UNIVERSITY OF KWAZULU-NATAL

Evaluating the implementation status of Lean Production systems at MAN Truck & Bus Pinetown Assembly Plant

By

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A dissertation submitted in partial fulfillment of the requirements for the degree of

Master of Business Administration

Graduate School of Business & Leadership

College of Law and Management Studies

Supervisor: Dr. Abdulla Kader

Year of Submission: 2015

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

College of Law and Management Studies

Supervisors Permission to Submit Thesis/ Dissertation for Examination

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Qualification: Master of Business Administration	School: Graduate School of Business & Leadership	
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I, Lindiwe Mthunzi, hereby declare that this thesis is my original work and that it has not been previously submitted for any degree at another Tertiary Institution. Materials that have been referenced have been acknowledged in full.

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December 2015

Acknowledgements

I wish to express my sincere appreciation and gratitude to the following statures, institutions and individuals, without whose assistance, this study would not have been possible:

- Firstly, all glory and honor goes to my heavenly father for granting me the wisdom, strength and courage to pursue my heart desires. All that I am is not by might nor by power but by the spirit of the Lord.
- University of Kwa-Zulu Natal: Graduate School of business & Leadership for allowing me the opportunity to empower myself in pursuit of this degree.
- Dr. Abdulla Kader, my supervisor, for availing himself to guide and support my research throughout the program.
- MAN Truck & Bus management team, for support, motivation and encouragement. I am grateful for the opportunity afforded to me to have access to the entire organization for conducting my research.
- MAN Truck & Bus employees, for taking part in the research study as respondents to my questionnaire, I thank all who participated in full and who supported my work, words are not enough to express my gratitude.
- Lynette Kuhn, my direct manager, for support and allowing me time off from work when required.
- My family, my mom, sister, brother and my niece; for their endless support, motivation, patience and their understanding that I could not be home at times.
- My friends, for giving me the chance to focus on my work and tolerating me for being an absent friend.
- My sincere gratitude goes to my Pastors Dr. Basil and Anne Tryon for instilling in me the word of God that is propelling me to my destiny.
- Last but not least, to the NCF praise and worship pastors and team for allowing me time off from serving when I needed it, I will forever be thankful for the support and understanding.

Abstract

Global competition, advances in manufacturing, latest technology and customer demands has forced optimization of processes by product manufacturers and service providers. Lean philosophy originating from Toyota Production System (TPS), has become one of the initiatives that many organizations have adopted with the aim to streamline their production processes and realize optimization of resources.

The purpose of this study was to evaluate the implementation status of lean production systems at a Truck and Bus assembly plant in order to determine effectiveness, establish challenges, identify benefits and make recommendations for future improvements. Due to the nature of the study, a descriptive research strategy was adopted in order to fulfill the purpose of this research. This study used a quantitative approach with a view to identify the impact of the topic within the organization. Research survey was used as a data collection tool to assess respondents opinion on the study. The study was conducted within the work environment and adopted a probability sampling method, where every member in the organization had a chance of being selected as a subject; therefore a sample of 103 employees was used for the study.

The findings of this study indicated that lean production methods have been adopted throughout the organization although there are areas that require further interventions. The study identified areas such as; communication, leadership and training. It was observed that lean implementation requires a good knowledge of the principles and therefore management needs to ensure that comprehensive training and education programs are available. Support by management and proper communication platforms are crucial towards achieving a common goal. Management needs to be well knowledgeable about lean methods in order to be able to provide the necessary leadership that will facilitate sustainability of the system.

List of Acronyms

CI	Continuous Improvement
CLA	Cargo line
DEC	Decentralization
IF	Integration of functions
JIT	Just-in-Time
LP	Lean Production
MFT	Multifunctional teams
MNPS	MAN Nutzfahrzeuge Production Systems
SMED	Single minute exchange of dies
SPSS	Statistical package for social science
TGS/M	Trucknology generation
TPM	Toyota Production Systems
TPS	Total Productive Maintenance
TQM	Total Quality Management
VMS	Value Stream Mapping
VW	Volkswagen
WIP	Work in Progress
ZD	Zero Defects

Glossary of Terms

Cell Manufacturing	A methodology that groups employees, machines and materials into a semi-circle or U-shape layout to produce a given product or product type.
Continuous Improvement	A concept that seeks ongoing effort to improve products, services or processes. These efforts can seek “incremental” improvement over time or “breakthrough” improvement all at once.
Decentralized Responsibilities	The process of transferring and assigning decision-making authority to lower level employees in an organization hierarchy.
Elimination of Waste	Any activity in production that does not add value to the finished product, such as excess inventory, unnecessary movements of employees, scrap, rework or transportation.
Five S (5S)	A methodology for organizing, cleaning, developing and sustaining a productive work environment.
Just-In-Time	It is a concept that controls inventory and material flow throughout the entire organization. The philosophy involves providing the required part, in the correct quantity at the exact point in time.
Kanban	A Japanese word meaning “card” or “visible record” that refers to cards used to control the flow of production through an organization. It signals the manufacture and supply of components.
Lead Time	The amount of time between the initiation of some process and its completion or the elapsed time between the receipt of a customer order and filling it.
Multifunctional Teams	A group of employees that are organized in a particular work area and are able to perform many different tasks. These teams are often organized along a cell based part of the product flow.
One-piece Flow	Refers to the concept of moving one work piece at a time between operations within a work cell.
Poke Yoke	Mistake-proofing methods aimed at designing failsafe systems that minimize human error.

Pull Production	A philosophy that emphasizes production planning to manufacture to order instead of manufacturing to stock. No one upstream should produce a part until the customer downstream requests for it.
Single minute Exchange of Dies	A system for dramatically reducing the time it takes to complete equipment changeovers.
Value Stream Mapping	A sophisticated flow chart that uses symbols and metrics to help understand the sequence of activities, visualize processes and track performance.
Visual Control	Visual indicators, displays and controls used throughout manufacturing plants to improve communication of information.
Work In Progress	Items, such as components or assemblies, required to produce a final product in manufacturing.
Zero Defects	A way of thinking and doing production tasks right the first time without manufacturing defects. This philosophy increases the organizations profits by eliminating the cost of failure and increasing revenues through increased customer satisfaction.

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Chapter 1 : Introduction

1.1 Introduction

Since the dawn of democracy, the South African automotive industry has developed and expanded. The South African automotive industry is regarded as a global machine for the manufacture of export vehicles and components. Various multinational organizations have used South Africa to source components and assemble vehicles for the local and international market. The automotive sector is one of the most important sectors in the South African economy, contributing at least 6% to the country's GDP and accounting for almost 12% of South Africa's manufacturing exports (MediaClubSouthAfrica, 2012). Operating in such a global scale requires practices that will support organizations to deliver world class performance. South Africa had to undergo a process of transformation not only in the automotive sector, but, in all variety of sectors within the county and these changes are still continuing.

