factors to Six Sigma. When the organisations want to adopt some new technology on site, there will be some discontent behaviours and resistance from technical members. Corbett (2011) mentions that, when the cost and revenue comparison and quality do not meet the expectations, unwillingness pops up for the adoption of new techniques from top management level. However, most construction professionals believe that the construction industry is quite traditional for new technologies to be implemented and management's mentality is also disbelieving of the successes of Lean.

ii) Culture factor:

The culture can be defined as the behaviours, attitudes, and beliefs that exist within the organisation. The simplest description of the culture is the combination of processes, systems, symbols, and rituals that are adopted in order to achieve the organisation's objectives and missions. The organisational culture is reflected in the structure, how information is communicated, and the set-up of hierarchal levels of the organisation (Corbett, 2011). Based on works of Rever (2010), organisational culture is the most challengeable roadblock to lean implementation. Rever (2010) has declared that the organisational culture is not monolithic because of the various subcultures' existence which is accounted as a main source of conflict within the firm. The sub-culture can exist as a result of variation in individual skills and education, and departmental objectives and values. Organisations differ in their resistance and response to change based on some factors such as: degree of

readiness to change within the organisation, leadership type, motivation and communication systems, individual knowledge and skill levels, and self-esteem and perspective.

iii) Learning factor:

It has been mentioned that each lean implementation project is unique because organisations vary in terms of their aims, objectives, capabilities and skills, policies, culture, problems, and constraints. Lean transformation may fail, when a firm attempts to copy a lean project which has been implemented successfully by a competitor. In most of the non-manufacturing industries, there is no research and development department so the learning barrier is formed when the developing organisation cannot recognise that the lean implementation process is a continuous learning process rather than a kit of tools and techniques.

iv) **Absence of customer voice and competition:**

No customer pressure drives or enforces the non-manufacturing industry especially in real estate to initiate any improvement process. For example, most of the flat quality before selling to the customer is not checked by any government agency in the market. Furthermore, an absence of low competition levels exists because of high market restrictions. This leads to the misconception of no need to implement any kind of improvement strategies.

v) **Providing the right training and education programs**:

Good and appropriate training and education programs should be provided in order to build multifunctional teams, and handle the misconceptions and encourage the people to participate in the changing and decision-making processes.

2.10 LINKING LEADERSHIP TO LEAN SIX SIGMA MANAGEMENT

The ultimate goal of any organisation is to increase its customers' satisfaction by adopting services and products to new standards which are custom-designed and in accordance with what clients want to receive. In order to succeed in this endeavour, leadership need both, Lean and Six Sigma working together in all its areas. Lean Six Sigma is a business improvement methodology that aims to maximise shareholder value by improving quality, speed, customer satisfaction and costs. It achieves these

by merging tools and principles from both Lean and Six Sigma (Petcu, Draghici & Anagnoste, 2010). Lean Six Sigma is a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom-line results. It is also being widely recognised that Lean Six Sigma is an effective leadership development tool (Snee, 2010). Good leaders usually come from organisations that have effective leadership development programs in place, although having these programs in place does not guarantee good leaders. The success of Lean Six Sigma depends heavily on the topmost leaders embracing it, believing in it, championing it, and properly applying it (El-Homsi & Slutsky, 2010).

Leaders may choose to implement the Lean Six Sigma methodology just because they heard about it from other leaders or maybe because they knew about its success in other service organisations, and when this is the only argument in driving the implementation, in most of the cases the project fails (Pamfilie, Petcu, & Draghici, 2012). It is not simple to implement Lean Six Sigma. First of all the leader has to be familiar with the methodology tools and techniques, so he can train the other employees involved into the continuous improvement project. If the team members feel a lack of confidence in their leader, they will start the project with many doubts and they will not give all their efforts in order to complete the project with good results (Khoshafian, 2014).

Both Six Sigma and Lean management have evolved into a comprehensive management system. In each case, their effective implementation involves cultural changes in organisations, new approaches to production and servicing customers and a high degree of training and education of employees, from upper management to the line worker (Pamfilieet al., 2012).

Lean Six Sigma refers to a more intelligent management of an organisation, which first takes into account customer requirements and satisfaction by using data and facts for elaborating medium and long-term strategies. One of the most important aspects of applying this methodology is to involve all employees in its implementation (Kahneman, 2012). Through their involvement, employees are encouraged to contribute to the change which will take place and which will bring all benefits for all of them, thus feeling more confident both in their own abilities and

their work capacity and also in the organisation in which they operate, developing their creativity and innovation (Khoshafian, 2014). If the implementation of Lean Six Sigma has resulted in improved processes within the organisation and the employees are informed of that, whether they were directly involved in the implementation flow, or that they could have seen the benefits brought, this will give a state of positive spirit, confidence in their workplace and within the organisations in which they operate. This is crucial for an organisation that invests in its employees and that has no aim in their disposal to save costs but to eliminate those processes that do not bring value to the company by filling them with effective processes without spare time to encourage employees to give maximum efficiency for the company's top management target to become a goal to achieve for each employee (Khoshafian, 2014).

This study focused on identifying the key factors for a successful Lean Six Sigma framework for non-manufacturing companies which encompasses customer centricity. For the successful implementation of such a framework, management and employee commitment is the key towards the changes that will occur in the organisation. This requires good communication, employee motivation for facing the project challenges and also well trained managers. The empirical study will focus on the following hypothesis:

Ho (Null hypothesis). Current continuous improvement methods within non-manufacturing companies do not incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are not performing optimally.

Ha (Alternative hypothesis). Current continuous improvement methods within large non-manufacturing companies incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are performing optimally.

An example of a competency-based perspective of success is where leadership commitment, open communication, employee empowerment and team structures

exist in an organisation (Pamfilie et al., 2012). It seems reasonable to assume that these factors are independent of the type of improvement program so would equally apply to Six Sigma and Lean Six Sigma (Pamfilie et al., 2012).

In a service organisation, as opposed to a production organisation, it is more challenging to define and understand where a process starts and when it ends. Because the processes are not tangible and can be influenced by the top management personal leadership style it is considerably complicated to identify the processes to be improved. Despite those challenges, identifying processes may lead the way for new opportunities to leaders' personal improvement (Kahneman, 2012).

2.11 SUMMARY

From a theoretical review of the literature, the combination of Lean and Six Sigma principles and tools have not yet been fully applied to non-manufacturing companies. Over the last several years Lean Six Sigma has increasingly been applied in manufacturing companies. There have been two implementation approaches to Lean Six Sigma:

1) Incorporating Lean and Six Sigma as complementary approaches, typically implementing Lean first applied to less complex problems and then Six Sigma to more complex problems where statistical tools can help to reduce variation; and 2) using the Six Sigma DMAIC improvement process framework to implement Lean tools and projects.

Lean Six Sigma has already been shown in case studies in the literature to be an effective program to help organisations reduce costs, eliminate waste, reduce variation, and improve quality of products and services, and improve customer satisfaction. The literature also shows that Quality practitioners believe that Lean Six Sigma can be applied in industries beyond manufacturing, such as non-manufacturing industries, to help eliminate waste, reduce or avoid costs of providing service to constituents, and improve quality of the services to enhance customer involvement and satisfaction in non-manufacturing companies.

The systems and techniques include developing the quality management system to provide controls, discipline and standardisation of the improvement efforts. The

measurement and feedback components include defining performance measures, obtaining input from the voice of the customer, establishing benchmarks, defining a recognition system to celebrate successes and providing a continuous feedback mechanism across the program.

The culture change includes planning and focusing on what it takes to change the culture to one that focuses on quality and continuous improvement. Incorporating customer centricity is important in soliciting customer experience and emotions so as to understand the requirements of a customer and how they can change as well as have a future orientation towards customer needs. Customer centricity also solicits perceptions of competitors' performance as well as of company performance.

Customer-centric companies must interact with customers constantly because they understand how quickly the requirements of a customer, segment or marketplace can change. Without real time communication a company can lose critical intelligence and customer loyalty.

Chapter 3

QUANTITATIVE LITERATURE ANALYSIS

3.1 INTRODUCTION

As the previous chapter shows, from a review of the literature, there was little evidence found of non-manufacturing companies using a combined approach of Lean Enterprise and Six Sigma. There are some examples of non-manufacturing companies applying Six Sigma principles and tools, and also quality management programs. Some of the literature identifies the elements that should be present to successfully implement a quality program, but no detailed framework exists to help non-manufacturing companies implement a successful Lean Six Sigma program.

This chapter reports on the results of a detailed quantitative literature analysis which establishes a conceptual background of a proposed theoretical framework. The researcher proposes the development of an implementation framework roadmap that can be used by implementers of Lean Six Sigma in non-manufacturing companies to guide them in successfully implementing Lean Six Sigma. The author developed the framework roadmap based on his knowledge and experience in implementing Lean Thinking and Six Sigma problem solving methods and tools in manufacturing and white collar transactional-based processes, as it applies to non-manufacturing companies. The literature will be used to provide the theory of Lean Enterprise, and Six Sigma, and to validate the framework components based on critical success factors in the literature.

The framework components are the building blocks to organise the framework. Once the author defined the framework components, he developed a detailed framework roadmap that prescribes how Lean Six Sigma can be implemented in non-manufacturing companies. Lean Six Sigma is a holistic program that impacts the entire organisation. The framework encompasses the major framework components, and a detailed roadmap for implementing a Lean Six Sigma program applied to non-manufacturing companies. The roadmap includes the methodology and activities to implement the problem solving approach and Quality and Lean tools.

3.2 QUALITATIVE VERSUS QUANTITATIVE DATA COLLECTION METHODS

Qualitative research is primarily exploratory research. It is used to gain an understanding of underlying reasons, opinions, and motivations. It provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative research (Johnson & Christensen, 2008). Qualitative research is also used to uncover trends in thought and opinions, and dive deeper into the problem. Qualitative data collection methods vary using unstructured or semi-structured techniques. Some common methods include focus groups (group discussions), individual interviews, and participation/observations. The sample size is typically small, and respondents are selected to fulfil a given quota (Johnson & Christensen, 2008).

Qualitative research is used to quantify the problem by way of generating numerical data or data that can be transformed into useable statistics. It is used to quantify attitudes, opinions, behaviours, and other defined variables – and generalise results from a larger sample population (Williams, 2011). Quantitative research uses measurable data to formulate facts and uncover patterns in research. Quantitative data collection methods are much more structured than Qualitative data collection methods. Quantitative data collection methods include various forms of surveys – online surveys, paper surveys, mobile surveys and kiosk surveys, face-to-face interviews, telephone interviews, longitudinal studies, website interceptors, online polls, and systematic observations (Williams, 2011).

This research adopted a quantitative approach. The research looked at the general case and moved toward the specific as indicated on the table 3.1, regarding the purpose of the quantitative method. This deductive approach to research considered a potential cause of something and verified its effect. If a very strong relationship exists between two variables, the cause and effect relationship may be said to be highly probable or highly likely (Williams, 2011). There is still room to say that the effect does not occur as a result of the cause, but this is considered not very probable. The empirical study for this research consisted of a questionnaire, as the basis for interviews with relevant personnel only within the selected non-manufacturing companies; hence the sample size was limited to 100 respondents.

The research study utilised the descriptive method. A descriptive study intends to present facts concerning the nature and status of a situation, as it exists at the time of the study and to describe present conditions, events or systems based on the impressions or reactions of the respondents of the research and the questionnaire will have a 7-point Likert Scale, as well as ranking questions.

Table 3.1: Qualitative versus Quantitative 1

Criteria	Qualitative Research	Quantitative Research
Purpose	To understand & interpret social interactions.	To test hypotheses, look at cause & effect, & make predictions.
Group Studied	Smaller & not randomly selected.	Larger & randomly selected.
Variables	Study of the whole, not variables.	Specific variables studied
Type of Data Collected	Words, images, or objects.	Numbers and statistics.
Form of Data Collected	Qualitative data such as open- ended responses, interviews, participant observations, field notes, & reflections.	Quantitative data based on precise measurements using structured & validated data-collection instruments.
Type of Data Analysis	Identify patterns, features, themes.	Identify statistical relationships.
Objectivity and Subjectivity	Subjectivity is expected.	Objectivity is critical.
Role of Researcher	Researcher & their biases may be known to participants in the study, & participant characteristics may be known to the researcher.	Researcher & their biases are not known to participants in the study, & participant characteristics are deliberately hidden from the researcher (double blind studies).
Results	Particular or specialized findings that is less generalizable.	Generalizable findings that can be applied to other populations.
Scientific Method	Exploratory or bottom–up: the researcher generates a new hypothesis and theory from the data collected.	Confirmatory or top-down: the researcher tests the hypothesis and theory with the data.
View of Human Behavior	Dynamic, situational, social, & personal.	Regular & predictable.
Most Common Research Objectives	Explore, discover, & construct.	Describe, explain, & predict.
Focus	Wide-angle lens; examines the breadth & depth of phenomena.	Narrow-angle lens; tests a specific hypotheses.
Nature of Observation	Study behavior in a natural environment.	Study behavior under controlled conditions; isolate causal effects.
Nature of Reality	Multiple realities; subjective.	Single reality; objective.
Final Report	Narrative report with contextual description & direct quotations from research participants.	Statistical report with correlations, comparisons of means, & statistical significance of findings.

Source: Johnson and Christensen (2008)

Questions in the questionnaire were designed around the key factors needed in order to successfully manage Lean Six Sigma deployment challenges, as identified by theory and case studies and to test the degree of conformance to these theories by the four non-manufacturing companies.

In quantitative research, there are at least two hypothesis statements. One hypothesis is called the *null* hypothesis, or *Ho*. At the conclusion of the research process, the researcher will analyse the data collected, and then will either accept or reject the null hypothesis. The second hypothesis is called the alternative hypothesis, or *Ha*. The researcher assumes the alternative hypothesis is true. Rejecting the null hypothesis suggests that the alternative hypothesis may be true that is, the chance that there is an error in the data that would make the alternative hypothesis not true is acceptably small, by scientific standards.

Hypothesis testing in quantitative research is never absolute. A chi-square hypothesis testing method tested the relevance and necessity of non-manufacturing companies to augment their current continuous improvement methodologies, to meet the criteria of the ideal theoretical framework that was developed. This is a statistical test which consists of three different types of analysis 1) Goodness of fit, 2) Test for Homogeneity, 3) Test of Independence.

The Test for Goodness of fit determines if the sample under analysis was drawn from a population that follows some specified distribution.

The Test for Homogeneity answers the proposition that several populations are homogeneous with respect to some characteristic.

The Test for independence (one of the most frequent uses of Chi Square) is for testing the null hypothesis that two criteria of classification, when applied to a population of subjects are independent. If they are not independent then there is an association between them.

3.3 QUANTITATIVE DATA COLLECTION RESEARCH JUSTIFICATION

Quantitative research is well-suited for the testing of theories and hypotheses. What quantitative methods cannot do very well is to develop hypotheses and theories. The hypotheses to be tested may come from a review of the literature or theory, but can also be developed using exploratory qualitative research. Advantages of using the quantitative method are as follows:

1. Provides estimates of populations at large.
2. Indicates the extensiveness of attitudes held by people.
3. Provides results which can be condensed to statistics.
4. Allows for statistical comparison between various groups.
5. Has precision, is definitive and standardised.
6. Measures level of occurrence, actions, trends, and more.
7. Can answer such questions as "How many?" and "How often?"

3.4 PROPOSED THEORETICAL FRAMEWORK COMPONENTS

This section describes the goals and activities, the Lean Six Sigma principles, tools and important framework components for each phase of the DMAIC problem solving process. It provides a detailed roadmap for the general case for implementing Lean Six Sigma in non-manufacturing companies. There are many tools that are used during each phase of the DMAIC process; some have been documented in Table 3.2 – Examples of DMAIC tools.

Table 3.2: Examples of DMAIC tools 1

Define	Measure	Analyse	Improve	Control
Project Selection Tools	Operational Definitions	Pareto Charts	Brainstorming	Control Charts
PIP Management Process	Data Collection Plan	C&E Matrix	Benchmarking	Standard Operating Procedures
Value Stream Map	Pareto Chart	Fishbone diagrams	Total Preventive Maintenance	Mistake Proofing
Financial Analysis	Histogram	Brainstorming	5S	Plan-Do-Check-Act Cycle
Project Charter	Box Plot	Detailed As-Is process maps	Kaizen	Implementation Plan

Source: Furterer (2011)

The author identified the framework components that form the building blocks of the SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap) based on his experience implementing Lean and Six Sigma in non-manufacturing and in transaction-based processes. Important components that would apply to transaction-based environments and processes, such as in non-manufacturing companies were selected and then mapped the components against the critical success factors identified in quality management and process improvement literature to help ensure that the framework roadmap is based on sound theory.

The critical factors help to ensure the success of a quality management oriented program, including total quality management, Six Sigma, a Lean or a Lean Six Sigma program. These programs draw upon similar bodies of knowledge and conceptual frameworks and principles, such as, employee empowerment, participative management, teamwork, training and education, problem solving and improvement. A critical success factor with respect to a Six Sigma program or

projects is defined as "… the essential ingredients without which a project stands little chance of success". First, the framework components were presented.

The critical success factors from the literature were presented. Then the critical success factors will be mapped against the defined framework components to ensure that the framework components were based on sound theory, and that they provided the critical infrastructure of the Lean Six Sigma framework roadmap.

3.5 DESCRIPTION OF FRAMEWORK COMPONENTS

The author has defined seven framework components that create the infrastructure for the SITE MAP for non-manufacturing companies. The framework was designed to be applied by non-manufacturing companies to improve the quality, reduce costs and variation of service delivered to its customers. Table 3.3 presents the theoretical framework components for implementing Lean Six Sigma in non-manufacturing companies. The table provides a description of each framework roadmap component and how each framework component applies to transaction-based entities, such as non-manufacturing companies.

Table 3.3: Proposed framework components 1

Framework Element	Define	Measure	Analyse	Improve	Control
Principles	• Customer value, • Empowerment • Team building • Teamwork and participation • Project definition and scope	• Value stream • Training • Systems thinking • Empowerment • Process focus • Customer focus • Statistical thinking and variability	• Continuous onepiece flow • Pull • Statistical thinking • Variability • Process focus • Empowerment • Teamwork and participation • Measurement • Training • Theory of knowledge	• Continuous onepiece flow • Pull • Standardization • Statistical thinking • Measurement • Education	• Perfection • Continuous improvement and Kaizen • Standardization • Statistical thinking, • Education • Learning • Knowledge transfer
Activities	• Define need • Identify goals • Form team	• Profile current state • Identify problems • Investigate root causes	• Analyze gaps • Plan improvements • Perform cost/benefit analysis	• Implement solutions • Measure impact • Document, train	• Define performance measures • Continuously improve • Celebrate, reward

Table 3.3: Proposed framework components 2

Framework Element	Define	Measure	Analyse	Improve	Control
Value Proposition	Tied to project goals: • quality • cost • productivity	• Cycle time • Cost • Quality of errors • Meeting customer expectations	• Process measures	• Process measures • Cost/benefits	Process measures: • Cost (people, resources) • Quality (errors, delivery time) • Productivity (cycle time, capacity)
Culture and Change Management	• Project scope • Top management commitment • Formal communication plan	• Identify resistance to change • Formal kick-off • Project status • Communication plan • Identify skills and training needed	• Project status and reporting • Continual and frequent communication	• Project status • Issues management • Communication • Improvement plans • Leadership commitment • Reports	• Communicate success and learnings • Project reports • Rollout strategies to other departments • Communication plan

Table 3.3: Proposed framework components 3

Framework Element	Define	Measure	Analyse	Improve	Control
Quality & Lean Tools	• Project definition, mission, and scope • Brainstorming • Interviewing • Facilitated sessions	• Process flow charts • Waste identification and elimination • Standardization of operations, • Good housekeeping • 5S's • Brainstorming • Cause and Effect • Pareto Analysis • SPC • Histograms • Performance metrics • Capability analysis • Affinity diagrams • Benchmarking • Check sheets	• Cost/benefit analysis • Waste identification • Standardization of operations • Good Housekeeping • Kanban and visual control • SPC • Improvement plans • One-piece flow • Pull	• Cost/benefit analysis • Improvement plans • Standardized procedures • Training, pull, one-piece flow	• Statistical Process Control (SPC), • One-piece flow • Kanban and visual control • Continuous improvement and Kaizen • 5S's • Check sheets

Table 3.3: Proposed framework components 4

Framework Element	Define	Measure	Analyse	Improve	Control
Measurement	Tied to project goals: • Cost • Quality • Productivity	• Estimates of processing time • Error rates • Costs	• Process Measures	• Cost/benefit • Project feasibility • Process measures tied to project objectives	• Process measures: cost, quality, productivity.
Human Resource Management	• Empowerment • Training • Team • Rewards	• Empowerment • Skill sets • Training	• Empowerment • Celebrate interim successes	• Teamwork • Project planning • Improvement planning	• Teamwork • Continuous improvement structure • Rewards • Celebrate
Customer-Centricity	• Define customers and stakeholders • Voice of the customer	• Collect customer requirements and expectations	• Analyze customer data	• Improve and measure impact of improvements to customers	• Responsiveness expectations and cycle time • Customer surveys

Table 3.3: Proposed framework components 5

Framework Element	Define	Measure	Analyse	Improve	Control
Infrastructure and Methodology	• Project charter • Mission • Vision • Goals • Roles and responsibilities	• Project work plan • Teamwork • Training • Knowledge transfer	• Project planning. • Improvement plans	• Implement improvements	• Continuous improvement structure • Controls/measures

Source: Furterer (2011)

The critical success factors from the literature were mapped to the Lean Six Sigma framework components to ensure that the framework model infrastructure will be based on sound theory. Table 3.4 shows the framework component and critical success factor mapping.

This mapping shows that the critical success factors from the literature map fitted well to the framework components and support the sound use of theory. The author's approach in developing the framework roadmap was to seamlessly integrate the Lean and Six Sigma principles, problem-solving activities, tools, and components within the framework. The Six Sigma problem-solving approach, DMAIC (Define-

Measure-Analyze-Improve-Control), and the infrastructure of a problem-solving team led by an experienced quality facilitator (comparable to a Six Sigma black belt) were used in the framework to implement Lean Six Sigma. The author applied appropriate Lean and Quality tools in an integrated fashion to improve the processes and eliminate waste and non-value added activities.

3.6 FRAMEWORK COMPONENTS TO CRITICAL SUCCESS FACTOR MAPPING

This section identifies critical success factors from the literature that were used to ensure that the framework components are based on sound theory. An article by Pattanayak and Maddulety (2011) identified twelve dimensions that were crucial to a Total Quality Management philosophy in service organisations. These can be applicable to non-manufacturing companies, since they provide services, as they are considered in manufacturing companies. The twelve dimensions identified are:

1) Top Management commitment and visionary leadership: In many articles this factor is considered to be the most important to the success of any organisation's change effort. Defining a vision of what the organisation will look like after implementing Lean Six Sigma and embracing the change is also a critical factor.

2) Human Resource management: There are many components of Human Resource management that are necessary for successful implementation of Quality programs, including: recruitment and selection, training and education, employee empowerment, and employee involvement.

3) Technical System: The technical system includes the design of services and management of key business processes.

4) Information and Analysis System: The Information and Analysis system helps to disseminate information and enable communication of the program goals and successes.

5) Benchmarking: Benchmarking compares an organisation against best of class related to processes, products, and financials as well as other issues related to customer and employee satisfaction.

6) Continuous Improvement: Continuous improvement is a critical factor that is a concept of Lean (Kaizen) as well as Six Sigma and other Quality Management programs, encouraged by Deming's philosophy.

7) Customer Centricity: The customers' needs and satisfaction are critical in a service-oriented organisation.

8) Employee Satisfaction: Several studies have found a relationship between employee and customer satisfaction. The more satisfied the employees, the better they provide service to their customers and that improvements and teamwork led to improved employee and customer satisfaction.

9) Union Intervention: Employee relations issues impact the success of a Six Sigma program. This factor encourages union and management to work together to effect change.

10) Social Responsibility: This dimension impacts the organisation's image and goodwill and potentially impacts customers' satisfaction.

11) Services capes: The services cape includes the tangible components of the organisation providing the services, such as the condition of the buildings, the dress code of the employees.

12) Service Culture: The organisational culture that stresses service quality throughout the organisation can establish seamless service delivery.

All of these factors were found to be critical for quality improvement. Neil Jones, (2010) identified areas that are important to avoid failure in productivity improvement programs, as follows:

1) Top management support through leadership: This factor includes management's setting of goals and providing leadership and direction.
2) Education and training: Educate and train management and the workforce in the concepts and tools for improvement.
3) Empowerment: Empower the employees to make decisions and solve problems.
4) Performance Measurement Systems: Measure the performance and improvement gains.
5) Total employee involvement: All employees should be involved in the improvement effort.
6) Reward systems: The reward system should be tied to and support the improvement program.

Table 3.4: Critical success factors

Framework Component	Critical Success Factor
Value Proposition	• Convince management of the value of Lean Six Sigma to the customer.
Culture and Change Management	• Top management commitment. • Clear vision and mission. • Values that support the changing culture. • Change strategy that builds flexibility to respond to customers, and focuses on the technical, political, individual and organizational elements of change. • Slow culture change. • Services capes that support the culture. • Union as part of the process. • Social responsibility of the organization.
Infrastructure and Methodology	• Visionary leadership. • Project management with projects focused on critical to quality characteristics and financial benefits. • Dedicate resources with Black belt structure. • Action plan and awareness. • Top management support through financials, personnel, greater organizational autonomy and effective oversight. • Design of services. • Management of key business processes. • Highly disciplined problem-solving approach. • Program methodology. • Continuous process improvement • Communication throughout the program. • Benchmarking of processes, products, financials, customer satisfaction, and employee satisfaction. • Incorporate suppliers into the value chain.
Customer Centricity	• Customer focused on defining needs and requirements. • Customer-satisfaction as the main goal.
Human Resource Management	• Training and education. • Employee empowerment. • Employee involvement and participation. • Recruitment and selection. • Drive fear from the organization and a safe environment without repercussions. • Reward and recognition systems that support the culture and program. • Encourage innovation. • Upward mobility and well-defined career path. • Teamwork.
Quality & Lean Tools	• Quality tools • Lean tools
Measurement Metrics	• Outcome-based, results oriented performance measurement system. • Measurement and feedback. • Measure customer satisfaction. • Link projects to financial benefits and business strategy.

Source: Furterer (2011)

3.7 CONCLUSION

This research proposes the development of an implementation framework roadmap that can be used by implementers of Lean Six Sigma in non-manufacturing enterprises to guide them in successfully implementing Lean Six Sigma. In this chapter, a detailed, quantitative literature analysis was established as conceptual background of a theoretical framework that was unpacked. The Lean Six Sigma principles, tools and important framework components for each phase of the DMAIC problem-solving process for the proposed theoretical framework was also discussed including the mapping of the these components to the critical success factors. In the next chapter, an empirical research design and methodology will be discussed. A set of questionnaires will be listed and the theory behind their development discussed. Moreover, it explains the selected case companies and their background.

Chapter 4

EMPIRICAL RESEARCH DESIGN

4.1 INTRODUCTION

The main aim of the study is to develop a theoretical framework for effectively implementing and deploying Lean Six Sigma (LSS) in large non-manufacturing companies.The previous chapter reported on the results of a detailed quantitative literature analysis which establishes a conceptual background of a theoretical framework. It also discussed the Lean Six Sigma principles, tools and important framework components for each phase of the DMAIC problem-solving process for the proposed theoretical framework including the mapping of these components to the critical success factors. This research is based on a survey addressed to non-manufacturing organisations which have already implemented Lean Six Sigma methodology and are familiar with continuous improvement tools. The goal of this research is to establish how customer centricity and Lean Six Sigma are connected and have the power to change organisation culture, leadership and employee vision using the changes which occur within the organisation.This chapter unpacks the empirical research design and methodology. A set of questionnaires are listed and the theory behind its development discussed. Moreover, the selected case companies and their background are explained.

4.2 RESEARCH METHODOLOGY

The objective of this chapter is to provide an account of how the research process was developed; to set out the research design that was developed to achieve the research objectives of the study. The researcher has an obligation to conduct a study using an appropriate methodology, as it is unethical to use a method that is inappropriate – that is, using a highly biased sample. The research was divided into three phases as follows.

Phase 1

Identification and development of a theoretical framework for implementation and deployment of Lean Six Sigma in four preselected large non-manufacturing companies in South Africa based on the most authoritative theory and recent research.

Phase 2

Undertaking qualitative, in-depth interviews to identify the respondents and administer the questionnaire for data collection. The empirical study consisted of a structured questionnaire, as the basis for interviews with relevant personnel only within these selected large non-manufacturing companies; hence the sample size was limited to 100 respondents. Phase two investigated and identified the four non-manufacturing companies' philosophy and current Lean Six Sigma models for continuous improvement.

Phase 3

This phase analysed and discussed the research findings and made recommendations regarding the steps required towards implementing the theoretical framework. The objective was to formulate specific change leadership or transformation management tasks to be performed so as to ultimately comply with the theoretical framework. The empirical study consisted of a questionnaire, as the basis for interviews with relevant personnel only within these selected non-manufacturing companies thereby limiting the response number to 100 respondents. The research study utilised the descriptive method. A descriptive research intends to present facts concerning the nature and status of a situation, as it exists at the time of the study and to describe present conditions, events or systems based on the impressions or reactions of the respondents of the research and the questionnaire had a 7-point Likert Scale, as well as ranking questions. A chi-square hypothesis testing method tested the relevance and necessity of non-manufacturing companies

to augment their current continuous improvement methodologies, to meet the criteria of the ideal theoretical framework to be developed.

4.3 EMPIRICAL DESIGN

The empirical investigation was conducted to gather information and data on the current Lean Six Sigma models in place for continuous improvement within the selected four large non-manufacturing companies. Large companies, defined by the Department of Trade and Industry (DTI) as those with annual turnover exceeding R35 million. The business could either be privately or publicly held.

Field-based interviews were conducted with the relevant senior personnel of four large non-manufacturing companies in order to complete the structured questionnaires to provide the data for understanding the mechanisms by which Lean Six Sigma deployment is addressed in the organisations. Fieldwork consisted of interviews with directors, senior executives, line managers and other staff that have in-depth knowledge of their organisation's Lean Six Sigma deployment activities. These personnel members were selected on the basis of their direct decision-making and long-term involvement in their organisations' continuous improvement activities throughout the assessment, negotiation and implementation phases.

Detailed research on each organisation's Lean Six Sigma activities preceded every interview. The interviews were highly structured, and focused on the specific organisation's Lean Six Sigma challenges on implementation and deployment of the method. Questions in the questionnaire were designed around the key factors needed in order to successfully manage Lean Six Sigma deployment challenges, as identified by theory and case studies and to test the degree of conformance to these theories by the four non-manufacturing companies.

4.4 DEVELOPMENT OF THE SURVEY INSTRUMENT

A survey instrument was developed and employed to measure the extent of Lean and Six Sigma implementations in firms and to gauge the nature and extent of these implementations' effects on organisational performance.

Given the need to obtain a well-validated questionnaire as well as ensuring that the questions accomplish the research's objectives; the survey instrument was adapted from two instruments available in the literature from Shah and Ward (2007) and Zu, Fredendall and Douglas (2008).This adaptation is discussed in full in this chapter.
Measures for each construct, therefore, are obtained from an extensive review of the relevant literature. Specifically, for measuring Lean system, content was mainly based on the instrument developed by Shah and Ward (2007). For Six Sigma implementation, the research mostly followed the work in Zu, Fredendall and Douglas (2008). In order to construct an instrument relevant to the development of a Lean Six Sigma framework for non-manufacturing companies, some questions developed in the two instruments were dropped and more relevant questions especially with regards to customer centricity were added.

The review of literature indicates that Lean systems consist of multiple underlying components and Lean systems manifest themselves in many dimensions and facets. Practical observation indicates that Lean implementation in industries is structured in various states of progress depending on the level of application. Despite this, little research has been done related to measuring Lean. Shah and Ward (2007) conducted research to identify the dimensional structure underlying the Lean system and to develop scales to represent it. The study empirically develops an operational measurement in a set of forty-eight items included in ten scales, reflecting a comprehensive set of Lean practices. These scales cover the ten distinct dimensions of a Lean system which was also maintained in this research instrument, including: *Supplier Feedback*, *Just-in-Time Delivery by Suppliers*, *Supplier Development*, *Customer Involvement*, *Pull*, *Continuous Flow*, *Set up*, *Total Preventive Maintenance*, *Statistical Process Control*, and *Employee Involvement*.

The choice of the Shah and Ward (2007) instrument allowed the researcher to assess the state of Lean implementation in firms and to test hypotheses about relationships between Lean and other organisations' characteristics that affect firm performance.

With regards to measuring Six Sigma, Zu, Fredendall and Douglas (2008) developed a survey instrument to investigate how Six Sigma practices integrate with seven

traditional quality management practices to generate organisational performance improvement. While measures for traditional quality management practices and performance were obtained/selected from the relevant literature, new measures were developed to evaluate the three new Six Sigma practices. All of these scales and items were statistically tested for reliability and validity in a large-scale survey in the US. Seventy four items included in ten scales were identified: *Top Management Support*, *Customer Relationship*, *Supplier Relationship*, *Workforce Management*, *Quality Information*, *Product/Service Design*, *Process Management*, *Six Sigma Role Structure*, *Six Sigma Structure Improvement Procedure*, and *Six Sigma Focus on Metrics*. The ten scales were retained for the purpose of this research instrument but some questions were dropped in order to add more relevant material especially regarding customer centricity.

The scale and items developed in this study are more comprehensive and empirically validated than other measures observed in the existing literature in the topic. Further, they allowed an accurate assessment of the state of Six Sigma implementation in firms as well as greatly assist an investigation of how Six Sigma works with other improvement methods such as Lean. They are, therefore, believed to be a justified choice. Questions regarding customer relationship, product/service design were altered in order to meet the requirements of the proposed Lean Six Sigma framework for non-manufacturing companies.

While there are many approaches to quality performance, perhaps the most predominant approach that can be identified and validated in the literature is to use cost, quality, delivery and flexibility as the four basis indicators of manufacturing performance (Flynn et al., 1995; Samson & Terziovski, 1999; Cua et al., 2001; McKone et al., 2001; Kaynak, 2003; Narasimhan et al., 2006; Shah & Ward, 2007; Zu et al., 2008). Zu et al. (2008) measure quality performance using seven items, including quality of product, process variability, delivery, cost of scrap and rework, cycle time, customer satisfaction, and equipment downtime.

Business performance is measured by looking at firm market performance and financial performance. Specifically, for this measure Zu et al. (2008) employ six items, which are sale, market share, unit cost of manufacturing, operating income,

profit, and return on assets. Nine other items were employed to measuring contextual information about the firms interviewed, organisational size, industry, duration of adoptions of Lean, Six Sigma, number of projects, and respondent's details. The entire instrument consists of a total of 144 items. Appendix A provides the survey instrument used in this study which is fully aligned with the literature study, problem statement, objectives of the study, and the proposed ideal theoretical framework mentioned in chapter two.

4.5 LIKERT TYPE SCALES AND PILOT QUESTIONNAIRE

Items were measured on 7-point Likert scales with end points of ‘‘strongly disagree" and ‘‘strongly agree’’. When measuring Lean and Six Sigma, respondents were asked to rate the extent to which they agree or disagree with statements that present the current status of implementation in their firms. In terms of firm performance, respondents were asked to rate the extent to which they agree or disagree with statements that reflect the degree of change in performance in the firms over the preceding three years.

A pilot questionnaire was reviewed by a number of university lecturers and graduate students for comprehensibility and accuracy. Instruments were double checked to confirm that they met certain requirements; including how well each scale captured the construct that it was intended to measure, whether the wording of each item was clear and understandable and whether the format was user friendly. Using the feedback, the instrument was further revised to ensure that the questionnaire was comprehensive, understandable and valid from these experts' perspective.

4.6 DATA COLLECTION METHOD

The research unit were the individual firms. The target sample was of South African non-manufacturing firms who had been identified as implementing Lean and/or Six Sigma. Firms with greater experience in Six Sigma and Lean were preferred candidates. As Lean Six Sigma is a relatively new method, the time-frames for performance measures were set to five years in the questionnaire. The study examined the challenges of Lean Six Sigma implementation on non-manufacturing

companies by obtaining a large sample as possible of firms with experience with Lean/Six Sigma/Lean Six Sigma.

Target respondents included firm managers and persons who are responsible for the implementation of the programs in firms, project managers, operations managers, quality managers, Six Sigma Master Black Belts and Black Belts. The intent was to mail surveys to possible participants using either surface mail or email.

4.7 DATA VALIDATION

To ensure the survey was conducted correctly and free of deception, all respondents' names, telephone numbers and e-mail addresses were recorded, and responses were controlled against these particulars. As indicated, respondents were all screened and a covering letter informed them that information would be kept confidential and used for research purposes only. This may have contributed to the level of openness in rating the statements, and therefore improved accuracy.

4.8 DATA EDITING AND ANALYSIS

Data was edited by verifying the questionnaire for completeness and ensuring all the questions' statements were rated. An independent editor and statistical analyst were engaged to verify and validate the questionnaire as well as the statistical results for the survey outcome.

4.9 CODING DATA

Coding involves grouping and assigning values to various responses from the survey instrument (Hair et al*.,* 2000:482). In this study coding was done by assigning a percentage score – based on the numbers represented by each of the Likert scale descriptors – received per statement.

4.10 DATA ENTRY

An independent research statistician used the SSPS computer program to capture various responses from the research questionnaire. Results were cross-checked and

verified for accuracy. Data was entered in a format that allowed for error detection by the researchers.

4.11 DATA TABULATION

Tabulation is a simple process of counting the number of observations classified into certain categories. Two common forms of data tabulation are used in research: one-way tabulation and cross-tabulations. One-way tabulation is the categorisation of single variables in the study. In most cases, one-way tabulation shows the number of respondents who gave each possible answer to each statement on the questionnaire. The actual number of one-way tabulations is directly related to the number of variables being measured in the study. Cross-tabulation simultaneously treats two or more variables in the study (Hair et al*.,* 2000:503).

4.12 DEPENDENT AND INDEPENDENT VARIABLES

In this study, no independent variables were introduced (Hair et al*.*, 2000:289). The respondents' level of knowledge, exposure and experience on lean Six Sigma were the only dependent variables in the data. Variables in this study were therefore not of any significance and the one-way tabulation technique was judged most appropriate (Hair et al*.*, 2000:504). For the purpose of this study, 'neither agree nor disagree' was interpreted to mean that the management practice proposed by the model is either not being practiced by the Company, or if it is, the respondent is not aware that it is being practised. Considering the seniority of the respondents, it is unlikely that such a practice could exist without them being aware of it. Even if such practices do exist in Company, a 'neither agree nor disagree' answer would indicate that these practices are not embedded, and do not form part of the day-to-day practices of Company, to the extent that it may be clearly or regularly observed by senior management, which would then warrant a recommendation to implement the practice or ensure it has been implemented.

Responses of 'disagree' and 'somewhat/somewhat not' were interpreted to mean that the management practice proposed by the framework is either not being practised by the Company, or not practised consistently. For these areas, it was recommended that practices identified by the framework be implemented. A response of 'agree' was interpreted to mean that the management practice proposed

by the framework is being followed by Company and, save for noting the areas where the Company conforms to the management practice proposed by the framework, did not warrant any further discussion.

The research findings have been grouped into three clusters as follows:

- Neither agrees nor disagrees
- Disagree and somewhat/somewhat not
- Agree

4.13 DESCRIPTION OF RESULTS

The results of the questionnaire were analysed per statement, and the percentages for each statement reported per Likert scaling indicator. If the majority of respondents believed a particular management practice/criterion was being/not being applied, the result was noted as compliance or non-compliance to the framework. If the response to a statement indicated a minority percentage for 'disagree' but a majority percentage for the combined results of 'disagree' and 'somewhat/somewhat not', then, and in accordance with the grouping philosophy as noted above ('somewhat/somewhat not' and 'disagree' reported as one result), the result was noted as non-compliance with the framework. If the response to a statement indicated an equal percentage for compliance and non-compliance, the result was noted as inconclusive.

4.14 Case studies companies' overview

This study utilised four cased studies for South African non-manufacturing companies currently in the process of deploying and implementation of Lean Six Sigma methodology. These companies would be referred to in this study by the following descriptions as their identities are to remain confidential.

1) Company Y and X, are in the call centre industry
2) Company S, is in the financial sector
3) Company L, is in the mining industry

1. Company Y and X backgrounds

South Africa is home to a large and mature call centre industry. Over the last five years, call centre and BPO&O (Business Process Outsourcing and Off-shoring) activity has shown a very healthy rate of growth, servicing both the South African market as well as foreign businesses. South Africa has tried to position itself as one of the preferred destinations for BPO and off-shoring, which is largely made up of call centres. A study released by the London School of Economics in November (2012) said the country is maturing and becoming strategic in its ability to offer voice, complex back office BPO and a shared service platform for Southern African markets. Moreover, "its extant, strong capability" in higher value work in financial services BPO and legal processing outsourcing provides a platform for delivering on its considerable potential in these areas over the next three to five years, the report says. As a service destination, South Africa caters for a number of prominent international brands including Amazon, British Gas, Shell, Lufthansa, Shop Direct, Talk Talk, SwissAir, T-Mobile and IBM.

The case studies for the two companies explore the following studies:

1) Using Lean Six Sigma to Improve Call Center Operations
2) Case of Mistaken Capability

Using Lean Six Sigma to Improve Call Center Operations: In this case study, Lean Six Sigma was adopted, after service in the company's third-party call centre, had deteriorated. Their job was to handle queries from independent business owners about financial services offered by the call centre's client. As in many call centres, the job was considered highly stressful because of expected response times and resolution. The Lean Six Sigma team approached the problem in the beginning using standard methodology. The first measurement system analysis (MSA) testing the application of these definitions failed reproducibility. This failure actually was a major moment in the life of the project. The project was later saved by adjustments to the methodology and process.

Case of Mistaken Capability: Company X initiated an investigation of a process that was failing to meet the required output on time. The process was considered stable and capable of meeting customer requirements until March 2012. There were no records of recent changes that could account for this downward performance trend, making it more difficult to pinpoint the cause or causes of failure. To address the problem, the improvement team implemented several different action plans, including altering the methodology in order to achieve the required results.

2. Company S, financial sector background

South Africa's financial services sector, backed by a sound regulatory and legal framework, is sophisticated, boasting dozens of domestic and foreign institutions providing a full range of services – commercial, retail and merchant banking, mortgage lending, insurance and investment. Lean Six Sigma combines focus on the customer with a structured, process-driven approach, leading to measurable improvements. The organisation’s employees play an important part in these improvements as the architects of the new process. This makes Lean Six Sigma more than just a set of improvement tools, but also a way to create a (improvement) culture shift of the organisation.

In the case of company S, the company implemented the process improvement program in its Personal and Business Banking division, which provides financial services to individual customers and small to medium-sized businesses after the executives have noticed that PBB faced several operational inefficiencies, including its product-centric structure that featured individual silo operations for each product group. This resulted in duplicated functions and documents, high rates of error, rework and waste. The division had no performance measurement system in place, making it difficult to locate the root causes of the problems it was facing and hampering the process of finding a solution. Lean Six Sigma brought better realisation of improved services after its deployment over a period of time.

3. Company L, mining industry background

The South African mining industry – a mainstay of the country's $357-billion economy, the biggest in Africa as well as the basis of this country's industrialisation. The industry widely uses either Lean or Six Sigma and just a few have attempted using the combined methodology of Lean Six Sigma. In the case of company L, the author proposed a transformation initiative which provided a structured process to ensure the effective use of (limited) capital, improved labour productivity, and improved quality of products which are produced in South Africa. Management of Company L, proposed that the transformation initiative can be compiled from three complementary approaches which, when integrated into a single transformation intervention, would significantly enhance the chances of a successful outcome. These approaches (or methodologies) are:

1. Six Sigma continuous improvement methodology.
2. Theory of Kotter on change management.
3. Balanced scorecard and strategy map theory by Kaplan and Norton.

Company L, integrated these three approaches and developed a seven-step deployment process for the successful implementation of Six Sigma. Lean Six Sigma provides an improved advantage as it also incorporates lean enterprise over and above the methods used by company L.

4.15 LIMITATIONS

The researcher had given a guarantee, detailed in the interview consent form, that the identity of the interviewees would remain confidential and will not be disclosed verbally or written in this study. The researcher adhered to this throughout the study and research gathering phase.

4.16 CONCLUSION

This chapter unpacked the empirical research design and methodology and a set of questionnaires were listed and the theory behind their development discussed. Moreover, the selected case companies and its background were explained. The next chapter summarises the conceptual background based on the literature study and analysis from chapter 2. It further provides an in-depth empirical study of

continuous improvement management practices in the different case companies, and explores the reasons and motivations for the adoption, which leads to the development of the decision-aid framework.

Chapter 5

ANALYSIS ON LITERATURE STUDY AND THE EMPIRICAL STUDY

5.1 INTRODUCTION

In the previous chapter, the empirical research design and methodology and a set of questionnaires were listed and the theory behind its development discussed. Moreover, the selected case companies and their background were explained. This chapter summarises the conceptual background based on the literature study and analysis. It further provides an in-depth empirical study of continuous improvement management practices in the different case companies, and explores the reasons and motivations for the adoption, which leads to the development of the decision-aid framework.