A big question arises, how did this transformation occur? Vehicle manufacturers such as BMW, Ford, General motors, Mercedes Benz, Nissan, Renault, Toyota and Volkswagen have production plants in South Africa and have taken advantage of the low production costs together with access to new markets as a result of trade agreements with the European Union (EU) and South African Democratic Communities (SADC). These organizations have developed their own production systems following the examples of Toyota. Global demands and constant pressure on costs, quality and delivery time forces organization to continuously improve their business processes. They all have a common challenge in managing their operations in highly competitive markets and hence they are investing a lot of efforts in becoming lean enterprises. This study therefore, aims to evaluate the implementation status of lean production systems adopted by a truck and bus assembly organization in Kwa-Zulu Natal, Pinetown.

1.2 Research problem statement

With the increase in global competition and customers demanding high quality products, at a reasonable cost, within a reasonable delivery time organizations are forced to adopt best manufacturing practices. In the quest to increase organizational capabilities and sustainability in globally competitive businesses , organizations have made investments in lean manufacturing principles such as 5S, 7 wastes, Just in time (JIT), Business process reengineering (BPR), Total productive maintenance (TPM) etc. According to Roslin et al. (2012), Lean manufacturing system is one of the proven strategy and has been regarded as a remedy to survive and be competitive in the global market. Pinetown Assembly Plant is no exception to any of these organizations. Belonging to a global sphere, German owned, local management found it necessary to align the plant to its European counterparts by implementing lean production systems. This was done with an intention to improve performance in order to increase productivity, quality, improve delivery and greater customer satisfaction, to list just a few benefits.

1.3 Research Aim

The aim of the study is to evaluate the implementation status of lean production systems at the assembly plant, highlighting the benefits of the system or otherwise.

1.4 Objectives

Based on the theoretical discussion on the literature review, the four main research objectives of the study are defined as follows:

1. To evaluate the status of lean production systems implementation within the assembly plant.

2. To establish challenges faced by management and employees during implementation
3. To identify the benefits of lean production systems implementation within the assembly plant.
4. To determine strategies or interventions that can be adopted for future projects and provide recommendations.

1.5 Research Questions

From the objectives stated above, the following main research questions have been developed:

1. What is the level of knowledge and use of lean production systems by employees?
2. What is the status of lean implementation within various operations of the organization?
3. What are the main barriers or challenges that management and employees are faced with during implementation?
4. What are the suggested success factors that can be attributed to lean production systems implementation within the organization?

1.6 Significance of the study

The results of this study will demonstrate the status of lean implementation in the organization. It will also express the extent at which the lean tools and techniques that are in place have benefited the organization. This will help the organization to identify the problems or gaps in the implementation of an effective lean production system. Consequently, the organization will be able to improve and sustain their lean production performance through a systematic communicative approach. Thus, it will increase and maintain organizations competitiveness in the industry.

1.7 Research Methods

The descriptive research strategy was supplemented by an investigational study to fulfill the purpose of this research. A descriptive study is undertaken in order to ascertain and be able to describe the characteristics of the variables of interest in a situation (Sekeran and Bougie, 2009). This study used a quantitative approach with a view to identify the impact of the topic within the organization. Research survey questionnaire was used as a data collection tool to assess respondents opinion on the study. The study was conducted within the work environment and adopted a probability sampling method, where every member in the organization had a chance of being selected as a subject. The organization employs 140 employees at different levels, in which 94 are blue collar, 37 white collar and 9 trainees. Therefore a sample of 103 employees was used for the study. A survey questionnaire was distributed electronically online (web based: QuestionPro) and manually (face to face). Manually collected data was then later captured into QuestionPro. Once all data had been collected, it was imported to excel and statistical package for social science (SPSS) was used for analysis and other various statistical techniques were also adopted.

1.8 Limitations of the study

The study was limited to the following constraints:

Level of literacy: the study involved every individual within the employ of the organization. A percentage of blue collar workers do not have the necessary educational qualification to understand some of the lean concepts. However it is assumed that internal trainings provided would have covered this knowledge area.

Area: Although lean implementation has been a drive throughout the entire MAN organization world-wide, this research only focused on the application at the Pinetown assembly plant and did not cover any other similar organizations in the region.

1.9 Layout of the thesis

The current study followed the research design as depicted in figure 1-1 to manage each step of the research project. This gives and overview of a step by step approach of strategies utilized to collate this research study.