5.2 CONCEPTUAL BACKGROUND OF CASE STUDIES

This section involves exploring and understanding the concept of Lean Six Sigma, and core elements continuous improvement initiatives through case studies research in this area. The conceptual background from the literature study identified the research gap on which a theoretical framework for non-manufacturing companies was developed. The section also expands the theoretical foundation for combining Lean and Six Sigma by studying and analysing a practical application of the concept. Case study research was chosen given the need to gather in-depth, rich data on the phenomenon of Lean Six Sigma implementation. The functional silo structure makes it difficult for the organisation to move fast, adapt to change, integrate across functions, and focus on high levels of quality and service. Re-organising around core business processes that turn customer requirements or inputs into outputs can eliminate fragmentation, restoring a whole system perspective that focuses on markets and customers.

The needed revolutionary approach to business performance improvement must encompass both how a business is viewed and structured, and how it is improved. Business must be viewed not in terms of functions, divisions, or products, but of key

processes. Achievement of order-of-magnitude levels of improvement in these processes means redesigning them from beginning to end, employing whatever innovative technologies and organisational resources are available.

Adopting a process view implies a commitment to process betterment. In their attempts to cope with the forces of change, companies need to realise that process management must permeate the organisation totally, and not be confined to a department, a discipline or viewed as a narrow organisation paradigm. Process management is an encompassing philosophy. It is one that ultimately must be appreciated by all stakeholders, the customer, the employees, the shareholders and society. Without a broad systems perspective, companies will continue to produce products/services that fail to satisfy and delight the customers.

Ultimately, narrow perspectives will lead to corporate downfalls. To be successful in the new era there is a necessity for transformation in perspective and values. Despite all the change that has occurred over the past years within the process management paradigm, organisationally there is a blind narrow focus on cost reduction and productivity. Events of recent times such as the drastic downsizing implemented by companies attest to this. By focusing their energies in this way, these companies have neglected or inhibited the other side of the business equation, namely, that of innovation, creativity and growth. To sustain themselves in the long run, companies must manage the future proactively.

5.3 LEAN SIX SIGMA CONCEPTS IN THE CASE STUDIES

Financial service has always been keen to reduce their operating costs. Over the last couple of years the company used many “once-off” and “quick win” approaches to achieve this, like downsizing the branch networks, installing call centres and more recently relocating call centres overseas. This has resulted in huge, non-sustainable reductions in their cost-to-income ratios and profitability. These are easily copied by competitors and are some of the things that could come about by applying Lean thinking.

Lean is a thinking solution that can deliver huge, sustainable returns if it is implemented in the spirit of “relentless improvement” instead of “quick fix” cost

reductions. South African Banks are not adopting Lean and/or Six-sigma to the point where it is going to make any sort of significant difference to the bottom-line over a significantly meaningful period of time. So where are they going wrong? Often it comes down to key issues that are not addressed effectively as part of the deployment. In the case of company S, the company implemented the process improvement program in its Personal and Business Banking division, the division had no performance measurement system in place, making it difficult to locate the root causes of the problems it was facing and hampering the process of finding a solution. Lean Six Sigma brought better realisation of improved services after its deployment over a period of time.

The companies that are thriving today realise that what reasonably could be considered a customer responsibility is now a great opportunity to take something on themselves. This is why your bank tells you when your mortgage payment is due and your pharmacy reminds you that it is time to refill your prescription. Customer engagement, loyalty and advocacy are no longer driven by the products you sell or the service you offer; they're driven by how well the experience you provide meets your customers' ever-changing emotional needs and wants. It is not the function a business provides, but the effect it has on customers' lives that create value.

The current structure in the financial industries in South Africa is that, customer centricity and continuous improvement efforts operate in silos. Organisational synergy suffers when silos and cross-departmental competitiveness predominate. Synergy happens when the work performance of two different departments produces a larger result than the simple addition of the two efforts together. Silos occur naturally because of the way organisations are structured.

Continuous improvement initiatives in non-manufacturing organisations need to pay more attention to customer experience and emotions in order to deliver products/services that customers need rather than what organisational leadership assumes is the best for the customer. This is a major concern across all companies under study on this research as efforts incorporates less emphasis on customer insights and priorities cost cutting and other waste elimination methods as means of improving performance and profitability. This works very well with manufacturing

companies as they have little contact with the consumer and their focus is mainly on producing a quality product at a minimised cost.

Lean Six Sigma for non-manufacturing companies is a business improvement methodology that maximises shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital. Six Sigma and Lean have often been regarded as rival initiatives — Lean enthusiasts noting that Six Sigma pays little attention to anything related to speed and flow, Six Sigma supporters pointing out that Lean fails to address key concepts like customer needs and variation. Both sides are right. Yet these arguments are more often used to advocate choosing one over the other, rather than to support the more logical conclusion that we need to blend Lean and Six Sigma and incorporate more emphasis on customer centricity in order to enhance customer experience and emotions.

The non-manufacturing corporations mainly deal with customers, suppliers and clients on a routine basis. It encompasses those soft processes that are the driving force behind the production and distribution of every product and service. The soft processes are human centric and each situation is a unique case hence, it requires scientific application to reduce and manage the variances. This necessitates standardisation, as the quantity of automated equipment is less and human resource is greater.

As in many call centres, Company Y and X, are in the call centre industry and the implementation of Lean Six Sigma initiatives operate in silos form customer centricity initiatives. Non-manufacturing organisations mainly deal with customers, suppliers and clients on a routine basis, hence the need to incorporate more focus on customer experience and emotions when deploying/implementing Lean Six Sigma initiatives. The study describes improvements in the operation of the call centre attributable to Lean Six Sigma: increase in first-call resolution ratio, reduction in operator turnover and streamlining of processes and draws on process information and primary data from a real project.

Although Lean Six Sigma has been extremely successful in the last two decades in the manufacturing sector, its applicability to the service sector has been a controversial topic. This study illustrates its application to a fast-growing area of the service sector, assisting companies in identifying areas of development for their call centres. Lean Six Sigma first emphasizes the use of Lean methodologies and tools to identify and remove waste and increase process velocity, then follows that with the use of Six Sigma methodologies and tools to identify and reduce or remove process variation.

Call centres nowadays are more than just operations: they are the first, and sometimes a unique, point of contact that a company may have with its customers. Their efficient and effective running and their timely resolution of customers' queries, all go a long way to establishing the company's brand and image. It is not a surprise that most call centres are much cost focused and not completely customer focused. There is an upside and a downside to this approach: on the one hand, call centres are traditionally "cost centres" – that is, they do not provide revenue for the firm. From this perspective, it is important that cost be contained and even reduced. On the other hand, the call centre can become a differentiator in the marketplace, where customer loyalty is harder and harder to come by.

Project selection is a critical component of success. Not all projects may be suitable candidates for the application of Lean Six Sigma, and this needs to be kept in mind in assessing the operation of a call centre. Also, different tools and techniques may be more suited to a specific project, depending on the nature and characteristics of the process it is trying to address.

The mining industry where company L, on the case studies operates within does not resemble much difference to the rest of the non-manufacturing companies as it also sees the rewards of implementing Lean Six Sigma in it operating environment. Faced with rising operations cost and huge demand for resources, more mining companies are now looking at how to eliminate waste and improve processes. The rewards of Six Sigma are not only limited to more efficient operations. Ultimately, companies are seeing direct improvements in their bottom-line.

The mining sector is increasingly incorporating a continuous improvement culture that focuses on customer satisfaction and process excellence, quality and operational efficiency. In order to stay at the forefront of the competition and capture maximum quality and efficiency, companies have been increasingly adopting lean and six sigma methodologies to gain a competitive advantage in the market. In the case of company L, the Lean Six Sigma initiative involved managers at every level posing the key problems that need to be solved and asking the teams they lead to develop and implement the answers. This is in stark contrast to more orthodox approaches to productivity improvement and the hardest to implement.

By working on real problems that add wealth to the business and mentoring staff in the use of continuous improvement tools company L, empowers its managers to be more effective, develops future managers and accelerates achievement of a Lean/Six Sigma culture.

5.4 CONCLUSION

This chapter explored the concept of Lean Six Sigma, and core elements continuous improvement initiatives through case studies research in this area. The conceptual background from the literature study was discussed in relation to the four case studies which form part of the empirical research for this study, providing an in-depth analysis of the case studies in order to identify the research gap on which a theoretical framework for non-manufacturing companies was developed. In the next chapter, the results and findings of the empirical research will be analysed and discussed. The empirical study consists of a questionnaire, as the basis for interviews with relevant personnel only within these selected non-manufacturing companies.

Chapter 6

DATA ANALYSIS AND INTERPRETATION

6.1 INTRODUCTION

The preceding chapters provided the orientation (Chapter 1) of the study, a literature study (Chapter 2), a quantitative literature analysis (Chapter 3) an empirical research design (Chapter4) and an analysis of the literature review and the empirical study (Chapter 5). In this chapter, the result of the primary research conducted is presented and interpreted. The presentation of results is aligned to the objectives of the study. The results of the propositions/hypothesis are given. The SPSS statistical program was used and the full details of the statistics are in appendix B and C.

6.2 QUESTIONNAIRE RELIABILITY

The Cronbach coefficient alpha was used to test the internal consistency of the factors.

Table 6.1 Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.992	.995	142

Cronbach's alpha is **0.992**, which indicates a high level of internal consistency for the scale with this specific sample of Lean Six Sigma Implementation. Cronbach's alpha simply provided us with an overall reliability coefficient for a set of variables (for instance, questions). If the Cronbach coefficient alpha is between 0.4 and 0.7, it indicates medium internal consistency and reliability. If the Cronbach coefficient alpha is between, 0.7 to 1.0, it indicates high or good internal consistency and reliability. The Cronbach coefficient alpha was produced for the overall

questionnaire. The coefficient of reliability was significantly high, thus indicating a high level of reliability. Hence, the reliability analysis of the questionnaire continuous statements indicate this research instrument (Questionnaire) continuous study variables have adequate internal consistency and reliability. Appendix D provides the full details on the calculations for each section.

6.3 RESULTS OF THE DEMOGRAPHICS OF THE RESEARCH

The following tables present the respondents' information related to the study. The survey was limited only personnel experienced in the deployment of Lean Six Sigma and senior management to respond.

Table 6.2: Demographics 1

How many employees work in your firm?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than 100	15	18.3	18.3	18.3
	100-500	15	18.3	18.3	36.6
	501-1000	11	13.4	13.4	50.0
	more than 1000	41	50.0	50.0	100.0
	Total	82	100.0	100.0	

50% of the respondents have more than 1000 employees working in their firms, 18.3% have less than 100 employees working in their firms.

Table 6.3: Demographics 2

How many years has it been since firm start-up?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than 5 years	17	20.7	20.7	20.7
	5-10 years	17	20.7	20.7	41.5
	11-20 years	14	17.1	17.1	58.5
	more than 20 years	34	41.5	41.5	100.0
	Total	82	100.0	100.0	

41.5% of the respondents are in firms with more than 20 years of start-up and only 20.7% are in firms with less than 5 years since start-up.

Table 6.4: Demographic 3

To which category of Industrial classification does your firm belong?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	financial industry	26	31.7	31.7	31.7
	retail & wholesale industry	6	7.3	7.3	39.0
	mining industry	13	15.9	15.9	54.9
	call centre industry	19	23.2	23.2	78.0
	hospitality industry	2	2.4	2.4	80.5
	other non-manufacturing industry	16	19.5	19.5	100.0
	Total	82	100.0	100.0	

31.7% of the respondents belonged to the financial industry and only 2.4% belonged to the hospitality industry, 23.2% belonged to the call centre industry, while 15.9% were from the mining industry. The case studies discussed in chapter 5 are mainly from the financial, call centre, and mining industry on which we have over 70%

response combined response. This will assist in further analysis on what challenges these industries are facing.

Table 6.5: Demographics 4

What is your role in the firm's Lean Six Sigma project?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Senior manager	32	39.0	43.2	43.2
	Financial controller	5	6.1	6.8	50.0
	Six sigma leader	4	4.9	5.4	55.4
	Master black belt (MBB)	4	4.9	5.4	60.8
	Black Belt (BB)	6	7.3	8.1	68.9
	Green Belt (GB)	2	2.4	2.7	71.6
	Finance Team	7	8.5	9.5	81.1
	Other	14	17.1	18.9	100.0
	Total	74	90.2	100.0	
Missing	System	8	9.8		
Total		82	100.0		

43.2% were senior managers in the firm's Lean Six Sigma project and 2.7% were Green Belt.

Table 6.6: Demographics 5

How many years of experience have you had with Lean Six Sigma?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than 2 years	19	23.2	26.8	26.8
	2-5 years	25	30.5	35.2	62.0
	more than 5 years	27	32.9	38.0	100.0
	Total	71	86.6	100.0	
Missing	System	11	13.4		
Total		82	100.0		

38% of the respondents had more than 5 years of experience with Lean Six Sigma and only 26.8% had less than 2 years of experience.

Table 6.7: Demographics 6

How many projects have you handled or been involved with so far, if any?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	9	11.0	12.3	12.3
	1-3 projects	36	43.9	49.3	61.6
	more than 3 projects	28	34.1	38.4	100.0
	Total	73	89.0	100.0	
Missing	System	9	11.0		
Total		82	100.0		

49.3% handled 1-3 projects and 38.4% indicated to have handled more than 3 projects.

6.4 THE RESULTS OF THE STUDY

The study results were analysed across all twenty three categories on the questionnaire. In this chapter, nine key areas were selected and discussed extensively while the rest summarised under the diversity of opinions on Six Sigma heading on this chapter. However, all categories results are available on appendix C with relevant calculations and interpretations.

6.4. 1 Top management support

The chi-square test showed that the two variables top management (i.e. top executives and major department heads) assumes responsibility for quality performance (P=0.036) and quality issues reviewed within firm's management meetings (P=0.054) were significantly different across the different firms. However, firm's top management providing personal leadership for quality products and quality improvement, firm's top management is evaluating for quality performance, major department heads within firm participating in the quality improvement process and top management having objectives for quality performance were not significant

(P>0.05). The correlations between the variables defining management support in implementing Lean Six Sigma (LSS) showed that the variables were highly correlated, indicating that variables were the same (Table 6.3). However when correlated against the firm variable, the firm's top management assuming responsibility, providing personal leadership for quality products and quality improvement and evaluating for quality performance showed strong inverse correlations. This implied that firms in financial industry, retail and wholesale somewhat agree, agree and strongly agree on the variables as compared to other industries.

Figure 6.1: Management responsibility for quality performance

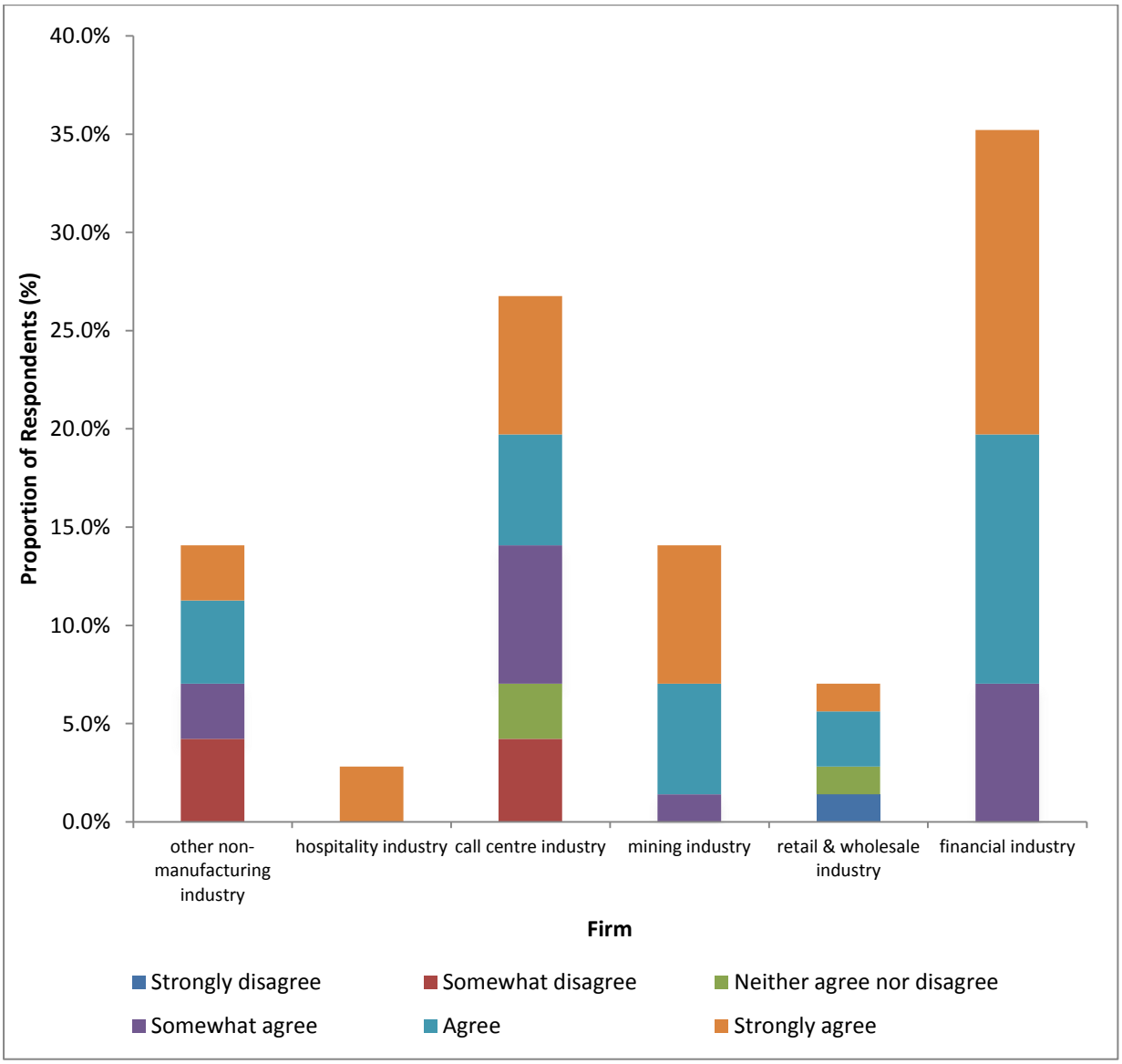
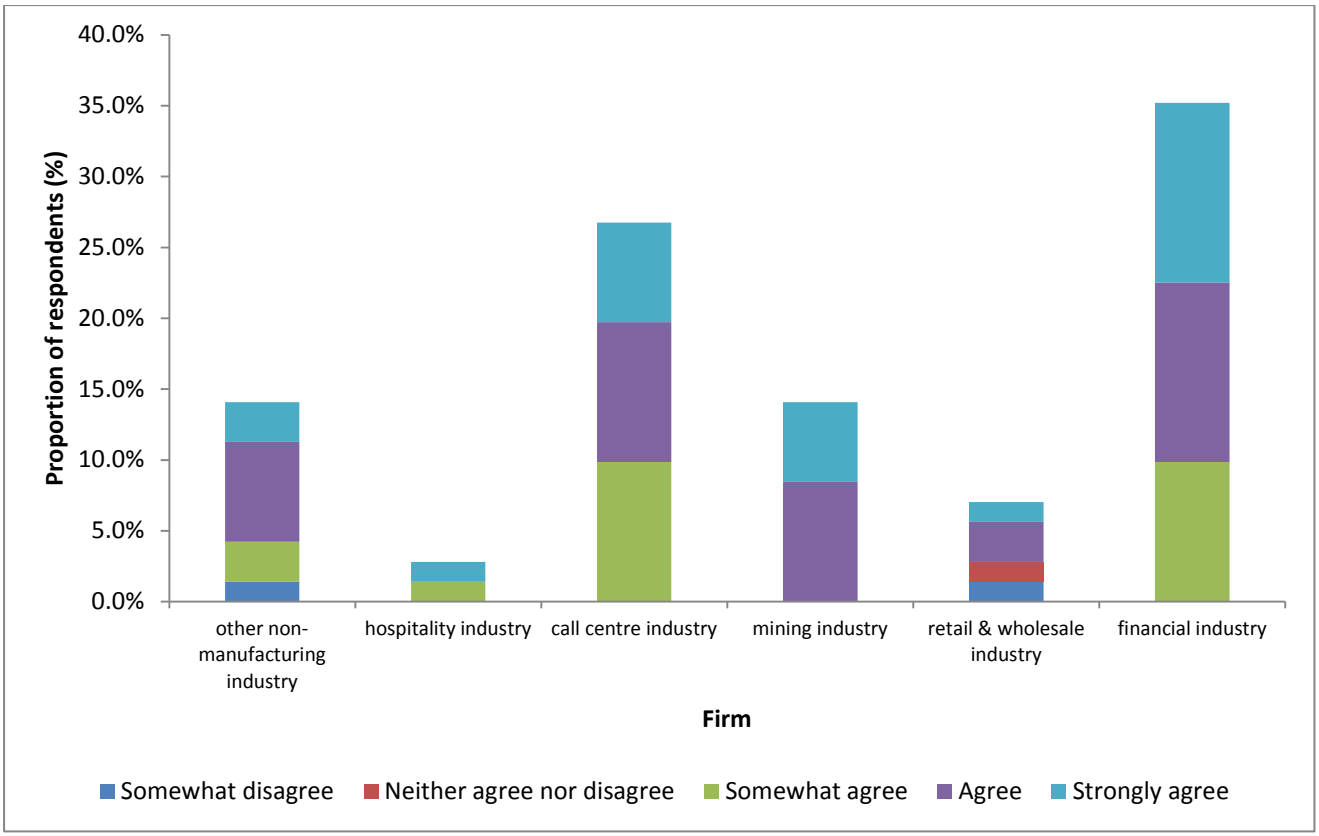


Figure 6.2: Quality issues reviews



There is a general satisfaction with management's commitment in reviewing quality issues during meetings, evident from the result which shows the majority of respondents' responding positively on the question.

Table 6.8: Correlations between Management support versus firm

		To which category of Industrial classification does your firm belong?	Our firm's top management (i.e. top executives and major department heads) assumes responsibility for quality performance.	Our firm's top management provides personal leadership for quality products and quality improvement.	Our firm's top management is evaluated for quality performance.	Major department heads within our firm participate in the quality improvement process.	Quality issues are reviewed in our firm's management meetings.	Our firm's top management has objectives for quality performance.
To which category of Industrial classification does your firm belong?	Pearson Correlation	1	-.256*	-.291*	-.249*	-0.099	-0.103	-0.137
	Sig. (2-tailed)		0.031	0.014	0.036	0.412	0.394	0.254
	N	82	71	71	71	71	71	71
Our firm's top management (i.e. top executives and major department heads) assumes responsibility for quality performance.	Pearson Correlation	-.256*	1	.819**	.721**	.729**	.756**	.808**
	Sig. (2-tailed)	0.031		0	0	0	0	0
	N	71	71	71	71	71	71	71
Our firm's top management provides personal leadership for quality products and quality improvement.	Pearson Correlation	-.291*	.819**	1	.834**	.756**	.755**	.837**
	Sig. (2-tailed)	0.014	0		0	0	0	0
	N	71	71	71	71	71	71	71

		To which category of Industrial classification does your firm belong?	Our firm's top management (i.e. top executives and major department heads) assumes responsibility for quality performance.	Our firm's top management provides personal leadership for quality products and quality improvement.	Our firm's top management is evaluated for quality performance.	Major department heads within our firm participate in the quality improvement process.	Quality issues are reviewed in our firm's management meetings.	Our firm's top management has objectives for quality performance.
Our firm's top management is evaluated for quality performance.	Pearson Correlation	-.249*	.721**	.834**	1	.787**	.804**	.851**
	Sig. (2-tailed)	0.036	0	0		0	0	0
	N	71	71	71	71	71	71	71
Major department heads within our firm participate in the quality improvement process.	Pearson Correlation	-0.099	.729**	.756**	.787**	1	.810**	.882**
	Sig. (2-tailed)	0.412	0	0	0		0	0
	N	71	71	71	71	71	71	71
Quality issues are reviewed in our firm's management meetings.	Pearson Correlation	-0.103	.756**	.755**	.804**	.810**	1	.900**
	Sig. (2-tailed)	0.394	0	0	0	0		0
	N	71	71	71	71	71	71	71
Our firm's top management has objectives for quality performance.	Pearson Correlation	-0.137	.808**	.837**	.851**	.882**	.900**	1
	Sig. (2-tailed)	0.254	0	0	0	0	0	
	N	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

6.4.2 Customer relationships

In this level of the research, a test of independence between firm type and customer relationships variables was performed. The firm type variable against we are frequently in close contact with our customers (P=0.002), our customers give us feedback on quality and delivery performance (P<0.001), our firm measures our

external customers' satisfaction (P=0.029) and our customers visit our firm (P=0.048) showed significant differences across firm type at 5% level of significance. However the variables, we use customer requirements as the basis for quality and our employees know who our customers are (P>0.05) indicated no significant differences across the firms. Further correlations between the variables showed that the variables are highly correlated but however none was correlated to the firm type variable.

Figure 6.3: Proportions of customer relationships

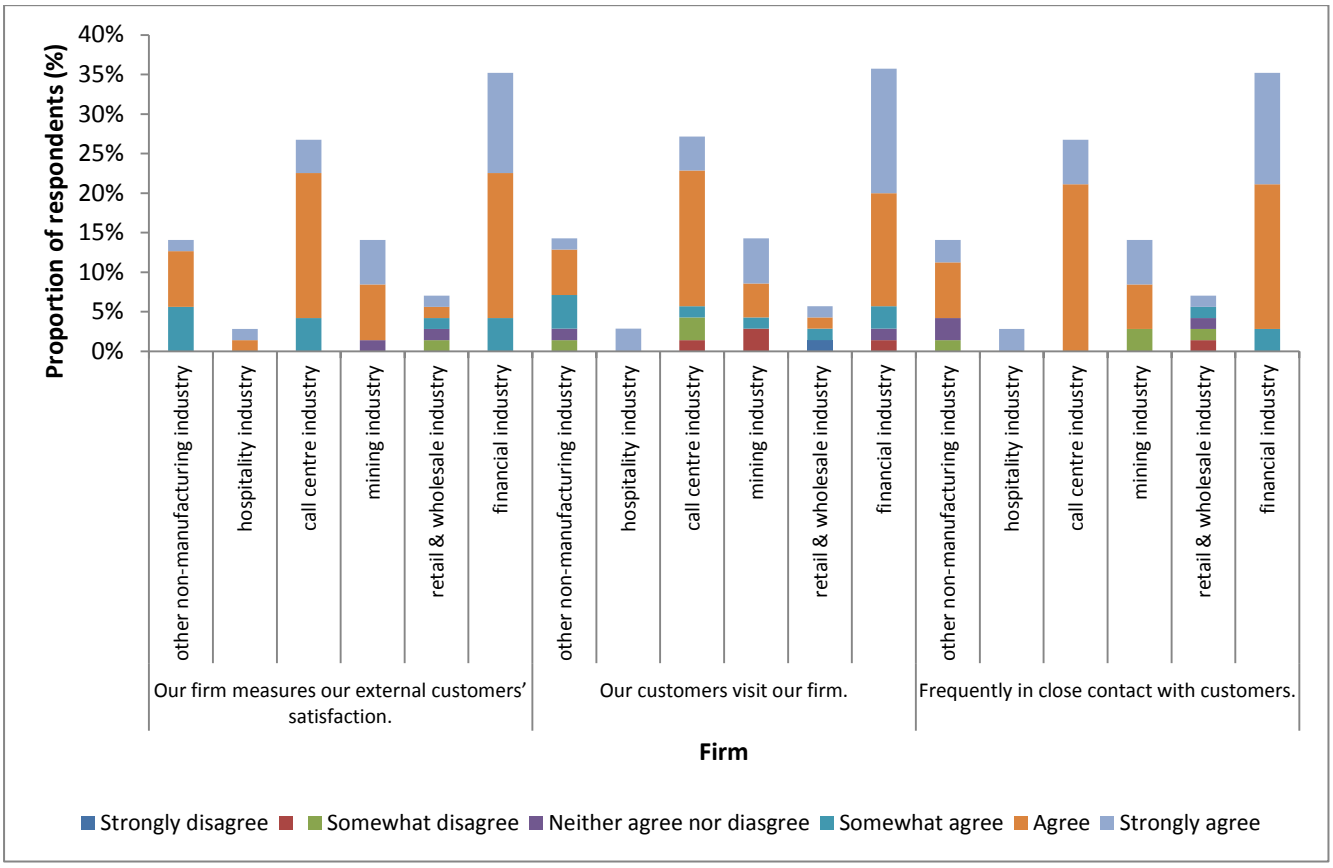


Table 6.9: Feedback on quality and delivery performance

			Our customers give us feedback on quality and delivery performance.						
			Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Total
Firm	other non-manufacturing industry	Count	0	1	0	4	4	1	10
		% of Total	0.0%	1.4%	0.0%	5.6%	5.6%	1.4%	14.1%
	hospitality industry	Count	0	0	0	0	1	1	2
		% of Total	0.0%	0.0%	0.0%	0.0%	1.4%	1.4%	2.8%
	call centre industry	Count	0	1	0	2	13	3	19
		% of Total	0.0%	1.4%	0.0%	2.8%	18.3%	4.2%	26.8%
	mining industry	Count	0	0	1	1	3	5	10
		% of Total	0.0%	0.0%	1.4%	1.4%	4.2%	7.0%	14.1%
	retail & wholesale industry	Count	1	0	3	0	0	1	5
		% of Total	1.4%	0.0%	4.2%	0.0%	0.0%	1.4%	7.0%
	financial industry	Count	0	0	0	4	11	10	25
		% of Total	0.0%	0.0%	0.0%	5.6%	15.5%	14.1%	35.2%
	Total	Count	1	2	4	11	32	21	71
		% of Total	1.4%	2.8%	5.6%	15.5%	45.1%	29.6%	100.0%

Count represents the observed frequencies.

6.4.3 Supplier's relationships

The analysis showed that there are differences between category of industries in terms of their striving to establish long-term relationships with suppliers ($P<0.05$) (see Figure 6.5), relying on a small number of high quality suppliers ($P=0.017$) and suppliers evaluation according to quality and delivery performance, and price, in that order ($p=0.003$). In terms of suppliers' involvement in quality training ($P=0.037$) (Figure 6.4), significant differences were noted across firm types. However, no significant differences were observed with respect to firm's thorough supplier rating system ($p>0.05$), provision of technical assistance to suppliers ($P>0.05$) and suppliers actively involved in product design/redesign process ($P>0.05$) (Appendix B).

Figure 6.4: Role of suppliers on quality aspects

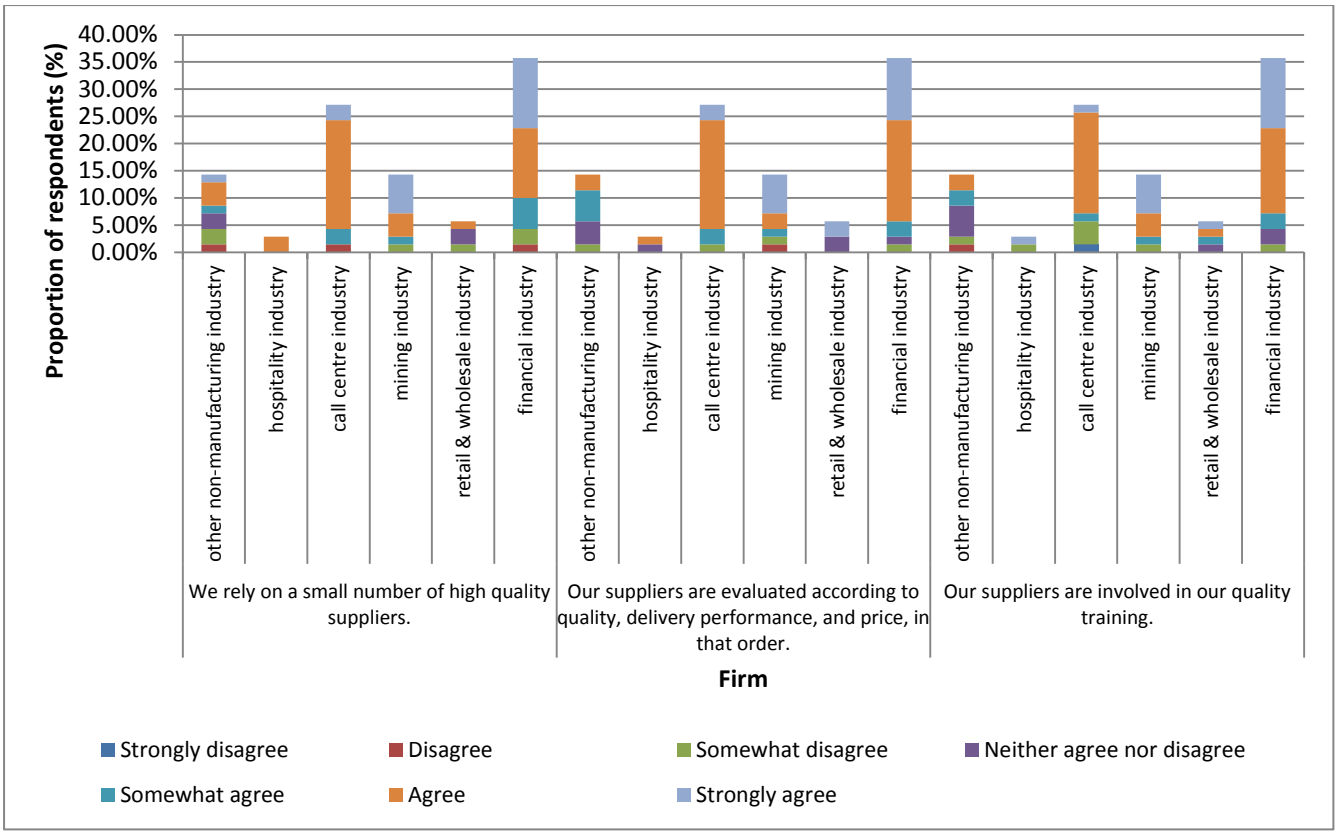
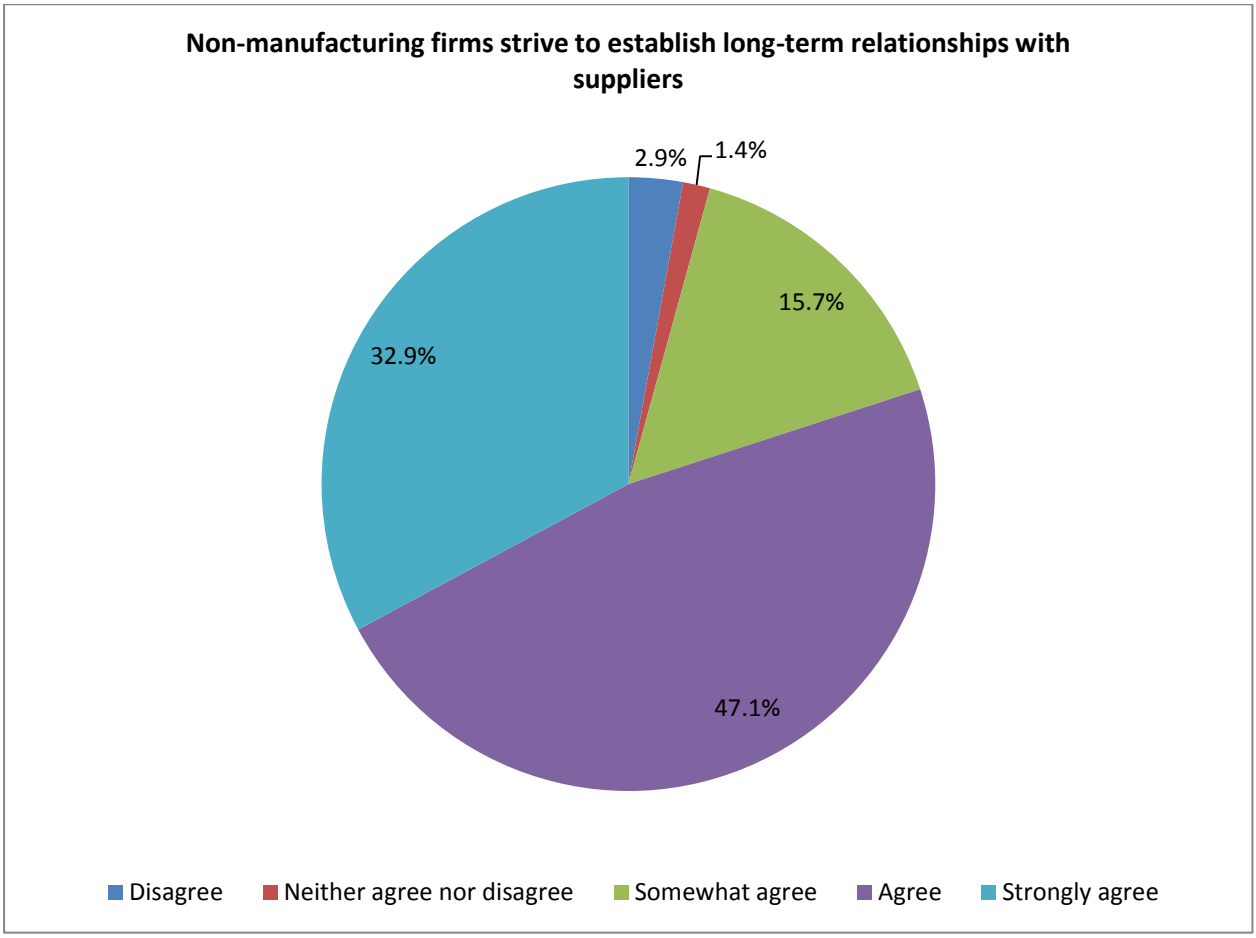


Figure 6.5: Supplier relationship



The graph above shows 47% plus 32.9% of the respondents' agreeing to the fact that their companies establish long-term relationships with their suppliers. An important point to note from the graph is the 2.9% of the respondents'' who disagree, although it seems to be a small figure.

6.4.4 Workforce management

The responses on workforce management were tested using different testing methods as shown on the table below. An interesting test reflected here is the Likelihood ratio test which was used at this instance to compare the fit of two models (the Null and the Alternative model). This expressed the number of times the data is more likely under one model than the other. Chi-square compares expected frequencies with observed frequencies that would occur most often if the Null hypothesis was true. The larger the chi-square values needed to achieve statistical significance, the more the degree of freedom.

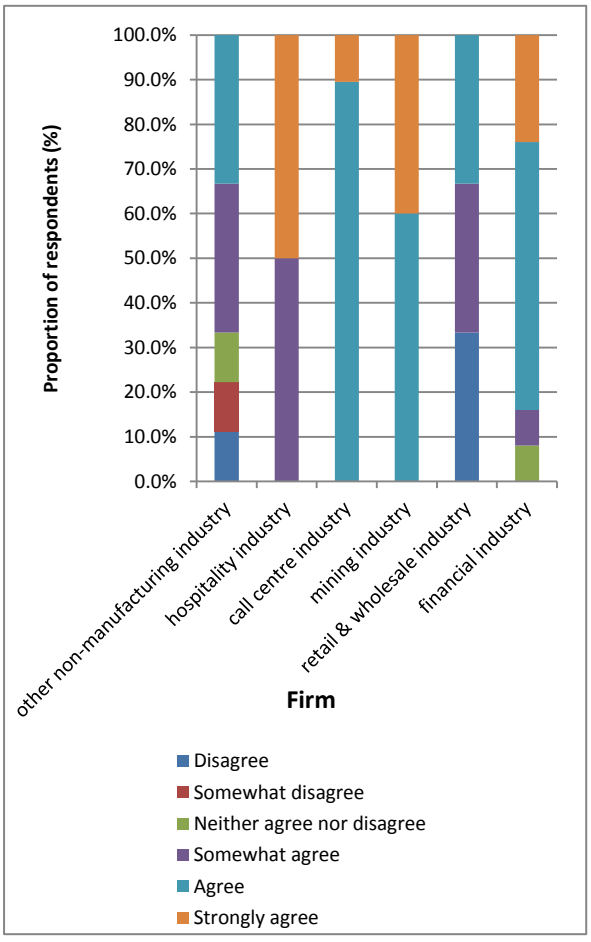
Table 6.10: Chi-Square Tests

		Pearson Chi-Square	Likelihood Ratio	Linear-by-Linear Association
Our firm forms teams to solve problems.	Value	75.207[a]	44.973	3.080
	Asymp. Sig. (2-sided)	.000	.008	.079
	df	25.000	25.000	1.000
Our firm gives feedback to employees on their quality performance.	Value	106.561[a]	53.597	5.618
	Asymp. Sig. (2-sided)	.000	.001	.018
	df	25.000	25.000	1.000
Our employees are recognized for superior quality improvement	Value	42.056[a]	36.236	2.747
	Asymp. Sig. (2-sided)	.003	.014	.097
	df	20.000	20.000	1.000
Hourly/non-supervisory employees are involved in quality decisions.	Value	45.031[a]	37.659	5.072
	Asymp. Sig. (2-sided)	.001	.010	.024
	df	20.000	20.000	1.000
Quality-related training is given to hourly workers in our firm.	Value	55.143[a]	49.884	10.037
	Asymp. Sig. (2-sided)	.000	.002	.002
	df	25.000	25.000	1.000
Supervisors encourage the persons who work for them to work as a team.	Value	77.149[a]	35.229	5.654
	Asymp. Sig. (2-sided)	.000	.019	.017
	df	20.000	20.000	1.000
Quality-related training is given to hourly workers in our firm	Value	37.375[a]	34.086	1.763
	Asymp. Sig. (2-sided)	.011	.026	.184
	df	20.000	20.000	1.000
Quality-related training is given to managers and supervisors in our firm.	Value	58.025[a]	40.494	8.121
	Asymp. Sig. (2-sided)	.000	.004	.004
	df	20.000	20.000	1.000
Training is given in the ''total quality concept'' (i.e., philosophy of company-wide responsibility for quality) in our firm.	Value	39.397[a]	39.094	3.318
	Asymp. Sig. (2-sided)	.001	.001	.069
	df	15.000	15.000	1.000
Training is given in the basic statistical techniques (such as histogram and control charts) in our firm	Value	62.798[a]	49.677	10.236
	Asymp. Sig. (2-sided)	.000	.002	.001
	df	25.000	25.000	1.000

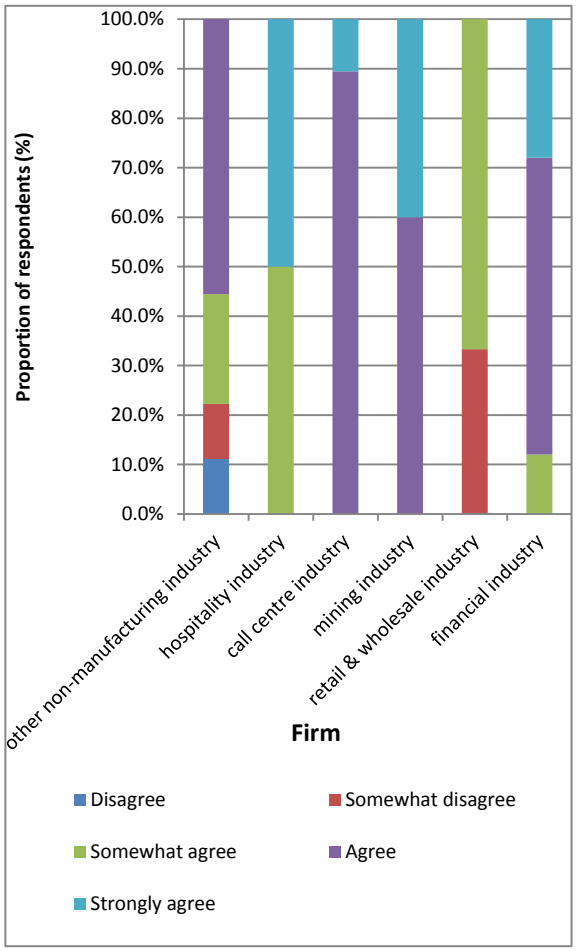
6.4: 5 Quality information

The figure below represents the results within firm assessments on availability of quality information and usage within different levels. Survey result shows that quality information is made available to all employees in different firms within the non-manufacturing companies. There is very high strong agreement on the responses to support the fact. The following figures represent the responses from the questions asked on each category as shown below each graph.