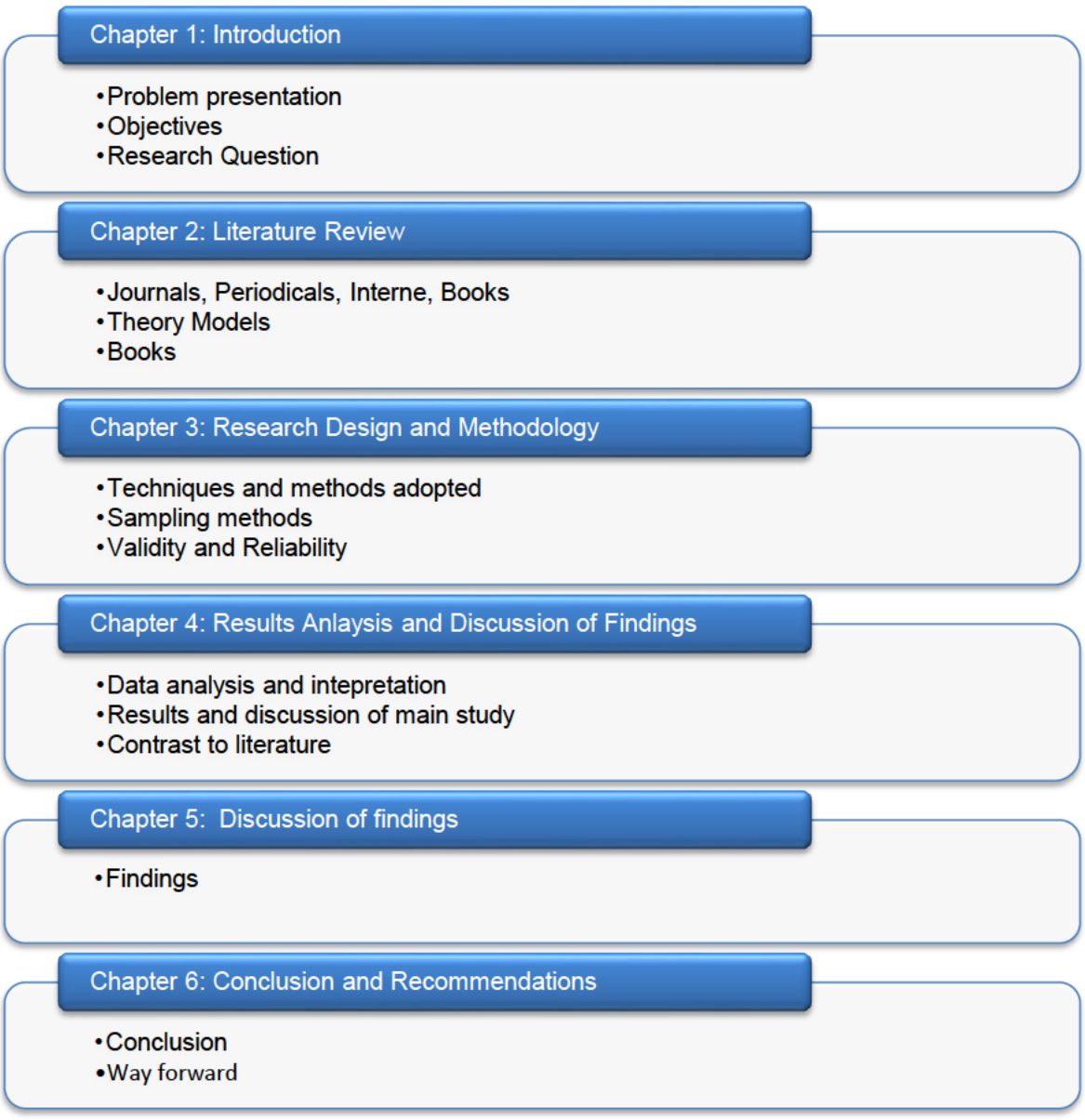

Figure 1-1: Research Layout

1.10 Summary

This chapter introduced the purpose of the study while laying the foundation and outlining the aggressive competition that emanates from globalization and the impact it has on the South African automotive industry. A list of lean production techniques such as JIT, 5S, BPR, TPM etc. was identified. These were then linked to the framework required by organization in order to determine lean effectiveness which in turn will result in the organizations global competitiveness. Research questions were devised and the significance of the study is highlighted. The chapter also introduced the research design instrument and methodology adopted to complete the study. The next chapter provides a discussion and review of related literature consistent with the topic and all relevant elements necessary to facilitate an effective and efficient investigation.

Chapter 2 : Literature Review

2.1 Introduction

Lean uses a number of principles and one of which is to identify value as perceived by the customer. Businesses need to provide their customers with products that meet their expectations and also their requirements. A business that provides top quality products and services on time, at the right place, is certain to succeed. Many businesses have embarked on a lean journey in order to be sustainable. By implementing Lean Production (LP) systems, organizations have a greater opportunity to reduce costs, customer lead times and cycle time. Literature indicates that lean is a philosophy or culture which, its roots are influenced by the production systems principles firstly introduced by the leading Japanese company called Toyota. This philosophy or culture has had a lot of impact on the rest of the globe. Observing Toyota's impressive operations and their ability to do more with less resource, their productivity and high quality products amazed the world and cultivated an enormous change in the manner in which businesses were being conducted.

In the 21st century everything is characterized by change, that is, our modern societies and mostly businesses. To remain competitive requires businesses either to be part of the game or take a lead in changing the game. Rapid technology evolutions, advanced global communication mediums and extreme competitive markets have intensified the need for businesses to change. According to Rich (2001), markets have become more competitive to an extent that even western organizations that formerly had a monopoly position, for example, telecommunications, electricity corporations and so on, have found themselves deregulated. Such changes to the market, enlarges the new competitive globe, whereby, consumers and customers have greater power and increasingly demand higher levels of customer service and greater value (Womack and Jones, 1996). These recent challenges in global competition have compelled

manufacturing organizations to move from their old traditional methods into adopting new manufacturing strategies in order to enhance their efficiency and competitiveness. Lila (2012) reveals that, most organizations have considered LP systems as a vital tool for management and have adopted the systems principles for their businesses. The most fundamental goal for organizations going lean is to establish a smooth, flexible and high quality process that is conducive to produce finished products in line with the demands of the customer without wasting resources. Recent research indicates that, application of lean tools namely, total quality and Just-in-time has improved production systems in relation to quality, costs and delivery performance. There is evidence which shows that, organizations that apply lean tools often acquire a competitive edge in comparison to those that still apply traditional methods (Glaser-Segura et al., 2009).

It is important to highlight that, although, there has been many successes reported on LP implementation, challenges also do exist, in turn, these have led to minimal value or show of benefits for such a great concept. Documented literature attests to the notion that organizations which have successfully implemented LP systems have seen tremendous improvements in terms of shorter lead times, lover inventory levels, better quality and higher profitability. In the same light, there are organizations that have implemented LP systems, however, are battling to change the work culture which is vital towards successful implementation of lean. This therefore results in major challenges in adapting and sustaining lean principles (Bhasin and Burcher, 2006) as cited in (Roslin and Ahmed, 2012). When lean is integrated within an organization as a comprehensive system, it allows confidence in flexibility and adaptation of required changes in a highly competitive environment. Lean has evolved into a management approach that improves all processes at each level of an organization. Understanding all these factors about lean, this therefore brings one to the main purpose of this study. However, before detailing all the motivation behind the study, it is important to firstly give a full background about the organization of interest.

2.2 Organizational Background

In the MAN Truck & Bus Group, the MAN Pinetown assembly plant is located in Westmead Industrial area where production of various product brands such as MAN cargo line (CLA), Trucknology generation (TGM/ TGS); Volkswagen (VW) and various bus chassis takes place. The organization is German owned and has been operational for just over 50 years in South Africa. With recent changes in management over the past decade, as well as change in the overall strategic direction, the assembly plant has seen a lot of operational transformations; one can literally say a metamorphic process of change. Due to these changes, the assembly plant has observed its performance improve considerably, that is, in its operating facilities, assembly processes, supplier relations, customer satisfaction, product quality and on time delivery to mention a few.

One of the latest projects namely Lean assembly which was introduced, aimed at eliminating any form of waste within the manufacturing process by streamlining processes to improve efficiency and productivity. The main objective of the project was to shorten the assembly line, improve operator utilization, productivity, product quality, internal processes and improve visual standardization within the plant. It is important to highlight that, this project was part of the lean improvements that have been applied further to lean principles already in place, for example, 5S, TPM, Kaizen (continuous Improvement) and so on. With such tools in place, this has sparked an interest about learning, understanding and evaluating the status of lean within the organization. Also, exploring what has been a success or failure in the adoption of these lean principles and determining if there were any challenges or barriers that could have or are hindering the development of the lean journey within the organization. This chapter will examine the evolution of LP as a concept giving background to its origin, uncovering its principles, tools and techniques. It will also specify the challenges encountered by organization during implementation of lean methods and further discuss its benefits.

2.3 The evolution of Lean Production: Practices

When exploring all available literature on LP, we are informed about this rigorous thinking process in manufacturing which was founded in the late 19th century. Frederick W. Taylor became the first to study work management scientifically and distributed the results at the end of 1890. His work led to the formalization of time and motion studies and the setting of common standards. Subsequently Frank Gilbreth then added the concept of breaking work down into elementary time blocks. At this time, the notions of eliminating waste and studying movement began to materialize. In 1910, Henry Ford first developed a manufacturing concept of a continuous moving assembly line for his standardized vehicle Ford Model T. Another explorer Alfred P. Sloan improved on Ford's system when he introduced the concept of assembly line diversity at General Motors (GM) (Vision-Lean, 2015).

"Just in Time", "Waste Reduction" and "Pull System" concepts used by Toyota, which, together with other flow management techniques resulted in the Toyota Production System (TPS) were created by Taiichi Ohno and Shingeo Shingo after Second World War. The TPS has since been developed and improved. In 1990, James Womack summarized these concepts to create LP at a time when Japanese expertise was spreading to the West and the success achieved by companies applying these principles and techniques became undeniable (Vision-Lean, 2015).