Figure 6.6: Quality information 1

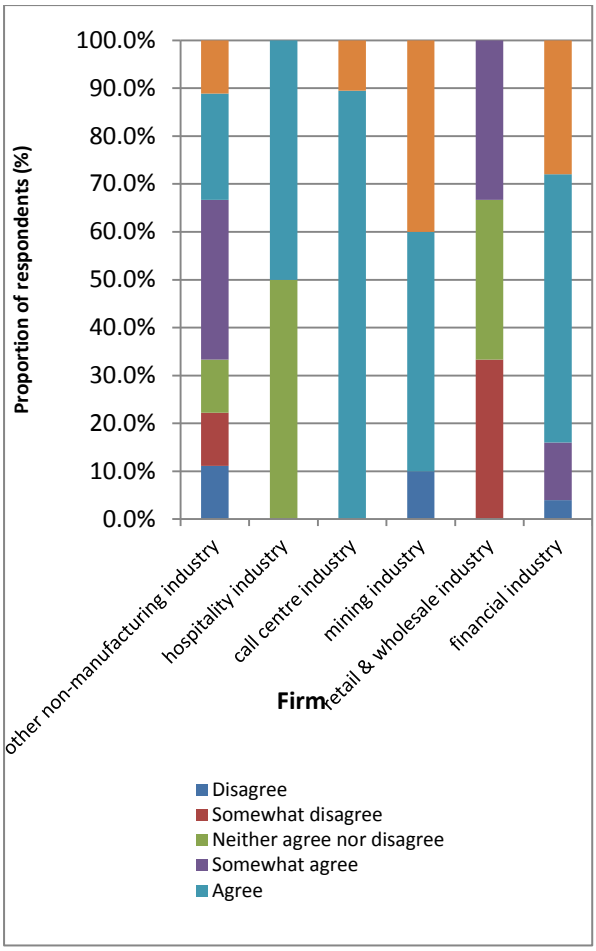


Quality data available in firm

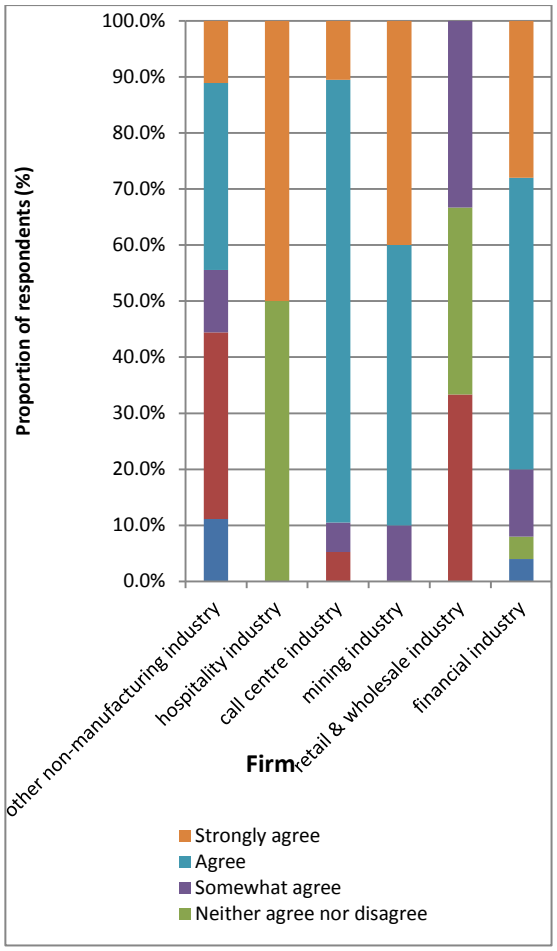


Quality data available to managers, engineers & supervisors

Figure 6.6: Quality information 2

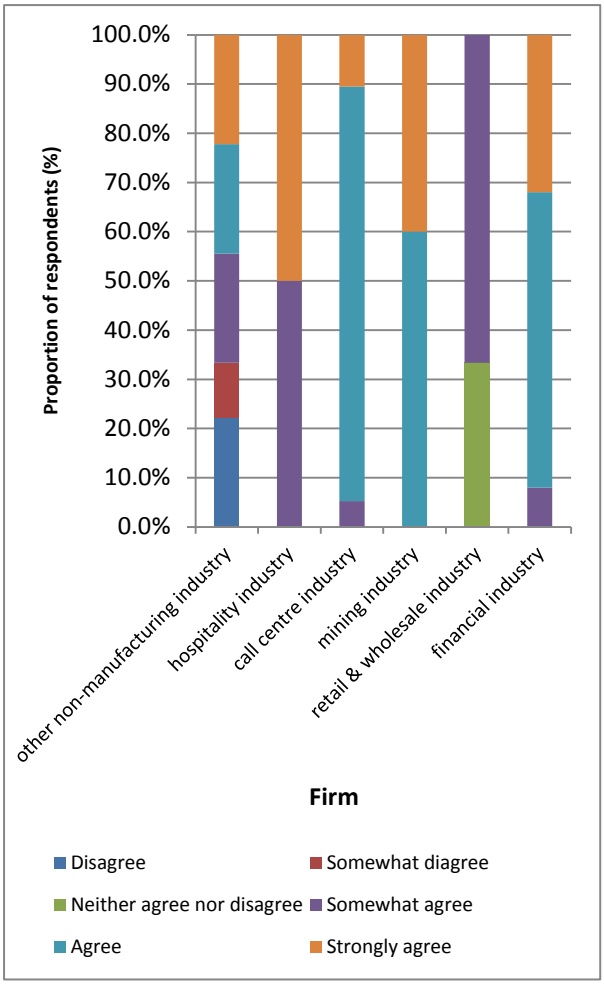


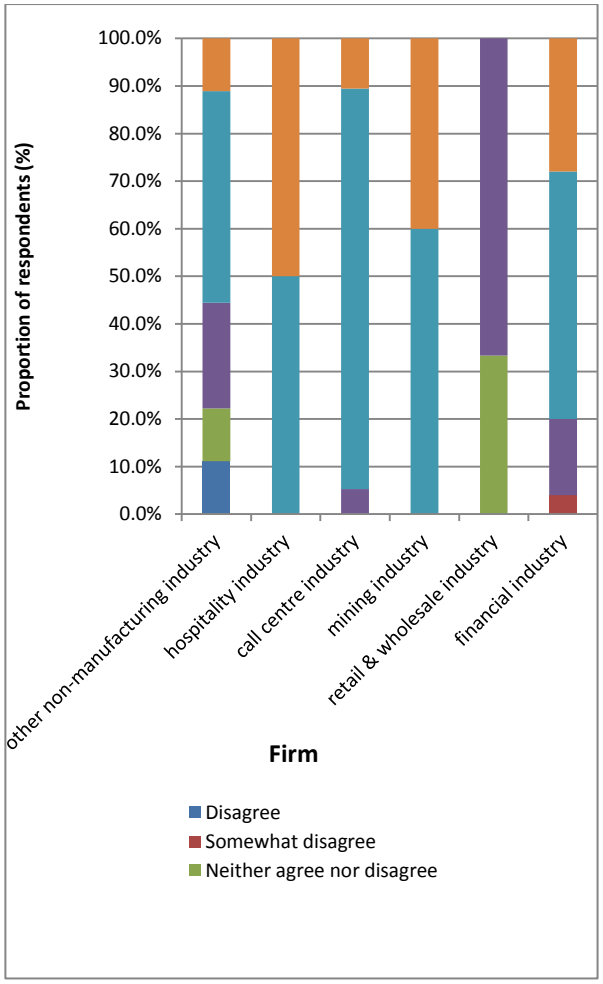
Quality data available to hourly/non-supervisory workers



Quality data is timely

Figure 6.6: Quality information 3





Quality data are used as tools to manage quality

Quality data are used to evaluate supervisory performance

6.4.6 Product/service design

Our firm conducts a thorough review of new product/service design before the product/service is produce (p=0.001). Multiple departments (such as marketing, manufacturing, and purchasing) coordinate in the product/service development process (P=0.001). Manufacturing and quality people are involved in the product/service development process (P=0.001). Quality of new products/services is emphasized in relation to cost or schedule objectives (P=0.007). We design for enhancing services (P=0.001). We make an effort, in the design process, to list only the specifications which are clearly needed (P=0.000).

Table 6.11: Product/service design

	Our firm conducts a thorough review of new product/service design before the product/service is produce.					Multiple departments coordinate in the product/service development process.					Manufacturing and quality people are involved in the product/service development process.				
	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Somewhat disagree	Neither agree nor Disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	1	2	2	2	1	0	3	1	3	1	0	2	1	4	1
	12.50%	25.00%	25.00%	25.00%	12.50%	0.00%	37.50%	12.50%	37.50%	12.50%	0.00%	25.00%	12.50%	50.00%	12.50%
hospitality industry	0	0	1	0	1	0	0	1	1	0	0	1	0	0	1
	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	50.00%	0.00%	0.00%	50.00%
call centre industry	0	0	1	16	1	1	0	1	15	1	0	0	3	14	1
	0.00%	0.00%	5.60%	88.90%	5.60%	5.60%	0.00%	5.60%	83.30%	5.60%	0.00%	0.00%	16.70%	77.80%	5.60%
mining industry	0	1	2	4	3	0	0	0	7	3	0	0	2	5	3
	0.00%	10.00%	20.00%	40.00%	30.00%	0.00%	0.00%	0.00%	70.00%	30.00%	0.00%	0.00%	20.00%	50.00%	30.00%
retail & wholesale industry	0	2	1	0	0	0	1	2	0	0	1	1	1	0	0
	0.00%	66.70%	33.30%	0.00%	0.00%	0.00%	33.30%	66.70%	0.00%	0.00%	33.30%	33.30%	33.30%	0.00%	0.00%
financial industry	0	1	0	16	8	0	0	1	17	7	0	0	1	17	7
	0.00%	4.00%	0.00%	64.00%	32.00%	0.00%	0.00%	4.00%	68.00%	28.00%	0.00%	0.00%	4.00%	68.00%	28.00%

	Quality of new products/services is emphasized in relation to cost or schedule objectives.				We design for enhancing services.					We make an effort, in the design process, to list only the specifications which are clearly needed.				
	Neither agree nor diagree	Somewhat agree	Agree	Strongly agree	Disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	1	2	3	2	0	3	0	4	1	0	3	2	2	1
	12.50%	25.00%	37.50%	25.00%	0.00%	37.50%	0.00%	50.00%	12.50%	0.00%	37.50%	25.00%	25.00%	12.50%
hospitality industry	0	0	2	0	0	0	0	2	0	0	0	0	2	0
	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
call centre industry	0	3	14	1	0	0	3	14	1	0	0	2	15	1
	0.00%	16.70%	77.80%	5.60%	0.00%	0.00%	16.70%	77.80%	5.60%	0.00%	0.00%	11.10%	83.30%	5.60%
mining industry	0	2	5	3	0	0	2	5	3	1	0	2	4	3
	0.00%	20.00%	50.00%	30.00%	0.00%	0.00%	20.00%	50.00%	30.00%	10.00%	0.00%	20.00%	40.00%	30.00%
retail & wholesale industry	0	3	0	0	1	0	2	0	0	1	0	2	0	0
	0.00%	100.00%	0.00%	0.00%	33.30%	0.00%	66.70%	0.00%	0.00%	33.30%	0.00%	66.70%	0.00%	0.00%
financial industry	0	1	16	8	0	0	0	17	8	0	0	0	17	8
	0.00%	4.00%	64.00%	32.00%	0.00%	0.00%	0.00%	68.00%	32.00%	0.00%	0.00%	0.00%	68.00%	32.00%

6.4.7 Process Management

Processes in our firm are designed to be ‘‘mistake-proof’’ to minimize the chances of errors (P<0.05), ‘We dedicate a portion of everyday solely to maintenance’ (P<0.05), ‘We usually meet the production schedule every day’ (P<0.05).

Table 6.12: Process management

	Processes in our firm are designed to be ‘‘mistake-proof’’ to minimize the chances of errors.					We dedicate a portion of everyday solely to maintenance.						We usually meet the production schedule every day.					
	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	0	2	3	2	1	0	2	3	1	2	0	2	2	1	0	3	0
	0.00%	25.00%	37.50%	25.00%	12.50%	0.00%	25.00%	37.50%	12.50%	25.00%	0.00%	25.00%	25.00%	12.50%	0.00%	37.50%	0.00%
hospitality industry	0	0	0	1	1	0	0	0	1	0	1	0	0	0	1	0	1
	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%
call centre industry	0	0	1	16	1	0	0	0	2	15	1	1	0	0	1	15	1
	0.00%	0.00%	5.60%	88.90%	5.60%	0.00%	0.00%	0.00%	11.10%	83.30%	5.60%	5.60%	0.00%	0.00%	5.60%	83.30%	5.60%
mining industry	0	0	1	5	4	1	1	0	0	4	4	0	0	0	3	3	4
	0.00%	0.00%	10.00%	50.00%	40.00%	10.00%	10.00%	0.00%	0.00%	40.00%	40.00%	0.00%	0.00%	0.00%	30.00%	30.00%	40.00%
retail & wholesale industry	1	0	1	0	0	0	1	1	0	0	0	0	0	2	0	0	0
	50.00%	0.00%	50.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%
financial industry	0	0	3	14	7	0	1	2	3	11	7	0	3	2	2	11	6
	0.00%	0.00%	12.50%	58.30%	29.20%	0.00%	4.20%	8.30%	12.50%	45.80%	29.20%	0.00%	12.50%	8.30%	8.30%	45.80%	25.00%

Production is stopped immediately for quality problems (P=0.058), our firm conducts preventive equipment maintenance (P=0.002), Clear work or process instructions are given to employees (P=0.028).

Table 6.13: Process management 2

	Production is stopped immediately for quality problems.						Our firm conducts preventive equipment maintenance.						Clear work or process instructions are given to employees.			
	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	0	3	1	1	2	1	1	1	2	0	4	0	1	4	3	0
	0.00%	37.50%	12.50%	12.50%	25.00%	12.50%	12.50%	12.50%	25.00%	0.00%	50.00%	0.00%	12.50%	50.00%	37.50%	0.00%
hospitality industry	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	1
	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	50.00%	50.00%
call centre industry	1	0	0	2	14	1	0	0	0	2	15	1	0	1	15	2
	5.60%	0.00%	0.00%	11.10%	77.80%	5.60%	0.00%	0.00%	0.00%	11.10%	83.30%	5.60%	0.00%	5.60%	83.30%	11.10%
mining industry	0	1	0	1	4	4	0	0	0	1	5	4	0	0	4	6
	0.00%	10.00%	0.00%	10.00%	40.00%	40.00%	0.00%	0.00%	0.00%	10.00%	50.00%	40.00%	0.00%	0.00%	40.00%	60.00%
retail & wholesale industry	0	0	1	1	0	0	0	1	0	0	1	0	0	1	1	0
	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	50.00%	0.00%	0.00%	50.00%	50.00%	0.00%
financial industry	0	3	3	1	10	7	0	0	1	7	10	6	1	4	13	6
	0.00%	12.50%	12.50%	4.20%	41.70%	29.20%	0.00%	0.00%	4.20%	29.20%	41.70%	25.00%	4.20%	16.70%	54.20%	25.00%

Our firm's shop floors are well organized and clean (P=0.808), A large number of the equipment or processes on the shop floor are currently under statistical process control (P=0.003), we make extensive use of statistical techniques to reduce variance in processes (P=0.006).

Table 6.14: Process management 3

	Our firm's shop floors are well organized and clean.				A large number of the equipment or processes on the shop floor are currently under statistical process control.						We make extensive use of statistical techniques to reduce variance in processes.					
	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	1	1	4	2	1	1	3	0	2	1	1	1	3	2	1	0
	12.50%	12.50%	50.00%	25.00%	12.50%	12.50%	37.50%	0.00%	25.00%	12.50%	12.50%	12.50%	37.50%	25.00%	12.50%	0.00%
hospitality industry	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	1
	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%
call centre industry	0	1	15	2	0	0	0	2	14	2	0	0	0	2	14	2
	0.00%	5.60%	83.30%	11.10%	0.00%	0.00%	0.00%	11.10%	77.80%	11.10%	0.00%	0.00%	0.00%	11.10%	77.80%	11.10%
mining industry	0	1	5	4	0	0	0	1	5	4	0	0	0	0	6	4
	0.00%	10.00%	50.00%	40.00%	0.00%	0.00%	0.00%	10.00%	50.00%	40.00%	0.00%	0.00%	0.00%	0.00%	60.00%	40.00%
retail & wholesale industry	0	0	2	0	0	1	0	1	0	0	0	0	1	1	0	0
	0.00%	0.00%	100.00%	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%
financial industry	1	2	13	8	0	0	2	4	12	6	0	0	2	3	12	7
	4.20%	8.30%	54.20%	33.30%	0.00%	0.00%	8.30%	16.70%	50.00%	25.00%	0.00%	0.00%	8.30%	12.50%	50.00%	29.20%

6.4.8 Six Sigma role structure

We employ a black/green belt role structure (or equivalent structure) for continuous improvement (P=0.002), we use a black/green belt role structure (or equivalent structure) to prepare and deploy individual employees for continuous improvement programs (P=0.001). In our firm, members of a quality improvement team have their roles and responsibilities specifically identified (P=0.001), The black/green belt role structure (or equivalent structure) helps our firm to recognize the depth of employees' training and experience (P=0.000), In our firm, an employee's role in the black/green structure (or equivalent structure) is considered when making compensation and promotion decisions (P=0.003), Our firm uses differentiated training so that employees who have different roles in the black/green belt role structure (or equivalent structure) can obtain the necessary knowledge and skills to fulfil their job responsibilities (P=0.002), see Appendix B.

Table 6.15: Six Sigma role structure

	We employ a black/green belt role structure (or equivalent structure) for continuous improvement.						We use a black/green belt role structure (or equivalent structure) to prepare and deploy individual employees for continuous improvement programs.						In our firm, members of a quality improvement team have their roles and responsibilities specifically identified.				
	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Somewhat disagree	Neither sgree nor disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	2	0	2	0	3	0	2	0	2	2	1	0	2	1	1	3	0
	28.60%	0.00%	28.60%	0.00%	42.90%	0.00%	28.60%	0.00%	28.60%	28.60%	14.30%	0.00%	28.60%	14.30%	14.30%	42.90%	0.00%
hospitality industry	1	0	0	0	1	0	1	0	0	0	1	0	0	0	1	1	0
	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%
call centre industry	0	1	0	1	14	2	0	1	0	1	14	2	0	0	1	16	1
	0.00%	5.60%	0.00%	5.60%	77.80%	11.10%	0.00%	5.60%	0.00%	5.60%	77.80%	11.10%	0.00%	0.00%	5.60%	88.90%	5.60%
mining industry	0	0	0	1	5	4	0	0	0	1	5	4	0	0	1	5	4
	0.00%	0.00%	0.00%	10.00%	50.00%	40.00%	0.00%	0.00%	0.00%	10.00%	50.00%	40.00%	0.00%	0.00%	10.00%	50.00%	40.00%
retail & wholesale industry	0	0	1	1	0	0	0	0	1	1	0	0	0	0	2	0	0
	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%
financial industry	0	1	1	1	14	7	0	1	1	1	15	6	0	1	2	15	6
	0.00%	4.20%	4.20%	4.20%	58.30%	29.20%	0.00%	4.20%	4.20%	4.20%	62.50%	25.00%	0.00%	4.20%	8.30%	62.50%	25.00%

6.4.9 Six Sigma Structured improvement procedure

In our firm, continuous improvement projects are conducted by following a formalised procedure (such as DMAIC—Define, Analyse, Improve and Control) (P=0.037), We use a structured approach to manage quality improvement activities (P=0.000), We have a formal planning process to decide the major quality improvement projects (P=0.020), All improvement projects are reviewed regularly during the process (P=0.031), We keep records about how each continuous improvement project is conducted (P=0.013), In our firm, the product design process follows a formalised procedure (P=0.000).

Table 6.16: Six Sigma Structured improvement procedure 1

	In our firm, continuous improvement projects are conducted by following a formalized procedure (such as DMAIC—Define, Analyse, Improve and Control).				We use a structured approach to manage quality improvement activities.				We have a formal planning process to decide the major quality improvement projects.				
	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	1	2	3	1	0	5	2	0	0	0	2	5	0
	14.30%	28.60%	42.90%	14.30%	0.00%	71.40%	28.60%	0.00%	0.00%	0.00%	28.60%	71.40%	0.00%
hospitality industry	0	0	2	0	0	0	2	0	0	0	0	2	0
	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
call centre industry	0	2	15	1	0	2	15	1	0	0	1	15	1
	0.00%	11.10%	83.30%	5.60%	0.00%	11.10%	83.30%	5.60%	0.00%	0.00%	5.90%	88.20%	5.90%
mining industry	0	1	5	4	0	1	5	4	1	0	0	5	4
	0.00%	10.00%	50.00%	40.00%	0.00%	10.00%	50.00%	40.00%	10.00%	0.00%	0.00%	50.00%	40.00%
retail & wholesale industry	1	1	0	0	1	1	0	0	0	1	0	1	0
	50.00%	50.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%
financial industry	1	1	16	6	1	1	16	6	0	1	1	16	6
	4.20%	4.20%	66.70%	25.00%	4.20%	4.20%	66.70%	25.00%	0.00%	4.20%	4.20%	66.70%	25.00%

Table 6.16: Six Sigma Structured improvement procedure 2

	All improvement projects are reviewed regularly during the process.					We keep records about how each continuous improvement project is conducted.					In our firm, the product design process follows a formalized procedure.				
	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
other non-manufacturing industry	1	0	1	5	0	1	0	2	4	0	0	0	3	4	0
	14.30%	0.00%	14.30%	71.40%	0.00%	14.30%	0.00%	28.60%	57.10%	0.00%	0.00%	0.00%	42.90%	57.10%	0.00%
hospitality	0	0	0	2	0	0	0	0	2	0	0	0	0	2	0
	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
call centre industry	0	0	1	16	1	0	0	1	16	1	0	0	1	16	1
	0.00%	0.00%	5.60%	88.90%	5.60%	0.00%	0.00%	5.60%	88.90%	5.60%	0.00%	0.00%	5.60%	88.90%	5.60%
mining industry	0	0	1	5	4	0	0	1	4	5	1	0	0	5	4
	0.00%	0.00%	10.00%	50.00%	40.00%	0.00%	0.00%	10.00%	40.00%	50.00%	10.00%	0.00%	0.00%	50.00%	40.00%
retail & wholesale industry	0	1	0	1	0	1	0	0	1	0	0	2	0	0	0
	0.00%	50.00%	0.00%	50.00%	0.00%	50.00%	0.00%	0.00%	50.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%
financial industry	0	1	1	16	6	0	1	1	16	6	0	1	1	16	6
	0.00%	4.20%	4.20%	66.70%	25.00%	0.00%	4.20%	4.20%	66.70%	25.00%	0.00%	4.20%	4.20%	66.70%	25.00%

6.4.10 Six Sigma focus on metrics

The Six Sigma method focused on metrics variables showed no significant differences across the different industry categories. All the variables showed the p-values greater than 5% which was the level of significance. The chi-square tests gave the following p-values for each tested variable; our firm sets strategic goals for quality improvement in order to improve firm financial performance (P=0.715), Our firm has a comprehensive goal-setting process for quality (P=0.614), Quality goals are clearly communicated to employees in our firm (P=0.585), In our firm, quality goals are challenging (P=0.105), In our firm, quality goals are clear and specific (P=0.690), Our firm translates customers' needs and expectation into quality goals (P=0.826), We make an effort to determine the appropriate measures for each quality improvement project (P=0.590), In our firm, measures for quality performance are connected with the firm's strategic quality goals (P=0.864).

The expected financial benefits of a quality improvement project are identified during the project planning phase (P=0.219), Financial performance (e.g., cost savings, sales) is part of the criteria for evaluating the outcomes of quality improvements in our firm (P=0.116), We assess the performance of core processes against customers' requirements (P=0.818), The measures for quality performance are connected with critical-to-quality (CTQ) characteristics (P=0.464), Our firm systematically uses a set of measures(such as defects per million opportunities, sigma level, process capability indices, defects per unit, and yield) to evaluate process improvements (P=0.353). The full cross tabulated tables are given in Appendix B.

6.4.11 Diversity of opinions on the Lean Six-Sigma Implementation

Table 6.17: Diversity of opinions on the Lean Six-Sigma Implementation

Diversity statistic	Different Six-Sigma Group Variables Assessed in the survey											
	Supplier Feedback	JIT delivery	Supplier Development	Customer Involvement	PULL	Continuous Flow	Setup-Time reduction	SPC	Employee Involvement	TPM	Quality Performance	Business Performance
Taxa S	7	6	6	7	5	6	6	6	5	6	6	6
Individuals	315	188	377	433	247	304	295	235	236	233	348	348
Dominace D	0.4185	0.3745	0.4205	0.4274	0.4443	0.5167	0.5139	0.5129	0.4955	0.4774	0.4746	0.5168
Simpson Index	0.5815	0.6255	0.5795	0.5726	0.5557	0.4833	0.4861	0.4871	0.5045	0.5226	0.5254	0.4832
Evenesse^H/S	0.479	0.5926	0.5566	0.4599	0.5982	0.4464	0.4332	0.4432	0.5317	0.4748	0.459	0.4316

Opinions were very diverse on the aspect of JIT delivery, were respondents showed that there is 62.55 % chance that opinions differ if any two individuals' opinion is sought. This was followed by the aspect of supplier feedback with 58.15% chance that we obtain diverse opinions. Opinions were agree on business performance, continuous flow, SPC and setup-reduction time, were the probabilities of two respondents giving us different opinions was quite low, with value of 0.4871 and below.

The individual statistic representing the total number of opinions observed regardless of the type of opinion showed that more opinions were observed on customer involvement (433); supplier development (377), the least total number of individual opinions was on JIT delivery. The evenness of opinions showed that there was evenly distribution on PULL (0.5982), meaning to say individuals in strongly disagree, disagree, somewhat disagree, neither disagree nor agree, somewhat agree, agree and strongly agree were even in those categories. However, low values of evenness are on business performance.

6.4.12 Non-parametric correlation analysis

The survey include questions that are intended to (1) verify the occurrence of a positive correlation between the model of operations management used in the company and the decision areas of the organisations (R1), (2) determine whether there is a positive correlation between the decision areas and the performance dimensions (R2).

Validation of the R1 relationship

The objective of R1 was to test the impact the adopted models had on decision areas. Since in relationship R1 of TCM, the parametric data were correlated with the non-parametric data (numerical and interval), the statistical test used was the chi-square test one-way analysis of variance. With these assumptions, the hypotheses of the statistical test were defined. For R1:

- H0: $p > 0.05$, Current continuous improvement methods within non-manufacturing companies do not incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are not performing optimally;
- H1: $p < 0.05$, Current continuous improvement methods within large non-manufacturing companies incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are performing optimally.

Once the hypotheses and the significance levels were determined, tests were carried out using statistical software to evaluate the data relating on the survey. The relationship results showed specifically for which relations H0 was rejected, that is, where there was a significant difference regarding the relationship of the management model adopted and the decision areas of the company.

Conducting the chi-square test for each decision area, a significant difference was found between the Six Sigma, lean and LSS models in the decision areas Facilities, Vertical Integration and PPC. For the other decision areas, there was no significant difference in the actions taken. That is, regardless of the model used by the companies, the intensity with which they took actions was similar in the decision

areas Capacity, Technology of Manufacturing Processes, Organisation, Quality, Human Resources, Introduction of New Products and Performance Measurement Systems (PMS). Table 6.18 shows the 'p' values of the chi-square test obtained using the Statistical software.

Table 6.18: 'p' values, chi-square test

Decision area	Model	Decision area	Model
Capacity	0.38	Quality	0.81
Facilities	0.02	PPC	0.02
Process Technology	0.13	Human Resources	0.65
Vertical Integration	0.03	Customer Centricity	0.28
Organisation	0.18	PMS	0.27

Although the three models studied have different characteristics yet similar objectives, it is acceptable that many of the decision areas overlap. For example, the cultural issue relates to the decision areas of Human Resources and Organisation. It is worthy to note that the research aimed to identify how necessary it is to take action in each decision area and not what actions should be taken. Both the Six Sigma and lean models value the qualifications of employees and check the profile of people that can carry out the duties and implement the model tools more effectively. A considerable change between the two models in the area of Human Resources is related to the degree of autonomy and employee participation. With lean, employees of all levels are encouraged to solve problems and continuously improve their activities. While in Six Sigma, the emphasis is on training a smaller group of employees in the use of statistical and quality tools, forming a group of experts who will lead improvements, aligned with the results obtained by Gutiérrez (2012).

Considering that LSS is the combined application of lean manufacturing and Six Sigma, it is important to analyse some of the differences between lean and Six Sigma in the decision areas. Some of the differences between lean and Six Sigma in Facilities are in the approach of lean related to continuous improvement of processes as a result of changes in layout and reducing excessive movements, for example (Staatsa 2011). While Vertical Integration in Six Sigma projects calls for decisions aimed at the supply system and consequently its suppliers, lean requires a

greater integration of the supply chain so that its objectives are met, such as more frequent and reliable delivery of materials (Shahin, 2006; Näslund, 2008). Finally, the PPC is an area of great importance for the lean system and that is why the area is going through major changes to adapt to the new production management system, from the process of demand management, capacity planning, signalling of the need for materials and the quantity to be produced, among others (Pepper & Spedding 2010; Singh, Garg & Sharma, 2010). In Six Sigma, the improvement projects are carried out without direct dependence on changes in the PPC area.

Validation of the R2 relationship

To test the second relationship, the following question was asked for each decision area, 'In relation to Capacity (and again for each of the decision areas), do the actions taken as a result of using the improvement management model and production management of your company contribute to the improvement of the following performance indicators: speed, quality, flexibility, reliability, cost and innovation?' For each decision area and performance dimension, respondents had to mark the answer on a Likert scale. The Spearman correlation test (R) was carried out, because the two are interval scales. For R2:

• H0: R= 0. There is no positive correlation between the variables.
• H1: R ≠ 0. There is a positive correlation between the variables, where R is the correlation coefficient of Spearman. Significance level (α) = 0.05

Based on the results from the correlations of R1, the block of five questions from the survey instrument was tested, that is, the R2 relationship between the decision areas and the six competitive priorities. Table 6.19 illustrates the correlation test between R1 and R2.

Table 6.19: Summary of correlations between decision areas and performance dimensions with a significance level of α < 0.05.

AD X CP	speed	Quality	Flexibility	Reliability	Cost	Innovation
Capacity	YES	YES	YES	YES	YES	YES
Facilities	YES	YES	YES	YES	YES	YES
Process Technology	YES	YES	YES	YES	NO	NO
Vertical Integration	YES	YES	YES	YES	YES	YES
Organisation	YES	YES	YES	YES	YES	YES
Quality	YES	YES	YES	YES	YES	NO
PPC	YES	YES	YES	YES	YES	YES
Human Resources	YES	YES	YES	YES	YES	YES
Customer Centricity	YES	YES	YES	YES	YES	YES
PMS	YES	YES	YES	YES	YES	YES

The results indicate that all of the decision areas correlate with at least part of the six competitive priorities: speed, quality, flexibility, reliability, cost and innovation.

To arrive at more detailed conclusions, a bivariate cross-tabulation was carried out for all correlations. The set of data in Tables 6.20 to 6.22 shows the tabulation for all 10 decision areas. The tabulation shows the average percentage of interaction between the decision areas and performance dimensions, within a 95% confidence interval. The first part of the analysis focused on the decision areas that show no differences in the use of the models individually, that is, the intensity of the actions taken in these areas was essentially the same for all of the models used (Six Sigma, lean or LSS).

They are as follows: Capacity, Process Technology, Organisation, Quality, Human Resources, New Products and PMS. For the decision area Capacity, the following competitive priorities stood out the following: speed and reliability (80%), cost (73%) and quality (71%). This means that the majority of companies studied achieved positive results in these performance dimensions when investing in capacity, regardless of the management model used. The confidence interval limits can be considered. These results are aligned with the results obtained by Laureani (2010), Snee (2010) and Antony (2011). Manufacturing Process Technology had high average percentages in the following performance dimensions: speed (81%), quality (79%), flexibility (73%) and reliability (71%). In the decision area Organisation, there was no performance dimension index over 70%, taking into account that the

methodology was not studied in isolation, since with lean and LSS the Organisation area directly helps flexibility performance, for example. For the decision area Quality, the most significant dimensions were Quality (83%) and Reliability (75%), that is, companies that invested in quality had higher performance indicators for Quality and Reliability than Products and Processes. For Human Resources, the quality dimension stood out the most with 70%, that is, companies that invest in people, recruiting, training and communication have a high return on the quality indicator.

This finding corroborates with the literature, because for the implementation of any one of the three models studied, there is a need for constant training of employees and this means that the focus of organisations is the people. For the decision area Introduction of New Products, performance dimensions like innovation (76%) and reliability (71%) stood out with a high average percentage. Results showed that when policies were created affecting new products, innovation and reliability indicators tended towards positive results, that is, for the companies surveyed, product innovation results in increased reliability. In the case of lean more specifically, this model shows the need for a longer product cycle. In other words, after the start of production of a new product, it is important to allow time for the results of the improvements to be incorporated.

Table 6.20: Cross tabulation for decision areas and the competitive priorities

AD X CP	Capacity		Facilities		Process technology		Vertical Integration		Organisation	
Performance objective	No.	% Average	No.	% Average	No.	% Average	No.	% Average	No.	% Average
speed	73	80	68	75	74	81	63	70	56	62
Quality	65	71	64	70	62	79	65	72	60	66
Flexibility	60	66	64	70	66	73	61	68	54	59
Reliability	73	80	62	68	65	71	64	71	60	66
Cost	66	73	62	68	59	65	59	66	59	65
Innovation	54	59	51	56	55	60	51	57	43	47

Table 6.21: Cross tabulation for decision areas and the competitive priorities

AD X CP	Quality		PPC		Human Resources		Customer Centricity		PMS	
Performance objective	No.	% Average	No.	% Average	No.	% Average	No.	% Average	No.	% Average
speed	53	60	72	81	51	57	58	64	62	69
Quality	74	83	50	56	62	70	60	67	68	76
Flexibility	53	60	63	71	45	51	62	69	61	68
Reliability	67	75	62	70	52	58	64	71	67	74
Cost	56	63	58	65	56	63	60	67	68	76
Innovation	49	55	40	45	46	52	68	76	56	62

Table 6.22: Cross tabulation for facilities decision area and the competitive priorities

Decision area: facilities	six sigma		lean		customer centricity		lean six sigma	
Performance objective	No.	% Average	No.	% Average	No.	% Average	No.	% Average
speed	59	82	84	68	146	81	66	100
Quality	62	82	86	67	145	73	65	81
Flexibility	61	82	88	67	147	73	67	81
Reliability	60	82	89	75	148	71	68	88
Cost	63	73	83	68	150	68	70	75
Innovation	64	64	85	61	149	62	69	31

Table 6.23: Cross tabulation for Vertical Integration decision area and the competitive priorities

Decision area: vertical integration	six sigma		lean		customer centricity		lean six sigma	
Performance objective	No.	% Average	No.	% Average	No.	% Average	No.	% Average
speed	71	82	84	38	15	63	78	88
Quality	73	82	86	39	20	81	77	83
Flexibility	76	64	88	38	18	69	80	78
Reliability	72	100	89	41	17	50	83	76
Cost	75	82	83	33	16	75	82	75
Innovation	73	64	85	32	185	44	76	60

In order to detail the information of these decision areas, bivariate cross-tabulation was used again, testing the performance dimensions of each methodology individually, Six Sigma, lean and LSS. The results of the three areas that show

significant differences for the three models – Facilities, Vertical Integration and PPC are presented in Tables 6.22 and 6.23.

For the decision area Facilities, analysing the Six Sigma model individually, it was found that the competitive priorities speed (82%), quality (82%), flexibility (82%), reliability (82%) and cost (73%) have a higher average percentage. While for the lean manufacturing model, the most outstanding dimension is reliability (75%). That is, approximately 87% of respondents pointed to this dimension as having the most significant results for the model in this decision area. With respect to LSS, it was found that the performance dimensions with the highest average percentage were the same as those for the Six Sigma model, the most notable being speed at 100%.
For the decision area Vertical Integration in the case of the Six Sigma model, the priorities speed (82%), quality (82%) and cost (82%) had a mean percentage value over 70%, the most notable being reliability at 100%. In lean methodology, the competitive priorities with the greatest return were reliability (73%) and quality (70%). In LSS, the dimensions with the highest average percentages were quality (81%), reliability (75%) and cost (75%).

Table 6.24 shows that the Cronbach Alpha index is 0.992; therefore, this set of variables are linearly correlated and are measuring a latent dimensional construction. The value obtained shows that the variables selected are consistent with each other.

Table 6.24: Inter-item Correlation Matrix

	Items	11	12	13	14
11		1	0.484	0.36	0.46
12		0.484	0.1	0.621	0.5
13		0.36	0.621	1	0.404
14		0.46	0.5	0.404	1

From the Inter-item Correlation Matrix shown in Table 6.24 it can be seen that all items have positive values, thus no favourable conditions are created for development of negative relationships between the items analysed. Therefore considering the average above 4 obtained in the performed analysis, the Cronbach's Alpha analysis and the results of the inter-Item Correlation Matrix we can conclude that the first hypothesis can be validated: Current continuous improvement methods within non-manufacturing companies do not incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are not performing optimally. Lean Six Sigma leaders not only have to incorporate customer centricity on their Lean Six Sigma initiatives but to act as catalysts for change, they also have to be facilitators of those changes from their position as experts in the change process.

It is due to this reason why non-manufacturing organisation fail to implement Lean Six Sigma. Their leadership view this exercise as a daunting task and an impossible undertaking in their environment In addition, the quality leaders have to improve their working practices in accordance with their own vision which should match the organization's vision. In order to achieve this, they must identify and exploit new ways of collecting customer feedback and effectively use them to improve the organization, which can lead to modernisation in different and complex environments where collaboration, virtual teams and alignment are more challenging and finally, to have more influence among the organisation's top management.

In order to test the second hypothesis, the survey included questions related to employee motivation in different stages of the project implementation. The results are presented using a cloud point diagram as shown in Figure 6.7. The diagram represents the dependence of a variable to another, both studied in the same category of respondents and it shows the potential causal relationship between the two analysed factors.

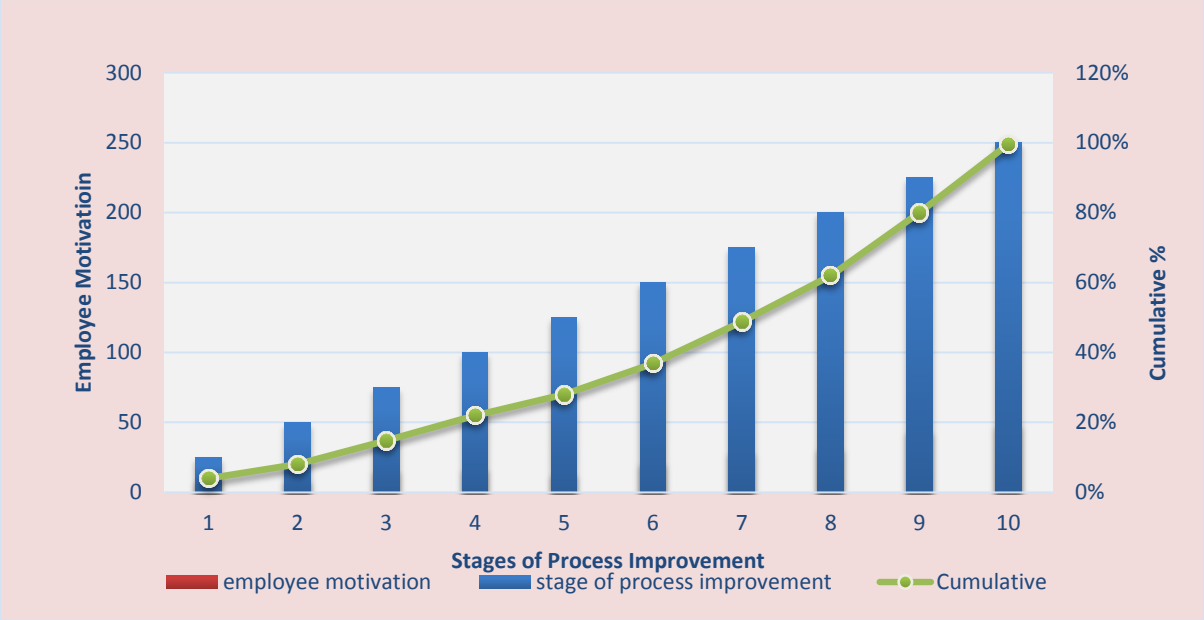


Figure 6.7: Correlations between employee motivation and stages of process improvement

In Figure 6.8 bellow we presented the main service organisation deficiencies, which act as an impediment in organisation cultural change, by applying the Pareto diagram to the data collected through the survey performed. The level of concern shows the cumulative values obtained by each cause obtained by applying the Likert scale. The causes were identified by reference to lead practices. The diagram shows that the first three causes cover 81% of the total deficiencies.

It can be seen that the difficult identification of the process in general, especially identifying those processes that can be improved through Lean Six Sigma, the leaders' lack of confidence in project success and the reduced involvement of employees are the main causes which acts as an impediment in organisation cultural change. After organisations analyse the main causes the leaders and top management have the option to define the proper measures to break down the barriers created between managers and theirs subalterns and may rebuild the diagram.

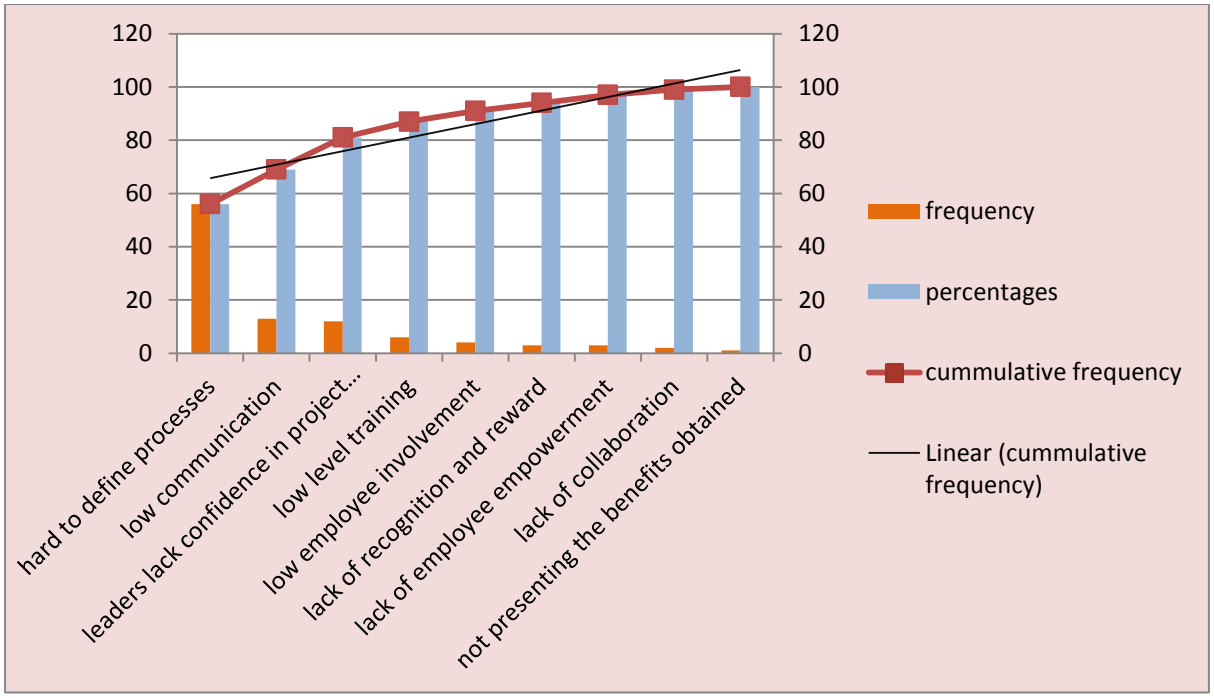


Figure 6.8: Pareto diagram

6.5 CONCLUSION

This chapter presented the results and findings of the data analysis. The information was analysed by using the statistical package SPSS. Descriptive statistics and central tendency statistics was used to establish the Critical Success Factors. The Cronbach coefficient alpha test was applied to test for reliability. A high degree of reliability was established. Anova-Tests, z-Tests and Chi-square Tests were used to test the assumptions of the research study. Correlation tests and comparison dispersions tests were performed and the results can be viewed in Appendix B appended. All propositions were tested and analysed.

The results presented in this study highlights that the leadership adopted by the organisation management may have a significant influence on their employees. The leaders' attitude may lead to a positive employee perception regarding his involvement in continuous improvement projects. Service organisations usually establish their goals and objectives in order to increase their customer satisfaction and this can be achieved by applying Lean Six Sigma methodology to their existing processes while considering the long-term goal of increasing the organisation's profitability.

By lowering the level of concern for the causes identified through Pareto diagram, service organisations can obtain a long-term significant cultural benefit that would facilitate the changing process of organisational culture. Lean Six Sigma organisations have the power to foster a climate of continuous organisational change by aligning the organisation vision to the excellence model. When top management decides to change the organisation culture, all the steps have to be made to accomplish that. A good communication and a leadership based on employee motivation can make important steps in developing continuous improvement projects. A dedicated employee may bring to an organisation only benefits, because if it feels that his work is important to his leader and that he is appreciate he will be more bounded to his workplace and he will put in a significant effort to do his job at a maximum efficiency. Due to the ever fiercer competition, leadership based on Lean Six Sigma can be a solution for service organisations to become competitive on international markets. There is a strong need for vision in every service organisation and motivation plays and important role in employees' development which in return can lead to higher organisation performance. In the next chapter the results and findings from this chapter will be discussed. An evaluation of each proposition against previous research and literature, and more importantly, in the direction of the findings of the survey, will be discussed and furnished.

Chapter 7

Conclusions and recommendations

7.1 INTRODUCTION

South African non-manufacturing companies are not adopting Lean Six Sigma to the point where it is going to make any sort of significant difference to the bottom line over a significantly meaningful period of time judging from the statistical analysis from the survey results presented on this study. So where are they going wrong? In the previous chapter, the statistical analysis revealed significant data differences, most of which are due to improper deployment of the continuous improvement methodologies. Often it comes down to key issues that are not addressed effectively as part of the deployment. The results presented in this study highlights that the leadership adopted by the organisation management may have a significant influence on their employees.