This remarkable journey is depicted in Figure 1-1, which highlights all key phase of contribution to the LP concept (Shah and Ward, 2007).

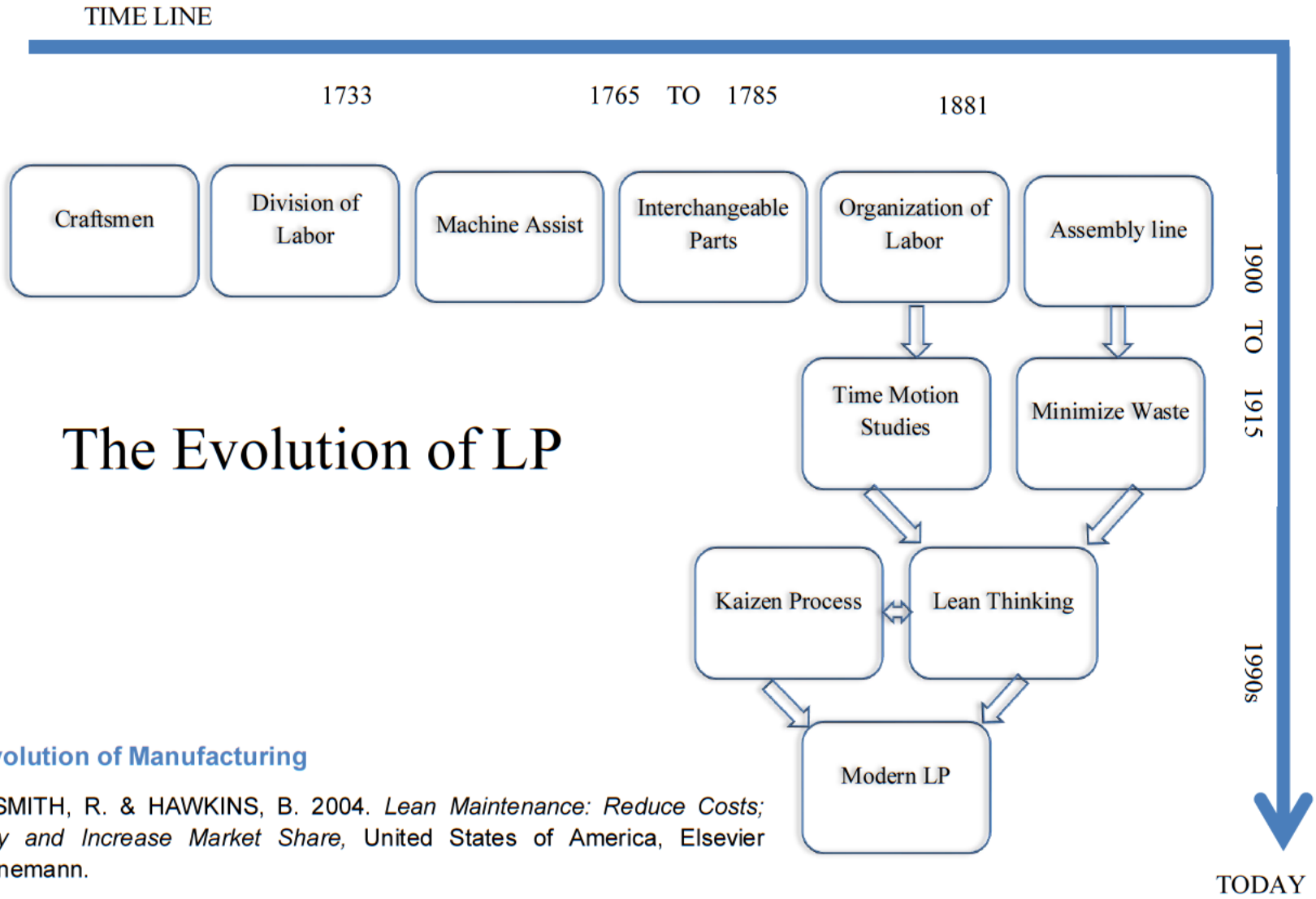

Figure 2-1: Evolution of Manufacturing

Adapted from SMITH, R. & HAWKINS, B. 2004. *Lean Maintenance: Reduce Costs; Improve Quality and Increase Market Share,* United States of America, Elsevier Butterworth-Heinemann.

2.4 Defining Lean Production

LP is an expression that has been around for many years, however, it gained its popularity when explored and described by famous authors Womack and Jones in 1990, on their study that led to the release of a book well known called, The Machine That Changed the World. Through its recognition, the topic has attracted a lot of interest whereby a number of researches have been conducted towards the understanding of its value. In this regard, one may discover a vast number of differing definitions of Lean, founded on the fact that, Lean is a continuously developing philosophy and it is applied in different approaches at various organizations. It is therefore important to note that, there are various interpretations of Lean. Although the concept was mainly established within manufacturing, Lean is similarly applicable within other sectors of business, such as service industries and other corporate administrative. There are various definitions and interpretations of LP as understood and reported by different authors of research.

It is understood that LP was developed by Taiichi Ohno at Toyota Motor Corporation. In his own construal, Lean is an innovation technique based on the minds and hands philosophy of the craftsmen era, merging it with work standardization and assembly line of the Fordism system, and adding the bond of teamwork and respect for human system, for good measure (Motwani, 2003). According to Santos et al. (2006), LP is defined as the systematic elimination of waste, meaning that lean is focused on cutting “fat” from production activities and can also be described as waste-free production. LP is adopted from Toyota’s Production System (TPS); in essence, it is also described as such. Defining this further the founder of TPS Ohno (1988) as cited in (Liker, 2004) said their exploits involved looking at the time line from the moment the customer places an order to the point when they collect the cash. The fundamental principle is to reduce the time line by removing all non-value added wastes.

Therefore in simplest terms, lean is a process of waste elimination throughout the organizations value chain resulting in waste free production. According to Santos et al. (2006); LP is strengthened by three philosophies, that is, Just-in –Time (JIT), Kaizen (continuous improvement: CI) and Jidoka, which is a Japanese term meaning autonomation. During their research work Shah and Ward (2003), stated that LP has turned out to be a combination of highly inter-related elements and an extensive variety of management practices, comprising of Just-in-Time, quality system, work teams, cellular manufacturing and so on. Soriano-Meier and Forrester (2002) mention that, in defining lean most authors have depended on the model that was developed by Karlsson and Ahlstrom which operationalizes the principles of LP. This model describes nine variables of lean identified as, the elimination of waste (EW), continuous improvement (CI), zero defects (ZD), Just-in-Time deliveries (JIT), pull of materials (PULL), multifunctional teams (MFT), decentralization (DEC), integration of functions (IF), and vertical information systems. Bhasin and Burcher (2006), argues that Lean is not merely about tools and techniques; however, it is ought to be viewed as a philosophy. It is a manner of thinking and not a mechanism to action these thoughts.