The leaders' attitude may lead to a positive employee perception regarding their involvement in continuous improvement projects. Service organisations usually establish their goals and objectives in order to increase their customer satisfaction and this can be achieved by applying Lean Six Sigma methodology to their existing processes while considering the long-term goal of increasing the organisation profitability. By lowering the level of concern for the causes identified through Pareto diagram, service organisations can obtain a long-term significant cultural benefit that would facilitate the changing process of organisational culture. Lean Six Sigma organisations have the power to foster a climate of continuous organisational change by aligning the organisation's vision to the excellence model.

When top management decides to change the organisation culture, all the steps have to be made to accomplish that. A good communication and a leadership based on employee motivation can make important steps in developing continuous improvement projects. A dedicated employee may bring to an organisation only benefits, because if it feels that his work is important to his leader and that he is

appreciate he will be more bounded to his workplace and he will put in a significant effort to do his job at a maximum efficiency.

7.2 DISCUSSION ON FINDINGS

The framework provides for clearly defining the project infrastructure and methodology before the Lean Six Sigma project begins. This clearly helps to gain funding to embark on the projects, and will be helpful in any non-manufacturing company that must justify, as most do, how they spend the capital budget. The detailed cost/benefit analysis created during the implementation phase provides for the ability to gain funding for the implementation activities. Even though the majority of the improvements implemented required very little capital investment, if consultants are used, their fees will need to be justified. In this chapter, the researcher concludes the study with a discussion of the research findings, and draws conclusions and recommendations.

The author's major contributions to the research are:

- Performed a literature review to understand the need for developing an implementation framework for Lean Six Sigma in non-manufacturing companies.
- Developed framework components, the building blocks of the framework roadmap.
- Reviewed the literature to understand the critical success factors related to process improvement and quality management programs to ensure that the framework components were based on sound theory.
- Developed the SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap) that provides the activities, principles, tools and important component factors to implement Lean Six Sigma.
- Derived conclusions from the case study to identify improvements to the framework and provide additional areas of research.
- Performed empirical research to collect primary data in support of the conclusions and recommendations.

The study adopted and modified an empirically developed operational measurement in a set of forty-eight items included in ten scales, reflecting a comprehensive set of Lean practices. These scales cover the ten distinct dimensions of Lean system which was also maintained in this research instrument. Seventy four items included in ten scales were identified for Six Sigma, and the ten scales were retained for the purpose of this research instrument but some questions were dropped in order to add more relevant material especially regarding customer centricity. All dimensions combined were 23 and the discussion below focuses on some key areas of interest from the selected elements below:

I. Top management support

The correlations between the variables defining management support in implementing Lean Six Sigma (LSS) showed that the variables were highly correlated, indicating that variables were the same (Table 6.3). However when correlated against the firm variable, the firm's top management assuming responsibility, providing personal leadership for quality products and quality improvement and evaluating for quality performance showed strong inverse correlations. It is vital to engage middle and senior managers as they play a pivotal role in the decision making and strategy development of the organisation. Not only will their engagement facilitate the implementation of ideas and improvements, but, by modeling and reinforcing associated behaviours', they will cause an exponential adoption of similar behaviours by others. Without the engagement of middle and senior management, adoption of Lean and Six Sigma is highly likely to flounder and die.

II. Customer relationship

The correlations between the variables showed that the variables are highly correlated but however none was correlated to the firm type variable. Customer relationship is important in non-manufacturing environment since this industries deal directly with customers on a day-to-day basis. Failure to properly manage and meet customer demands and needs might result to serious damaging results for any organisation.

III. Supplier relationship

The analysis showed that there are differences between category of industries in terms of their striving to establish long-term relationships with suppliers (Figure 6.5), relying on a small number of high quality suppliers and suppliers evaluation according to quality and delivery performance, and price, in that order. The buyer and supplier are partners. If the buyer succeeds, the supplier succeeds.

IV. Workforce management

Motivation among the workforce plays a key role in developing quality and maintaining a lean Six Sigma for service transformation. Timely recognition of both suggestions and achievements creates a sense of ownership and pride. This, in turn, leads to quality service for customers. The survey results in the previous chapter, revel that non-manufacturing companies are recognising the importance of acknowledging the efforts of their employees, hence a positive response on indicating their satisfaction with management commitment in creating a conducive working environment.

V. Quality information

Quality is defined where value entitlement is realised through all key business processes to the organisation, that is, its customers and its suppliers in every aspect of the business relationship. Quality means delivering world-class products with approximately zero defects. It is highly important for Lean Six Sigma implementing organisations to communicate quality information to all relevant stakeholders in order to ensure that products and services meet the required standard. It also encourages consistency, competitive markets, reduced waste, and ensures customer satisfaction as well as increased revenues. The survey result shows that, some companies take pride in sharing quality information while others do no value the importance of doing so.

VI. Product / Service design

Lean Six Sigma programs yields products and services that provide great customer satisfaction and increased market share if properly implemented. The survey conducted on this study reveals that some organisations are failing to properly

structure their services. When asked the question on product / service design, a high percentage of the respondents' were in agreement.

'Our firm uses differentiated training so that employees who have different roles in the black/green belt role structure (or equivalent structure) can obtain the necessary knowledge and skills to fulfil their job responsibilities'.

VII. Six Sigma focus on metrics

The Six Sigma that focused on metrics variables showed no significant differences across the different industry categories. All the variables showed the p-values greater than 5% which was the level of significance.

7.3 RECOMMENDATIONS

The research objectives have been met and the research questions/problems have been addressed and the following are critical success factors that are essential for the effective implementation of Lean Six Sigma implementations in non-manufacturing companies.

7.3.1 Proposed Framework Components

Value stream Mapping is the first step any company should take in creating an overall lean Six Sigma initiative plan. Developing a visual map of the value stream allows everyone to fully understand and agree on how value is produced and where waste occurs. Creating a value stream map also provides the following benefits:

- Highlighting the connections among activities and information and material flow that impact the lead time of your value stream.
- Helping employees understand the company's entire value stream rather than just a single function of it.
- Improving the decision-making process of all work teams by helping team members to understand and accept your company's current practices and future plans.

- Creating a common language and understanding among employees through the use of standard value stream mapping symbols.
- Allowing an organisation to separate value added activities from non-value added activities and then measures its lead time.
- Providing a way for employees to easily identify and eliminate areas of waste.

Maps and flowcharts help make work visible. Increased visibility improves communication and understanding, and provides a common frame of reference for those involved with the work process. Maps are often used to show how work currently gets done in an organisation. When used in this way, they represent a snapshot in time that shows the specific combination of the functions, steps, inputs, and outputs that your organisation uses to provide value to its customers. Thus, maps and flowcharts are key in documenting current pathways to customer satisfaction. Analysis of the processes which the maps represent can help you increase customer satisfaction by identifying actions to reduce process cycle time, decrease defects, reduce costs, establish customer-driven process performance measures, reduce non-value-added steps, and increase productivity are a few.

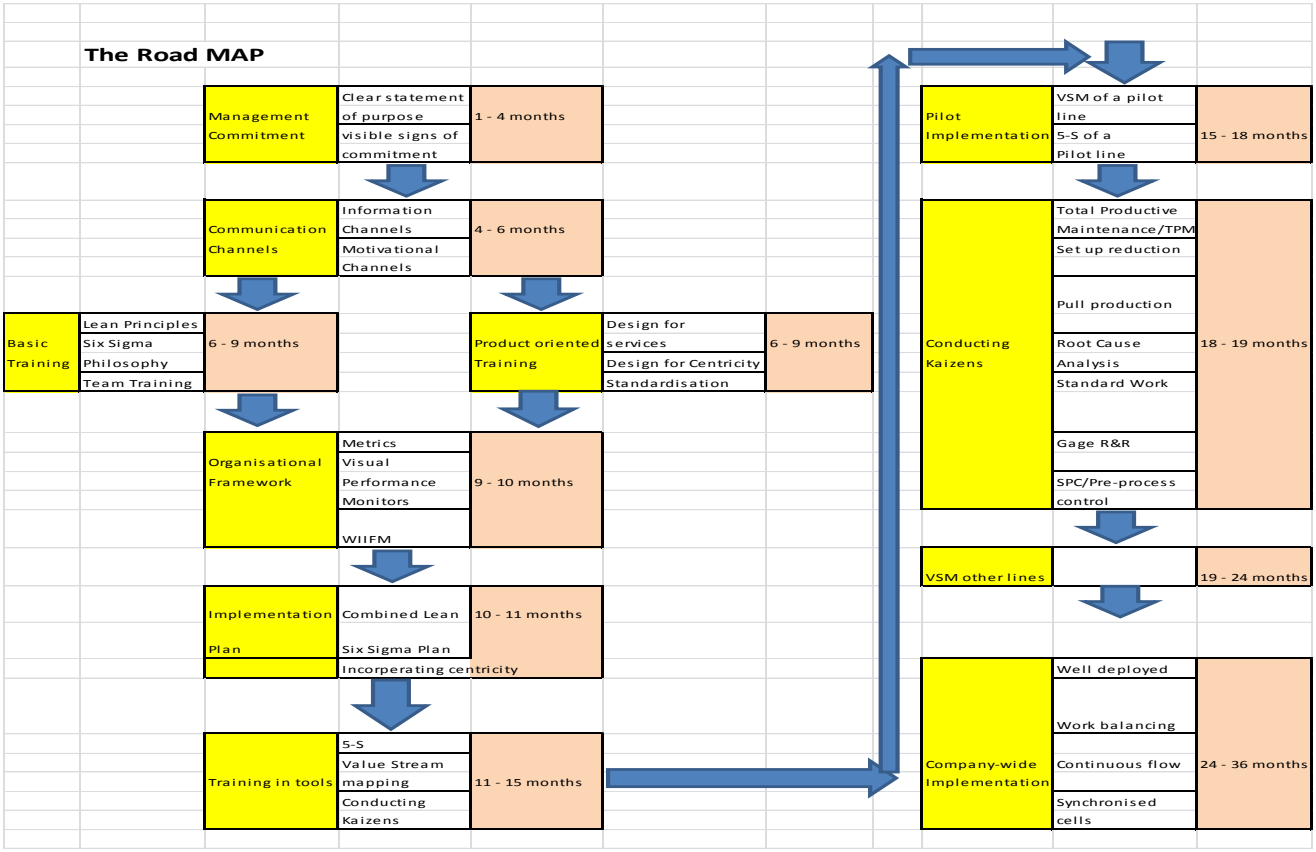
Additionally, maps and flowcharts can be used to show how work can be done in an organisation. By examining a map of current process performance in light of customer requirements and data on sources of customer-perceived value, one can draw a different picture to help in illustrating the pathways you will create to provide value to customers. Thus maps are also important prerequisites to successful organisational design, process reengineering, or benchmarking projects.

To effectively create a value stream map for the company's business processes, focus should be on the following areas:

- *The flow of information,* from the receipt of a sales order or production data all the way through the services, production control, production, purchasing, shipping and accounting processes.
- *Production activities,* which are the physical tasks employees, must perform to produce a product or deliver a service.

- *Material flow,* the physical movement of materials from receiving, through production, to the shipment or delivery of finished goods or services.
- *Customer value,* which is an aspect of a product or service for which a customer is willing to pay.
- *Cycle time,* which is the time it takes to complete an activity from start to finish.
- *Any waste,* involved in your business or service processes.

Figure 7.1: Proposed process roadmap



Source: Mehta, IIE Lean Solutions Conference (2005)

The author has defined seven framework components that create the infrastructure for the road MAP for non-manufacturing companies. The framework is designed to be applied by non-manufacturing companies to improve the quality, reduce costs and variation of service delivered to its customers. Figure7.2 presents the framework components for implementing Lean Six Sigma in non-manufacturing companies. The

following section provides a description of each framework roadmap component and how each framework component applies to transaction-based entities, such as the service industry.

Figure 7.2: Adopted and Modified Lean Six Sigma framework components

Source: Furterer (2011)

7.3.2 Customer Centric Culture

Organisational culture is "the way we do things around here." It is a learned set of behaviours that is common to all employees and drives how the organisation performs. If customer service doesn't seem to be highly valued at your organisation, recognise that you have the power to change that mindset. In a supply chain network, the Strategic Fit of Customer Service is often the voice-of-the-customer post-release of the service or product. The phrase “start with the customer and work backwards” is really a misnomer. In most products or services, it really starts with the customer and ends with the customer — that is, the customer’s voice is heard at the level of product design and then the voice-of-the-customer is heard at the market monitoring level, post-release of the product or service.

Starting to build towards achieving customer experience excellence is a tough and challenging process. In understanding that success hinges on listening to the Voice of the Customer (VoC) you have already laid a firm foundation, the next step is to plant the four pillars of VoC - volume of feedback, quality, insight and operational focus. Getting the highest possible volume of responses is crucial. You want to hear from as many customers who have had an interaction with your organisation as possible if you are going to get a view that is representative of your customer-base, as well as to pick up and respond to individual customer issues. The quality of response (as well as the volume) can be correlated with the time lag between the interaction taking place and asking the customer for feedback. The closer the request is made to the interaction the better the response will be. To achieve a quantity of quality feedback you need to have an engaging process for gathering this feedback from the customers. However, simply measuring the customer experience will achieve little in terms of improvement. The real gains are achieved by embracing VoC within the business and as part of the organisational Lean Six Sigma programs.

7.3.3 Design for Service

South African non-manufacturing companies should constantly drive innovation, which will elevate them to be first in the market to offer successful services such as free onboard drinks in buses and taxis, free headset and individual in-flight monitors, and unlimited access to internet for online banking customers. When designing new products, services, software, or anything else, it is crucial to achieve customer delight at the lowest cost and shortest time to market. The Design for Lean Six Sigma set of approaches can dramatically improve new product and service success rates, reduce costly redesigns and software patches, and eliminate service headaches after the launch.

7.3.4 Value Proposition

The value proposition is used to “sell”, or convince management of the value of implementing a Lean Six Sigma program. The sell-off point is that, Lean Six Sigma helps clients achieve operational speed, quality, cost reduction and customer satisfaction in the delivery of products and services – a key ingredient to achieve

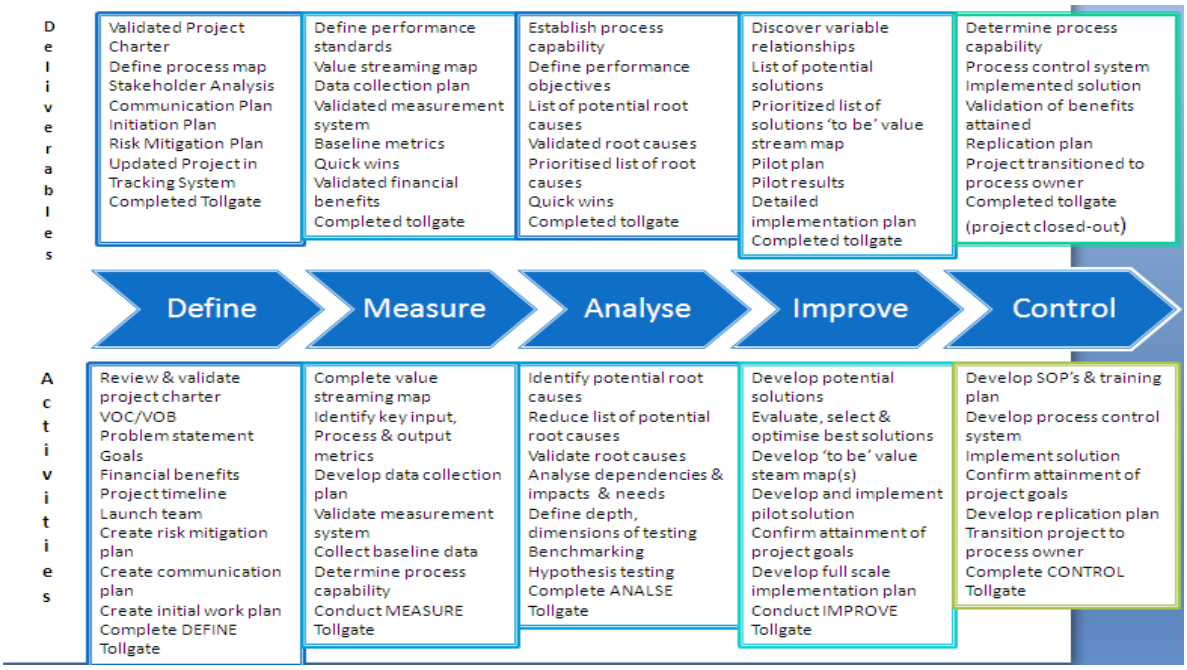
high performance and sustain competitive advantage in businesses and governmental organisations. Value proposition addresses strategic priorities and transforms operations by removing waste and driving high-quality business processes through the integration of the proven improvement methodologies of Lean (Speed) and Six Sigma (Quality). Eliminating waste not only reduces costs, but more importantly allows a business to become faster and much more responsive to its customers, driving revenue growth.

7.3.5 Quality and Lean tools

Quality and Lean Tools are valuable techniques to solve problems and improve the quality and some of the tools are fishbone diagrams, a Balanced Scorecard, 5S, AQL, DPU, FMEA, DMAIC, root cause analysis, Theory of Constraints, Total Quality Management, business process reengineering, statistical tools, innovation tools, and much more! Whether you work in quality assurance, quality management or are responsible for quality improvement, these are some of the tools which can be used at different stages of your deployment during the DMAIC phase as shown in figure 7.3.

When faced with meetings around determining what causes a problem, we frequently find that many Lean Six Sigma process improvement teams do not get past the “Usual Suspects” to look for other root or contributing causes. Most organisations have been in a situation where one of the early possibilities offered was around people, and the entire idea generation became identifying the guilty party? Or one where Training was identified as the cause and the group failed to look anywhere else? A great Lean Six Sigma process tool to use for situations like this, to ensure you are really uncovering all the possible causes of issues, is the Cause and Effect Diagram. This tool is also referred to as a Fishbone Diagram, or Ishakawa diagram.

Figure 7.3: Adapted DMAIC phase process flow



Source: Firefly consulting (2011)

Fishbone and the 6Ms is a good starting point for a proactive PFMEA review. This should be combined with a Gemba walk of the process, with a cross-functional team, to further develop and refine potential risks. The PFMEA can then be used as part of Risk Priority Number (RPN) reduction program to systematically look at the highest RPN number to proactively reduce potential risk. There are many areas/parameters which we may possibly miss while coming up with the solution. Cause and effect diagram helps us to give a holistic view of the problem by putting all aspects on paper in a graphical format which is easy to comprehend. Hence, cause and effect diagrams help to analyse and diagnose problems to find better solutions. These solutions can help to reduce defects.

7.3.6 Measurements Metrics

Metrics are the cornerstone of successful Lean and Six Sigma improvement efforts. When used effectively, metrics can be powerful mechanisms for helping organisations to achieve, assess, and communicate results. In 2009, the Environmental Protection Agency in USA published a document stating that Lean and Six Sigma place a strong emphasis on measuring, evaluating, and

communicating performance results. In this context, metrics enable organisations using Lean and Six Sigma to:

- Identify and target the right problems during Lean and Six Sigma events and projects
- Evaluate potential process improvements and select appropriate actions for implementation
- Establish baselines for process performance and track progress over time
- Understand and communicate the results (outcomes) of Lean and Six Sigma efforts
- Inform and monitor efforts to deploy Lean and Six Sigma throughout an organisation

Process Metrics

- Time: Time metrics evaluate the time to produce and deliver a product or service to customers, the portion of time that is spent processing the product or idle time, whether customers receive products or responses on time, and other time-related considerations.
- Cost: Cost metrics measure cost savings and the costs of products or processes, such as the amount of full-time equivalent employees needed for a process.
- Quality: Quality metrics examine the quality of products or services, such as customer satisfaction and whether documents are complete and accurate.
- Outputs: Output metrics track the production or activity of agency processes, such as the number of permits issued.
- Process complexity: Process complexity metrics describe the complexity and nature of a process, such as the number of handoffs and steps in the process.

Organisational Metrics

- Lean deployment: Lean deployment metrics measure the status of Lean implementation at an agency, such as the number of Lean events or trainings conducted.

- Morale: Morale metrics pertain to employee satisfaction and staff retention, including responses to staff surveys and turnover rate.

Non-manufacturing companies can use Lean process metrics to answer the following types of questions:

- Time metrics: How long does it take to produce a product or deliver a service? How much of that time is processing time and how much is idle time?
- Cost metrics: How much does the process cost to operate (for example, the number of full time equivalent employees)? What cost savings did the team identify in the Lean event?
- Quality metrics: How often does the process lead to mistakes (for example, incomplete or inaccurate forms) that require rework? How do customers view the process?
- Output metrics: How many products (for example, permits, credit cards, and vouchers) are completed or processed each month or year? What backlogs exist in the process?
- Process complexity metrics: How many steps are in the process? How many times is a document handed off between individuals, offices, or departments in the process?

It is important to note that some types of metrics will likely be of greater interest to certain audiences, although all types are useful for understanding the varied dimensions that affect process performance and outcomes. For example:

- Lead time, customer satisfaction, and other measures of product or service quality may be of particular interest to key “customers,” those who receive and/or benefit from the process outputs and outcomes; and
- Other process metrics, such as those related to process complexity and efficiency, may be of particular interest to internal audiences such as managers of the process.

7.3.7 Infrastructure and Methodology

The infrastructure and methodology component provides the structure to support the Lean Six Sigma effort. It includes defining a methodology of how to perform the problem-solving and improvement effort (DMAIC) as highlighted in figure 7.2. It includes having visionary and committed leadership as a critical element of success. It includes incorporating a project management structure to ensure that the projects are successful and continually move toward a successful implementation. This component also includes developing a communication plan to communicate the mission, goals, objectives, and progress of the Lean Six Sigma program and projects.

7.3.8 Human Resources Management

Most of the quality and process improvement programs, such as TQM, BPR, Six Sigma, Lean, and Lean Six Sigma incorporate elements to address managing the people in the organisation. They advocate empowering employees to make and be accountable for decisions about their processes. They including training, education and providing the right skills for people to do their jobs. The Lean Six Sigma program is based upon a team structure where team members solve problems together. An important element is to carefully recruit and select new employees, especially in governments where it has been difficult to terminate employees.

This component also includes rewarding and recognising employees for their involvement on project teams, their teamwork and efforts, and their successful implementation of process and financial improvements, and meeting the goals and objectives of the project. One of the most important components in human resources management is organisational culture and the managing this component is an essential key to the success of any continuous improvement initiatives. However, roadblocks that impact your culture and inherent structure of the company are the main cause of high rate failure in the deployment and implementation of Lean Six Sigma initiatives. What is common is that after a few months of excitement about the improvement changes, the level of interest plateaus because people are busy. They are more focused on deadlines than suggestions of improvements.

Total commitment from the leadership/management team is absolutely vital in maintaining a continuous improvement culture. Managers and Leaders have to be held accountable for driving the changes, and the improvement outcomes have to be incorporated as KPIs into their position descriptions. The KPIs have to be filtered down the organisation structure. Costs-benefits analysis has to be performed continually. Not only does the cost of implementing the changes have to be assessed against the realisation of benefits, we have to assess the cost of doing nothing as well. Leadership will often be motivated to change when they have an impact on the bottom-line laid out on their desk.

Organisation culture is a double-edged sword that can either elevate an organisation to world-class status or reduce the most brilliant strategy to a recipe for disaster. Superior strategies, technologies and methods such as Lean, Kanban, Six Sigma, and others fail without human systems to link effective leader with engaged employees. The Lean Six Sigma process when applied mindfully to organisational culture has been proven to achieve this. Leaders, who create Lean cultures, enable their people to engage, innovate, adapt and sustain high performance.

Organisational culture should enable strategies rather than derail them. However, no one should take culture for granted. Reinforcing culture has to be built and nurtured by leaders. A culture that promotes continuous improvement across the organisation is definitely a strong positive. However the same culture could some time deeply embed ' instrumentalism' in the organisation and oppose major changes that bring quantum improvements. Leaders have to constantly remind their people that, too much of the same can deliver only so much. New approaches have to come in. The same thing applies to Six Sigma, Lean and others where too much of these methods can start diminishing the returns. You may have to totally rewrite a process at times rather than keep on reducing its variability.

7.4 Lean Six Sigma Education and Research

A search on engines such as Google and Yahoo yields many educational institutions located in the United States that offer certification programs and courses (classroom based and online) related to Lean Six Sigma. Some of these include California

University, Gorge Washington University, Kent State University, Ohio State University, University of Texas and Villanova University to name a few. However the options are limited outside the United States, in fact, South African educational institutions do not offer continuous improvement courses as a specialist area. Their operations modules cover Lean Six Sigma and other continuous improvement methodologies as topics within this module but without paying more attention to such an important part of operations. Milpark Business School in Johannesburg is one example of a South African institute which covers the blue oceans strategy on its strategic operations module at masters' level in detail.

The University of Strathclyde at Glasgow in UK offers a Master's of Science course in process excellence while the University of Newcastle offers a course in Black Belt tools. There is scanty evidence of either universities or colleges or schools offering courses in Lean Six Sigma in other countries including in the emerging economic powerhouses of India (for reference, the Indian Statistical Institute is the only well-known face that offers courses and certifications related to Lean Six Sigma) and China. The use of Lean Six Sigma methodology is wide-spread – yet, are there barriers that prevent the expansion and morphing of Lean Six Sigma into a full-fledged educational course? Is there an audience for Lean Six Sigma in educational institutions?

The concepts of hypothesis, regression, correlation, run charts and more are included in courses related to economics and statistics. However, there is merit to include the basics of Lean Six Sigma in the secondary and higher secondary syllabus in schools. It could be further positioned as a vocational and job-oriented module in the industrial and technical institutes owned by the public sector. This will benefit the students by inculcating a data-driven and logical mindset to approach and resolve problems in the real world. Plus it will secure a pipeline of well-trained professionals to the diverse business sectors in different countries.

For emerging 21st century economic powerhouses like India, China, Brazil, South Africa and Russia, encouraging standalone Lean Six Sigma courses in educational institutes maybe a wise strategic move. The potential long-term gains for industry in these geographies include:

- reduction of existing flab in the workforce
- standardisation of processes by elimination of WASTE
- enhancement of process controls
- faster cycle-time for new products
- Increased visibility into any potential barriers (production, supply-chain and others)
- higher customer satisfaction

The Lean Six Sigma-enabled workforce will bolster the competitiveness of the industry and thereby contribute to the economic strength of these nations.
The encouragement of research is likely to provide useful insights on utility and trends related to deployment of Lean Six Sigma within the private and public sector. For example it could generate data on usage of tools within a specific industry segment and relevance versus the rise of the Industrial Internet. There is a possibility that leading corporate entities could sponsor research and learn from other firms regarding implementation techniques and challenges, including best practices. Moreover, it may unearth precious nuggets related to moves by rival firms to dislodge industry leaders.

Another key outcome of nurturing research would be to cement the linkage between the industry segments and the academic world. And there may be new perspectives on how local and transnational firms are leveraging new practices/theories like TRIZ, Theory of Constraints, and Blue Ocean Strategy and others as compared to Lean Six Sigma to strengthen their respective businesses. The body of research could lead to greater collaboration between countries, enable a common economic language, boost development of industry and add teeth to the regional trade blocs.

The onus rests with Lean Six Sigma professionals and how they engage the other stakeholders (government bodies, industry associations, academicians, teachers, parents, regulatory bodies and more) in a constructive dialogue to kick-start this journey. A proof of concept on the path of “PDSA or the Plan, Do, Study, Act cycle”

as described by Deming is a recommended approach to plant the seeds of change and herald a timely intervention.

7.5 HYPOTHESES

From the findings, it is evident that HO has been met. Ho (Null hypothesis) ; Current continuous improvement methods within non-manufacturing companies do not incorporate a customer centricity together with the latest theory for Lean Six Sigma implementation and deployment; therefore these organisations are not performing optimally. Based on the above hypothesis, due to significant differences that existed or were shown in terms of opinion across the different organisations within the non-manufacturing industry, it can be concluded that firms do not 100% incorporate customer centricity with LSS implementation and deployment. The objectives of this study were achieved as the data and analysis of the primary research supports the Null hypothesis.

Opening up the organisation to learn more about what customers need is only of value if the organisation is clear about who makes decisions based on this information. Decision rights clarity is important for all effective organisations, but for organisations adopting a customer-centric strategy it is absolutely critical, for at least two reasons.

First, poorly managed decision rights mean that the rich customer insight the organisation has accessed, will go unused. Product designers will continue to make decisions on product features in isolation from operations managers adapting customer service standards, separate from marketing teams changing promotions and brand positioning. Acting on customer insight typically requires greater cross-functional collaboration than an internally focused product or service development effort. Decision rights must be clear to avoid having cross-functional decision-making either slow the process down while consensus is reached or duplicate effort (and cost) as each function continues to operate in isolation. This requires the organisation to first understand what the critical decisions are, then define who is accountable for making these decisions versus those that provide information to support the decision-making process.

The second reason it is important to adjust decision rights when adopting a customer-centric strategy is that a little bit of knowledge can be dangerous: Although the most effective customer-centric organisations in the case study discussed in chapter four and five, understand the importance of moving decision-making close to the front line to customise marketing and communication for customers, they also recognise that offering front-line discretion over pricing, credit assessment, and service delivery can increase margin pressure, credit risk, and operational complexity. For example, a bank branch manager may have the authority to run a marketing campaign to specifically meet the needs of his customers bilingual communications in areas with diverse populations or retirement seminars in areas with large numbers of retirees—but not change the products offered or the credit scoring rules that apply.

7.6 LIMITATIONS AND OPPORTUNITIES FOR FURTHER RESEARCH

The proposed framework is a contribution to the current body of knowledge and attempts to meet the needs within non-manufacturing companies. Further empirical research is required to test the strength of the framework once implemented. This research was limited to non-manufacturing organisations operating within South Africa and focused on the input from top management and Lean Six Sigma professionals within these organisations.

7.7 FINAL CONCLUSION

A Lean Six Sigma implementation strategy which incorporates a customer-centric strategy is equally important in bad times and good. It can help companies understand changing customer needs and the prices customers are willing to pay, and consistently deliver on their promises to customers. Making this happen requires not just a vision statement from the CEO or great marketing techniques—it requires an organisation to rethink its operating model and how its people, process, and technology enablers support a Lean Six Sigma and customer-centric strategies. For most organisations, this will be a multi-year journey. To ensure that the board and management stay the course, there must be a clear and measurable financial impact from this increased customer focus. Charting out the journey—and the targets to

achieve at each stage of the journey—is critical to truly embed this change in the organization and reap the financial rewards.

People used to think of customer-centricity programs mostly in terms of CRM systems. Therefore, this research proposed a framework for management, supported by technology to become customer centric in a holistic manner. Many projects need not begin with any major technical investments. What matters more is a sustained focus on the financial goal and the transformation effort required to achieve that goal. Profitable Lean Six Sigma companies focus not only on integrating customer centricity into the organisation, but on ensuring that the entire “ecosystem” of the business-stakeholders, along with organisational processes, and structures are aligned in ways that support Lean Six Sigma and customer-centric growth strategy.

7.8 FURTHER RESEARCH RECOMMENDATIONS

Further research can be done to help answer the question of whether the proposed framework components from the author’s knowledge and experience, and the critical success factors from the literature will help ensure the successful implementation of Lean Six Sigma. The proposed framework components and roadmap can be reviewed by experts in the field to build consensus on the validity of the framework. A deeper search into what the actual expectations of the respondents were for the success of the Lean Six-sigma initiatives and the reasons they believe that they were not met should be considered for future researches. The proposed framework for Lean Sigma implementation needs to be validated in different scenarios for establishing its validity. This can be considered as one of the limitations of the proposed framework. Despite the limitations, this study makes important contributions to the knowledge hub.

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Appendix A Survey instrument

A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Section 1: Firm's information

Please answer all the questions as best as you can and where a problem exists, please provide your best approximation.

1. How many employees work in your firm?

	Select
Less than 100	◯
100-500	◯
501-1000	◯
More than 1000	◯

2. How many years has it been since firm start-up?

	Select
Less than 5 years	◯
5-10 years	◯
11-20 years	◯
More than 20 years	◯

3. To which category of Industrial classification does your firm belong?

	Select
Financial Industry	◯
Retail and Wholesale Industry	◯
Mining Industry	◯
Call Centre Industry	◯
Hospitality Industry	◯
Construction Industry	◯
Other non-manufacturing Industry	◯

4. Please tick the boxes below to indicate which quality improvement methods your firm has implemented and the duration of the implementations.

	Duration < 3 years	Duration 3-5 years	Duration 6-10 years	Duration > 10 years
Lean Six Sigma	◯	◯	◯	◯
Lean production	◯	◯	◯	◯
Six Sigma	◯	◯	◯	◯
Other	◯	◯	◯	◯

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Section 2: Respondent's information

5. What is your role in the firm's Lean Six Sigma project?

	Select
Senior Manager	◯
Financial Controller	◯
Six Sigma Leader	◯
Master Black Belt (MBB)	◯
Black Belt (BB)	◯
Green Belt (GB)	◯
Finance Team	◯
Other ___	◯

6. How many years experience have you had with Lean Six Sigma?

	Select
Less than 2 years	◯
2-5 years	◯
More than 5 years	◯

7. . How many projects have you handled or been involved with so far, if any?

	Select
None	◯
1-3 projects	◯
More than 3 projects	◯

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Section 3: Lean Six Sigma program's information

8. Q9. Please tick on the box to indicate the number of Lean Six Sigma projects in your firm that has completed, are on-going, or are opening

	None	1-3 projects	> 3 projects
Completed	◯	◯	◯
On-going	◯	◯	◯
Opening	◯	◯	◯

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Top management support

Please circle the number to indicate the extent to which you agree or disagree on statements that represent the current status of implementation in your firm.

9. Our firm's top management (i.e. top executives and major department heads) assumes responsibility for quality performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

10. Our firm's top management provides personal leadership for quality products and quality improvement.

Strongly disagree	Disagree	Somewhat agree nor disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

11. Our firm's top management is evaluated for quality performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

12. Major department heads within our firm participate in the quality improvement process.

Strongly disagree	Disagree	Somewhat diagree	Neither agree nor disagree	Somewhat agree	agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

13. Quality issues are reviewed in our firm's management meetings.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

14. Our firm's top management has objectives for quality performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Customer relationship (Centricity)

15. We frequently are in close contact with our customers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

16. Our customers give us feedback on quality and delivery performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

17. Our firm measures our external customers' satisfaction.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor diasgree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

18. We use customer requirements as the basis for quality.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

19. Our employees know who our customers are.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

20. Our customers visit our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor diasgree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Supplier relationship

21. We strive to establish long-term relationships with suppliers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

22. We rely on a small number of high quality suppliers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

23. Our suppliers are actively involved in our product design/redesign process.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

24. Our suppliers are evaluated according to quality, delivery performance, and price, in that order.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

25. Our firm has a thorough supplier rating system.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

26. Our suppliers are involved in our quality training.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

27. We provide technical assistance to our suppliers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

Workforce management

28. Our firm forms teams to solve problems.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

29. Our firm gives feedback to employees on their quality performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

30. Our employees are recognized for superior quality improvement.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

31. Hourly/non-supervisory employees are involved in quality decisions.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

32. Quality-related training is given to hourly workers in our firm.

Strongly Disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

33. Supervisors encourage the persons who work for them to work as a team.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

34. Quality-related training is given to hourly workers in our firm.

Strongly disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

35. Quality-related training is given to managers and supervisors in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

36. Training is given in the "total quality concept" (i.e., philosophy of company-wide responsibility for quality) in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

37. Training is given in the basic statistical techniques (such as histogram and control charts) in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Quality information

38. Quality data (error rates, defect rates, scrap, defects, cost of quality, etc.) are available in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

39. Quality data are available to managers, supervisors and engineers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

40. Quality data are available to hourly/nonsupervisory workers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

41. Quality data are timely.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

42. Quality data are used as tools to manage quality.

Strongly disagree	Disagree	Somewhat diagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

43. Quality data are used to evaluate supervisory and managerial performance.

Strongly diagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

Product/service design

44. Our firm conducts a thorough review of new product/service design before the product/service is produce.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

45. Multiple departments (such as marketing, manufacturing, and purchasing) coordinate in the product/service development process.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

46. Manufacturing and quality people are involved in the product/service development process.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor Disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

47. Quality of new products/services is emphasized in relation to cost or schedule objectives.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor diagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

48. 39. We design for ehancing services.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

49. We make an effort, in the design process, to list only the specifications which are clearly needed.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Process management

50. Processes in our firm are designed to be "mistake-proof" to minimize the chances of errors.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

51. We dedicate a portion of everyday solely to maintenance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

52. We usually meet the production schedule every day.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

53. Production is stopped immediately for quality problems.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

54. Our firm conducts preventive equipment maintenance.

Strongly diagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

55. Clear work or process instructions are given to employees.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

56. Our firm's shop floors are well organized and clean.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

57. A large number of the equipment or processes on the shop floor are currently under statistical process control.

Strongly disagree	disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

58. We make extensive use of statistical techniques to reduce variance in processes.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Six Sigma role structure

59. We employ a black/green belt role structure (or equivalent structure) for continuous improvement.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

60. We use a black/green belt role structure (or equivalent structure) to prepare and deploy individual employees for continuous improvement programs.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

61. In our firm, members of a quality improvement team have their roles and responsibilities specifically identified.

Strongly disagree	Disagree	Somewhat disagree	Neither sgree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

62. The black/green belt role structure (or equivalent structure) helps our firm to recognize the depth of employees' training and experience.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

63. In our firm, an employee's role in the black/green structure (or equivalent structure) is considered when making compensation and promotion decisions.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

64. Our firm uses differentiated training so that employees who have different roles in the black/green belt role structure (or equivalent structure) can obtain the necessary knowledge and skills to fulfill their job responsibilities.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Six Sigma structured improvement procedure

65. In our firm, continuous improvement projects are conducted by following a formalized procedure (such as DMAIC—Define, Analyse, Improve and Control).

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

66. We use a structured approach to manage quality improvement activities.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

67. We have a formal planning process to decide the major quality improvement projects.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

68. All improvement projects are reviewed regularly during the process.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

69. We keep records about how each continuous improvement project is conducted.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

70. In our firm, the product design process follows a formalized procedure.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Six Sigma focus on metrics

71. Our firm sets strategic goals for quality improvement in order to improve firm financial performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

72. Our firm has a comprehensive goal-setting process for quality.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

73. Quality goals are clearly communicated to employees in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree nor disagree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

74. In our firm, quality goals are challenging.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

75. In our firm, quality goals are clear and specific.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

76. Our firm translates customers' needs and expectation into quality goals.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Srongly agree
◯	◯	◯	◯	◯	◯	◯

77. We make an effort to determine the appropriate measures for each quality improvement project.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

78. In our firm, measures for quality performance are connected with the firm's strategic quality goals.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

79. The expected financial benefits of a quality improvement project are identified during the project planning phase.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

80. Financial performance (e.g., cost savings, sales) is part of the criteria for evaluating the outcomes of quality improvements in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

81. We assess the performance of core processes against customers' requirements.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

82. The measures for quality performance are connected with critical-to-quality (CTQ) characteristics.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

83. Our firm systematically uses a set of measures(such as defects per million opportunities, sigma level, process capability indices, defects per unit, and yield) to evaluate process improvements.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

Section 4: Lean production's information

Supplier feedback

84. We frequently are in close contact with our suppliers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

85. Our suppliers seldom visit our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

86. We seldom visit our supplier's firms.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

87. We give our supplier feedback on quality and delivery performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

88. We strive to establish long-term relationship with our suppliers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

JIT delivery by supplier

89. Suppliers are directly involved in the new product development process.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

90. Our key suppliers deliver to firm on JIT basic.

Strongly disagree	Disagree	Somewhat disagree	Niether agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

91. We have a formal supplier certification program.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Supplier development

92. Our suppliers are contractually committed to annual cost reductions.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

93. Our key suppliers are located in close proximity to our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

94. We have corporate level communication on important issues with key suppliers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

95. We take active steps to reduce the number of suppliers in each category.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

96. Our key suppliers manage our inventory.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

97. We evaluate suppliers on the basis of total cost and not per unit price.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat disagree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Customer involvement

98. We frequently are in close contact with our customers.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

99. Our customers seldom visit our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

100. Our customers give us feedback on quality and delivery performance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

101. Our customers are actively involved in current and future product offerings.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

102. Our customers are directly involved in current and future product offerings.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

103. Our customers frequently share current and future demand information with marketing department.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

104. We regularly conduct customer satisfaction survey.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Pull

105. Production is "pulled" by the shipment of finished goods.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

106. Production at stations in "pulled" by the current demand of the next station.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

107. We use a "pull" production system.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

108. We use Kanban, squares, or containers of signals for production control.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Continuous flow

109. Products are classified into groups with similar processing requirements.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor diagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

110. Products are classified into groups with similar routing requirements.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

111. Equipment is grouped to produce a continuous flow of families of products.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

112. Families of products determine our factory layout.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

113. Pace of production is directly linked with the rate of customer demand.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Set up time reduction

114. Our employees practice setups to reduce the time required.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

115. We are working to lower setup times in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

116. We have low set up times of equipment in our firm.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

117. Long production cycle times prevent responding quickly to customer requests.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

118. Long supply lead times prevent responding quickly to customer requests.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Statistical process control (SPC)

119. Large number of equipment/processes on shop floor is currently under SPC.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

120. 37. Extensive use of statistic techniques to reduce process variance.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

121. Charts showing defect rates are used as tool on the shop floor.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

122. We use fishbone type diagrams to identify causes of quality problems.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

123. We conduct process capability studies before product launch.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Employee involvement

124. Shop-floor employees are key to problem solving teams.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

125. Shop-floor employees drive suggestion programs.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

126. Shop-floor employees lead product/process improvement efforts.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

127. Shop-floor employees undergo cross functional training.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

Total productive/preventive maintenance (TPM)

128. We dedicate a portion of everyday to planned equipment maintenance related activities.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

129. We maintain all our equipment regularly.

Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

130. We maintain excellent records of all equipment maintenance related activities.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

131. We post equipment maintenance records on shop floor for active sharing with employees.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Section 5: Quality performance and business performance

Quality performance

132. The quality of our firm's products and services has been improved over the past three years.

Strongly Disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

133. The process variability in our firm has decreased over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

134. The delivery of our products and services has been improved over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

135. The cost of scrap and rework as a % of sales has decreased over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

136. The cycle time (from receipt of raw materials to shipment of finished products) has decreased over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

137. Customer satisfaction with the quality of our products and services has increased over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

138. The equipment downtime in our firm has decreased over the past three years

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Business performance

139. Our firm's sales have grown over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

140. Our market share has grown over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

141. The unit cost of manufacturing has decreased over the past three years

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
select	◯	◯	◯	◯	◯	◯	◯

142. Our firm's operating income has grown over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

143. Our firm's profits have grown over the past three years.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

144. Return on assets of our firm has increased over the past three years

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

"A Framework for Implementing Lean Six Sigma in Non-Manufacturing

Customer Centricity

Customer insights

145. Our products and services are designed with the customer in mind.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

146. Customer feedback is important and has a future orientation towards customer needs.

Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

147. Our customers are completely satisfied with our levels of service.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

148. Our Lean Six Sigma initiatives incorperate customer insights.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

149. The organisation actively capitalises on the feedback from customers

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

150. Customer contacts and service delivery are consistent across all contact channels, i.e. email, mobile, internet banking, call center, branch, etc

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
◯	◯	◯	◯	◯	◯	◯

Appendix 2: Permission letter

MINISTRY OF AGRICULTURE, MECHANISATION AND IRRIGATION DEVELOPMENT

All Communications to be addressed to "THE HEAD"
Telephone: +263-0383-212/312/264/5
E-mail address: mrsregistry@gmail.com
mobile: +263 772 144 749

DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES (DR&SS)
Division of Animal And Pastures Research
Matopos Research Institute
P B K 5137
Bulawayo
Zimbabwe

21st December 2013

TO WHOM IT MAY CONCERN

Dear Sir/Madam

Re: Data Collation and Statistical Analyses for Mr Lotshi Dube

This letter serves to confirm that I Givious Sisito, handled and conducted all the data manipulation and statistical analyses for Mr Lotshi Dube's PhD thesis data to North West University of South Africa. I am a Statistician/Biometrician in the Department of Research & Specialist Services, employed by the Republic of Zimbabwe. I have ten (10) years experience of data management, manipulation and analyses and provision of statistical technical backstopping in developing models for different policy makers in different enterprises. I have also University lecturing experience in statistical courses and use of different packages and research proposal writing. I thank you in advance for your support given to Mr Lotshi Dube. For any further information required to hesitate to conduct me on the above given contact details.

Yours faithfully

G Sisito, MSc (NUST)
Statistician (Matopos Research Institute)

Appendix 3: Letter from language editor

DYNAMIC MANAGEMENT & BEAUTY CONSULTANTS (BK)
Esselen str 71
Potchefstroom
2531
Tel: (018) 293-3046
CK 95.17794\73

November 25 2014

TO WHOM IT MAY CONCERN

Re: Letter of confirmation of language editing

The dissertation **"A framework to implement lean six sigma in selected large non-manufacturing South African companies"** by **L Dube (23995238)** was language, technically and typographically edited. The sources and referencing technique applied was checked to comply with the specific Harvard technique as per North-West University prescriptions. Final corrections as suggested remain the responsibility of the student.

Antoinette Bisschoff
Officially approved language editor of the NWU since 1998
Member of SA Translators Institute (no. 100181)