Considering lean as a philosophy, a few definitions have been cited in the study work done by (Bhamu and Sangwan, 2014) whereby, (Blackstone and Cox, 1998) state that LP can be considered as a philosophy of production that highlights the minimization of the amount of all the resources (including time) used in the various function within an organization, encompassing a process of identifying and elimination non-value adding activities in design, production, supply chain management, and dealing with the customers. Lean manufacturers utilize teams of multi-skilled workers at all hierarchy levels of the organization and employ highly flexible, increasingly automated machines to produce volumes of products in potentially enormous variety. In the same notion, another author views lean as a philosophy that shortens the lead time between a customer order and the shipment of the products or parts through the elimination of all forms of waste, stating that it is beneficial to an organization by means of cost reduction, cycle times and unnecessary, non-value added activities, resulting in a more

competitive, agile and market responsive organization. In view of all the inputs provided on LP, it is evident that there are diverse interpretations about the topic. However, there are two points of views that are distinguished about Lean. In major group of studies lean thinking has been mentioned as a Philosophical concept regarding principles and goals (Womack and Jones, 1996, Spear and Bowen, 1999, Monden, 1983, Ohno, 1988), in a different view to that, recent studies focus is on practical issues, techniques and tools which are required in order to achieve the goal (Shah and Ward, 2003, Li et al., 2005, Mehta et al., 2012). As defined by Womack and Jones (1996), these tools and techniques include a five step process: defining customer value, defining the value steam, making it "flow", "pulling" from the customer back and striving for excellence.

Majority of research studies have shown LP as the best manufacturing system in the 21st century (Mehta et al., 2012). Being a lean manufacture necessitates a manner of thinking that focuses on making the product flow through value adding processes without interruption (one piece flow); a "pull" system that cascades back from customer demand by replenishing only what the next operation takes away at short intervals, and a culture in which everyone is striving continuously to improve. According to Womack and Jones (2010), lean thinking can be summarized as; correctly specify and enhance value, identify the value stream, make the product flow, let the customer pull value and pursuing perfection.

2.4.1 The core of LP model: A system based on a structure

LP derived from the Toyota Production System, also described as LP is known to be one of the most popular models in waste elimination (*muda*) applicable in the manufacturing and service industry (Wahab et al., 2013). Despite the fact that every lean journey is distinctive, there are certain features of the model that are common to all lean implementation models irrespective of whether the organization makes vehicle engines, actual vehicles etc. or it makes clothing or even sell a service.

The first focus area relates to management, whereas, the second area pertains to the change in processes and operational personnel (Rich et al., 2006). The essential elements of lean are best described in figure 2 below, which depicts a house used as a symbol characterizing a structural system of the Toyota Production System (TPS).

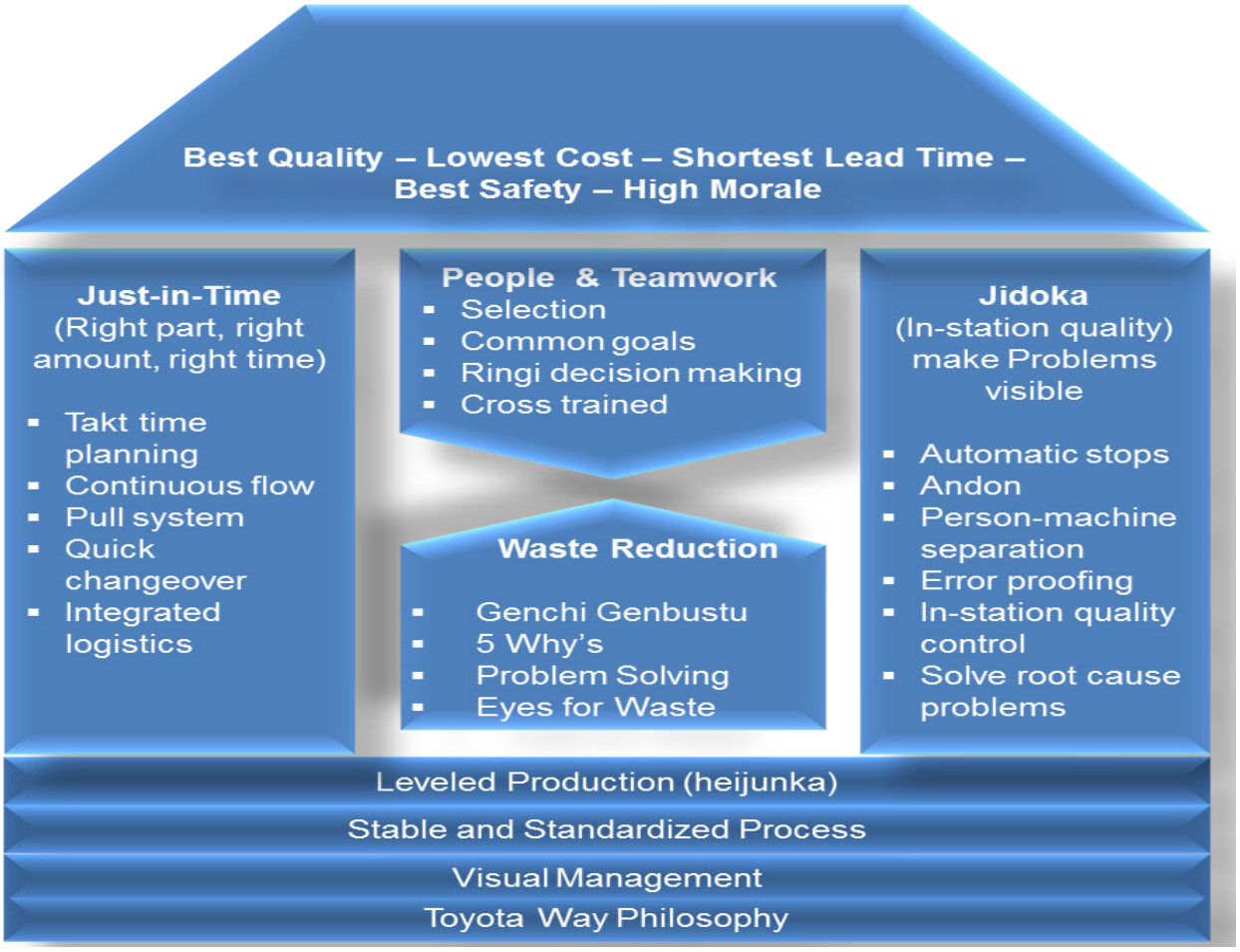

Figure 2-2: The Toyota Production Systems (House)

Adapted from LIKER, J. K. 2004. *The Toyota Way: 14 Management Principles from the World's Greatest Manufacture,* United States of America, McGraw-Hill.

The TPS house can be broken down into various parts, each of which complements the other. Starting from the top (roof) of the house, we find a description of all operational requirements driving any organization. These requirements are translated into goals and targets for achievement, that is, highest possible quality, lowest possible costs and shortest lead time. It is important to state that, fulfilling these goals is an indication that the organization can satisfy the needs of its customers and other relevant stakeholders. We then look at the two structured pillars of the house defined as Just-in-time (JIT) and Jidoka. Elaborating on these, JIT relates to an action of removing all inventory used to buffer operations against unforeseen problems that may arise during production. According to Ohno (1988) just-in-time means that, in a flow process, the right parts needed in assembly reach the assembly line at the time they are needed and only in the amount needed. The goal is an implementation of a flow production with zero work-in-progress (inventory). Whereas the second pillar called Jidoka (autonomation), refers to a principle that was invented by Saichi Toyoda who created an auto-activated weaving machine towards the end of the 19th century, which stopped instantly if one of the warp or weft threads broke (Miltenburg, 2001). Essentially, Jidoka can be understood as a method that allows for a halt in a production process when an error occurs. This method allows workers and managers to resolve problems immediately in order to resume production.

The other parts of the house constitute to very important elements a well. At the bottom of the house is stability as a solid foundation. The crucial elements at this point are depicted as; leveled production (heinjuka), along with vital concepts of standardized work, visual management and lastly, the actual Toyota way philosophy which relates to respect for humanity for example. Continuous improvement can only be driven by people and hence, people are at the core of the system. Most authors view lean as a toolkit, however, (Liker, 2004) concluded that, it is a sophisticated system of production in which all of its elements contribute to a whole in other to continuously improve processes.

2.4.2 The heart of Lean Production: Eliminating waste

According to Liker (2004), when applying lean, the very starting point is to examine the manufacturing process from the customers perspective, asking the big question, "what does the customer want from this process?". In this perspective, the organization is able to define value through the eyes of the customer. The main focus of lean systems is reducing waste of all types, highlighting continuous improvement (Kovacheva, 2010). When introducing a waste elimination topic, mostly people interpret this as relating to the seven types of waste as defined by most lean experts. However, there are other contributors to waste which are normally not mentioned but are of extreme importance as the seven wastes (*muda*), namely overburden (*muri*) and unevenness (*mura*). These are normally referred to as three M's. In his book the Toyota way, Liker confirms that when an organization focuses on LP efforts, all types of waste need to be considered and these fit together as a system. He states that, if the focus is only on the muda, this might compromise the productivity of people and the production system. The different wastes are visualized in figure 3 below.

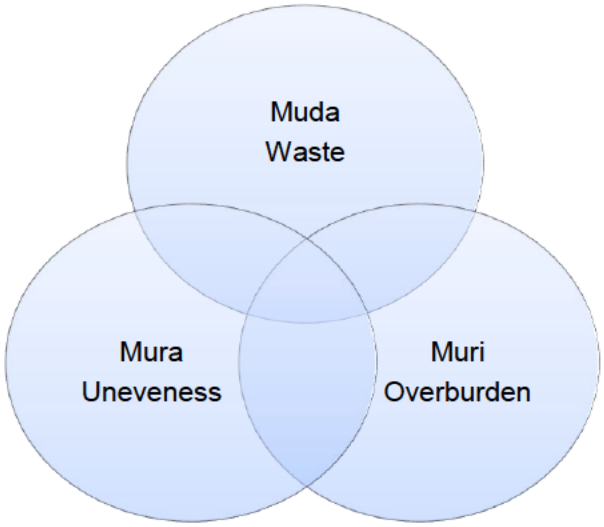

Figure 2-3: The Thee M's

Adapted from LIKER, J. K. 2004. The Toyota Way: 14 Management Principles from the World's Greatest Manufacture, United States of America, McGraw-Hill.

It is imperative to understand that all three M's refer to some class of waste. With all that considered, for a better insight, the three M's are further detailed in the following.

2.4.2.1 Muda (non-value added): 7 types of waste

Muda is pronounced as the most familiar M, which is linked to the 7 types of waste. Muda relates to all wasteful activities that attribute to prolonged lead times, any unnecessary movements relating to collecting of material, tools or equipment for assembly, any process that creates unnecessary inventory and any idling time within the processes (Liker, 2004). Overproduction is considered to be the most fundamental waste since it causes most of the other wastes for example, if the organization produces more than what the customer requires; any input to that process will lead to a build-up of unnecessary product resulting in a high volume of inventory. Like many other lean experts, (Liker, 2004) expanded on these types of waste by introducing an additional waste which he named; unused employee creativity. By this he referred to losing time, ideas, skills, improvements and learning opportunities by not engaging or listening to employees. Identifying and eliminating these types of waste, striving to continuously improve, this has helped organizations improve their performance.

Womack and Jones (2003) mentioned that Ohno in TPS focused on seven types of wastes and; identification and reduction of these wastes is the core of the lean concept. These wastes were categorized by Ohno (1988) within the Toyota production system and are exhaustively described in the list on table 2 below.

Table 2-1: Seven Types of Wastes

Adapted from LIKER, J. K. 2004. The Toyota Way: 14 Management Principles from the World's Greatest Manufacture, United States of America, McGraw-Hill.

Type of Waste	Description/Examples
Over production	Producing items without an orders or producing items not in a timely manner
Waiting (time on hand)	Delays associated with stock-outs, lot processing delays, equipment downtime, capacity bottlenecks
Unnecessary transport	Creating inefficient transport, moving materials between processes
Over processing	Process steps that are not required to produce the product
Excess inventory	Excess raw material, Work in Process (WIP) or finished goods
Unnecessary movement	Unnecessary movement due to searching for parts, tools, etc.

2.4.2.2 Mura (Unevenness)

Mura is the waste of unevenness or inconsistency, meaning there is more work than the people or machines can manage. Inversely to that, there can also be insufficient or lack of work. This unevenness results from irregular production schedules putting unfair demands on processes and people and causing the creation of inventory and other wastes (Liker, 2004).

2.4.2.3 Muri (Overburdening people or equipment)

Muri is described as overburden by means of pushing a machine or people to extremes beyond natural limits. By so doing, this may result in safety and quality problems. When equipment is overburdened, it is bound to fail and cause more defects out of the process compromising the quality of the product. Mura produces Muda, the seven wastes are actually indicators of the failures to undertake Mura and Muri within processes in an organization (Liker, 2004).

2.4.3 Lean Production principles

Academic research has provided various view points on the subject of LP. Different authors have devised numerous methods on how the system can be implemented using its philosophies, ultimately seeking to reduce waste in every operational aspect of the business, optimizing resources and promoting customer satisfaction. Becoming lean requires a distinctive manner of thinking, a specific philosophy and management system.

Authors have presented the concepts of LP in a credible way, but, that does not take away the fact that it is based on TPS. (Smith and Hawkins, 2004, Womack et al., 1990, Womack and Jones, 2010), defined five core lean principles required for implementation of lean, figure 2-4 provides an overview of these principles in a form of a sequential step process.

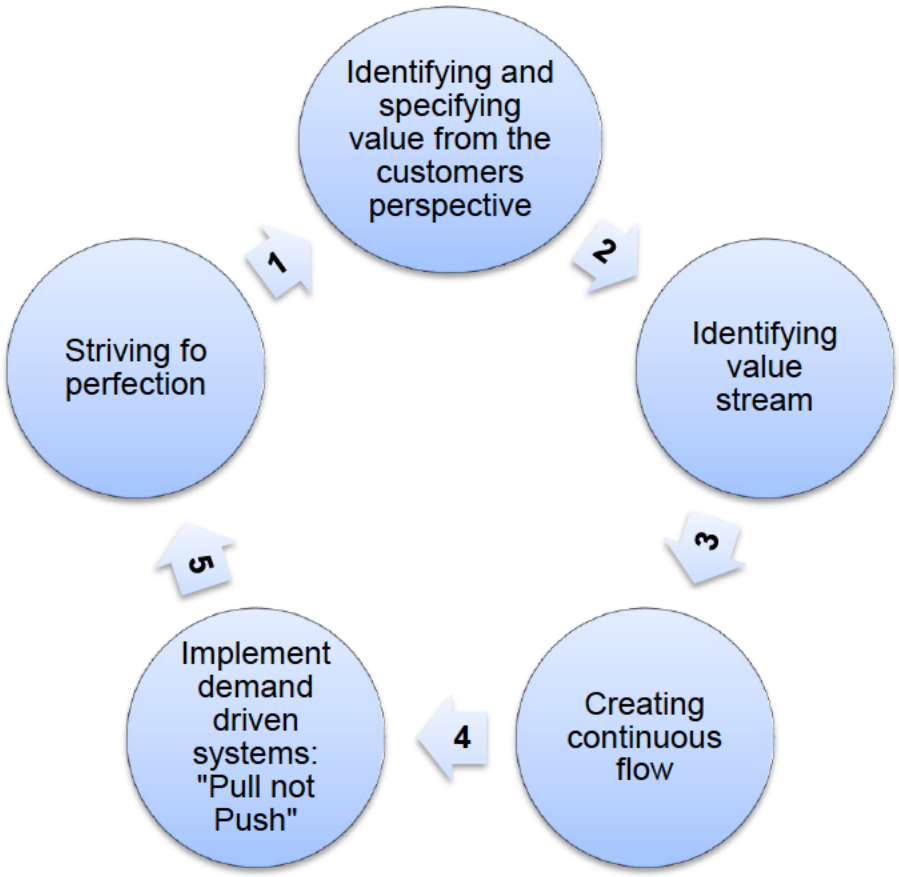

Figure 2-4: Lean Principles

Adapted from SMITH, R. & HAWKINS, B. 2004. *Lean Maintenance: Reduce Costs, Improve Quality and Increase Market Share,* United States of America, Elsevier Butterworth-Heinemann.

It is important for every organization to understand how the customer values its product and services. Value can be regarded as something that the customer wants and is willing to pay for. Therefore the customer will create value for the organization based on needs, pricing, and timing of products or services (Karim and Arif-Uz-Zaman, 2013). Liker (2004), defines value as a process of examining the manufacturing process from the customers perspective, throughout all functions, internal and external. Specifying value accurately is considered as the critical first step in lean thinking. Through customers' perspective, the organization can observe its processes and separate value added steps from non-value added steps.

Value should be defined through a constant communication with ultimate customer (Womack and Jones, 2010). Specifying value accurately is the critical first step in leaning thinking. Once value has been defined, the next step would be identifying the value stream, whereby, all activities or processes required in producing a product, service or both are classified. These processes include every function within the organization that is required to transform raw materials into a product. Womack and Jones (2010), defined the approach used to identify these activities into three critical management tasks such as; problem solving task which includes steps from concept introduction, detailed design through to product launch, information management task consisting of order taking, scheduling and product delivery, physical transformation task encompassing all functions required to convert raw material into final product as purposed for the customer. Identifying value stream for each product is also considered as one of the critical steps in lean thinking. Unfortunately this process is seldom utilized to its maximum benefit and that is, in the case it is used at all. However when properly utilized, it may lead to discoveries of large amounts of waste. Conducting a value stream mapping activity allows organizations to identify these wastes and eliminate the ones that can be easily avoided (Womack and Jones, 2010).

Once the first two steps have been clearly introduced, the next step to consider is creating a continuous flow. At this point all non-value adding and value adding functions have been distinguished; the focus is then drawn into all value adding functions with an intention to get the most out of it. The traditional methods encouraged mass production by arranging all production functions and departments, grouping activities according to their type and these were also performed in batches. This method obviously is not recommended as it promotes overproduction resulting in large inventories and this actually hides any existing or possible errors. Lean thinking allows for higher efficiency by creating continuous flow of value adding functions throughout the value chain (Womack and Jones, 2010).

With the implementation of the three previous steps, the organization will then experience dramatically reduced lead times from customer order to. Products produced without a demand will mostly result to waste because they are built to stock. This method is best described as a push system. Lean thinking defines a pull system whereby no production, of any product is undertaken unless there is a demand for it, that is, a customer has put a demand for it. Lean promotes that production of a product should only be initiated when the customer has requested for it and this method prevents any batch building (Womack and Jones, 2010).

When organizations have specified value, identified the entire value stream, created value steps for specific product flow continuously and allow for customers to pull value from the business, a new picture begins to surface. With lean there is no final destination. The process of reducing effort, time, space, costs, and errors never ends because the customer is always expecting more (Womack and Jones, 2010). This is now journey of endless pursuit of perfection. This refers to the essence that lean is a continuous improvement process. It is believed that there will always be a room for improvement in any process within the organization. Lean thinking means that organizations must always aim for perfection and that cycle never ends. It is important that all the steps are working together, so that the influence of each of them is strong enough to enhance the outcomes of the others (Kovacheva, 2010).

A famous author on Lean publications, in his book The Toyota Way acknowledged the five principles stated in figure 2-3 above, however, he came up with his own outlook on lean principles. He mentions fourteen principles that constitute the Toyota Way, which describes the culture behind TPS. He then constructed these fourteen principles into four categories all starting with a letter P, namely, Philosophy, Process, People and Partners and Problem Solving.

This has since been known as a “4P” model, which is further detailed in figure 2-4 below and discussed in the following paragraphs (Liker, 2004).

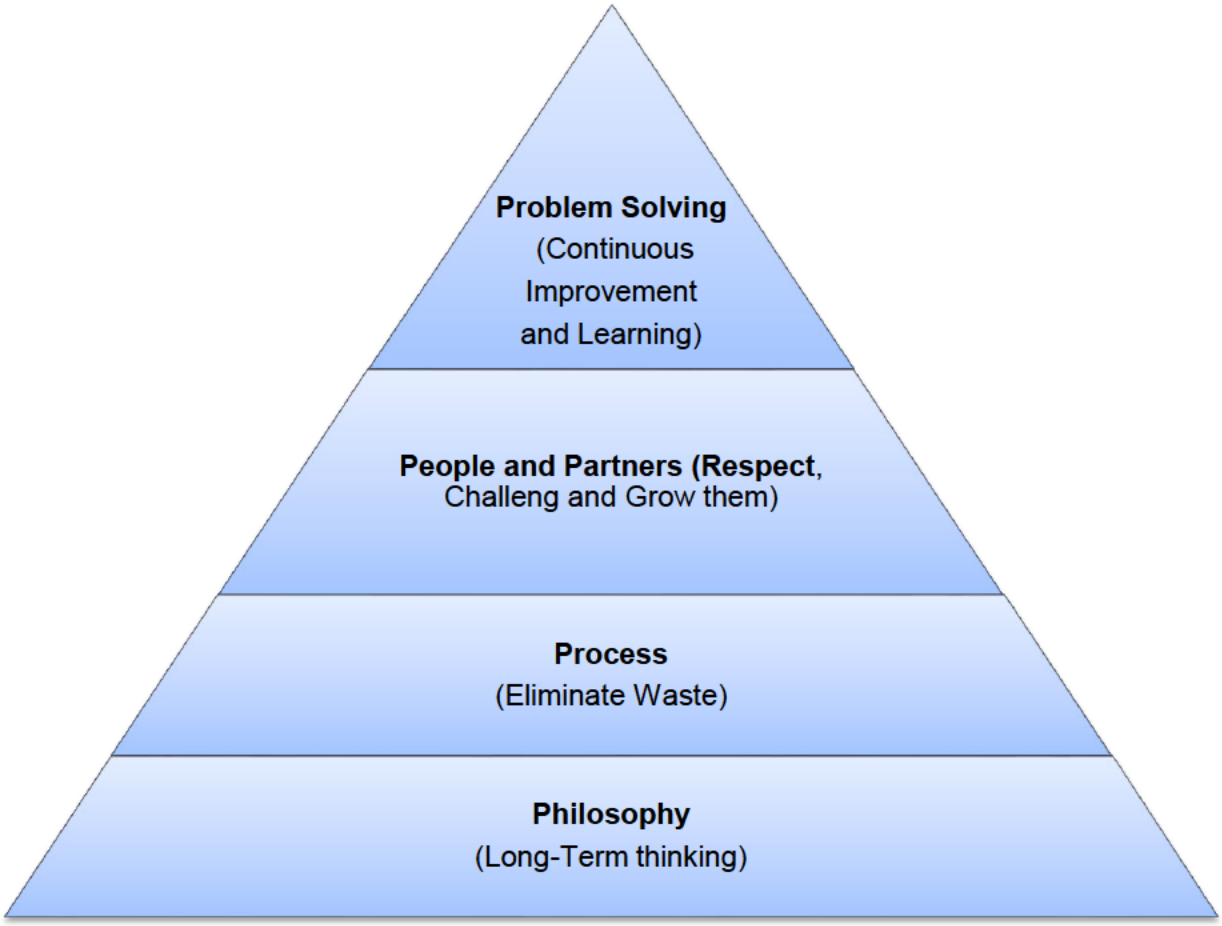

Figure 2-5: The 4"P" Model

Adapted from Adapted from LIKER, J. K. 2004. The Toyota Way: 14 Management Principles from the World's Greatest Manufacture, United States of America, McGraw-Hill.

2.4.3.1 Long term Philosophy

In this first category, an applicable principle suggests that management decisions are based on a long term philosophy, albeit that short term financial goals are sacrificed. The whole organization must be aligned towards a common purpose that will be more credible than making money. The organization should also ensure that it generates value for the customer, society and the economy. This can be achieved by ascertaining

that each function within the organization is designed to accomplish this common purpose (Liker, 2004).

2.4.3.2 The Right Process Will Produce the Right Results

This category covers a number of valuable principles and it is quite self-explanatory. If the organization manages its processes will, definitely the results with be outstanding. Managing processes means that all work functions have been designed to create a continuous flow where any deviations from the norm are brought to surface and easy to handle. It is imperative to note that this category addresses most of the principles defined by (Womack and Jones, 2010). These include the following; Incorporating a "pull" system to avoid overproduction, leveling out the workload, building a culture of stopping to fix problems, to get quality right the first time, standardizing tasks for continuous improvement and employee empowerment, use of visual control so no problems are hidden and lastly the use of only reliable technology serving people and processes (Liker, 2004).

2.4.3.3 Add Value to the Organization by Developing Your People and Partners

This category highlights the significance of employees and partners within an organization. For instance, Toyota Motor Corporation regards its employees as greatest assets of the organization and believes that investing in the development of their employees means investing towards the future of the organization. One of the principles define in this category is, growing leaders who understand the work, live the philosophy of the organization and are willing to share this with others. Every organization needs to produce employees of such talent and competency, who can even go an extra mile to fulfill the vision of the organization. Another principle encompasses the ability of the organization to develop exceptional people and teams who follow the organizations

philosophies. An organization is not about individualism, but team work. The stronger the team, the more stable is the organization. Organizations need to breed a workforce that is determined, understands the culture of the organization and empowered to use the tools available to them in order to improve the organization. Lastly under this category is the principle to respect extended networks of partners by challenging and helping them improve. By adopting this principle, it means that the organization is putting additional importance in its partners both external and internal, treating them with great respect and value as extended partners of the organization (Liker, 2004).

2.4.3.4 Continuously Solving Root Problems Drives Organizational Learning

There are three main principles in this category and these denote very crucial points necessary for continuous improvement. A structured approach towards problem solving is of utmost importance and to understand all problems the organization faces, superficial methods of problem solving are not valuable. A method of going to the area where the problem occurs and understanding the actual problem is what is recommended, and this method is well known to the Japanese as Genchi Genbutsu. Employees at all levels need to be familiar with this method as it promotes brain storming at source, consideration of various options and promotes consensus decision making, which is another principle mentioned in this category (Liker, 2004).

As explained by (Liker, 2004, Womack and Jones, 2010, Ohno, 1988), lean is not merely about duplicating tools used by Toyota, but it is about the organization developing a culture and principles that are applicable and necessary to create sustainable growth and improvement for the organization. Organizations must diligently practice these principles in order to achieve high performance and have sustainable competitive advantage.

2.4.4 Lean Production tools

Current literature demonstrates that since the beginning of the new century most organizations have moved from their old traditional manufacturing methods and are trying to implement lean methods, that is, if they have not already done so. A number of tools and techniques have been developed and to date, new ones still emerge. LP has become an integrated system composed of highly inter-related elements and a wide variety of management practices (Bhamu and Sangwan, 2014). Different authors discuss various methods and tools that organizations use to implement LP Systems. Melton (2005), listed five key tools within the lean system namely; Kanban, 5S, Visual Control, Poke yoke and Single Minute Exchange of Dies. (Ravikumar et al., 2009) expanded on these tools in their research work they mention other lean tools namely; Total Productive Maintenance (TPM), Cellular manufacturing / One-piece flow production systems, Just-In-Time Production, Six Sigma, Pre-Production Planning (3P) and Lean Enterprise Supplier Networks. Green and Dick (2001) as cited by (Bhamu and Sangwan, 2014) also alluded to the fact that there is an excess in number of the different tools and techniques for different purposes and waste elimination. Bhamu and Sangwan (2014) explored all available literature and reviews on LP and identified 18 lean tools in total, ranging from Value Stream Mapping (VMS) to Total Quality Management (TQM). However they noted that there are nine tools that are frequently used in different organizations and these are listed here in the order of popularity; VSM, Pull Production, JIT, 5S, TPM, Cellular Manufacturing, Kaizen, TQM and SMED. According to Pavnaskar et al. (2003), LP tools and techniques have multiple names; some of them overlap with other tools and techniques, and particular tools/techniques might even have a different method of implementation proposed by different researchers. Many of these tools are used in conjunction with each other to achieve optimum results; figure 2-5 below presents some of the tools, techniques and methodologies used in LP. Nine of these tools as indicated above are further explained in the following paragraphs with the exception of VMS and Pull production as these have been detailed previously in this literature.

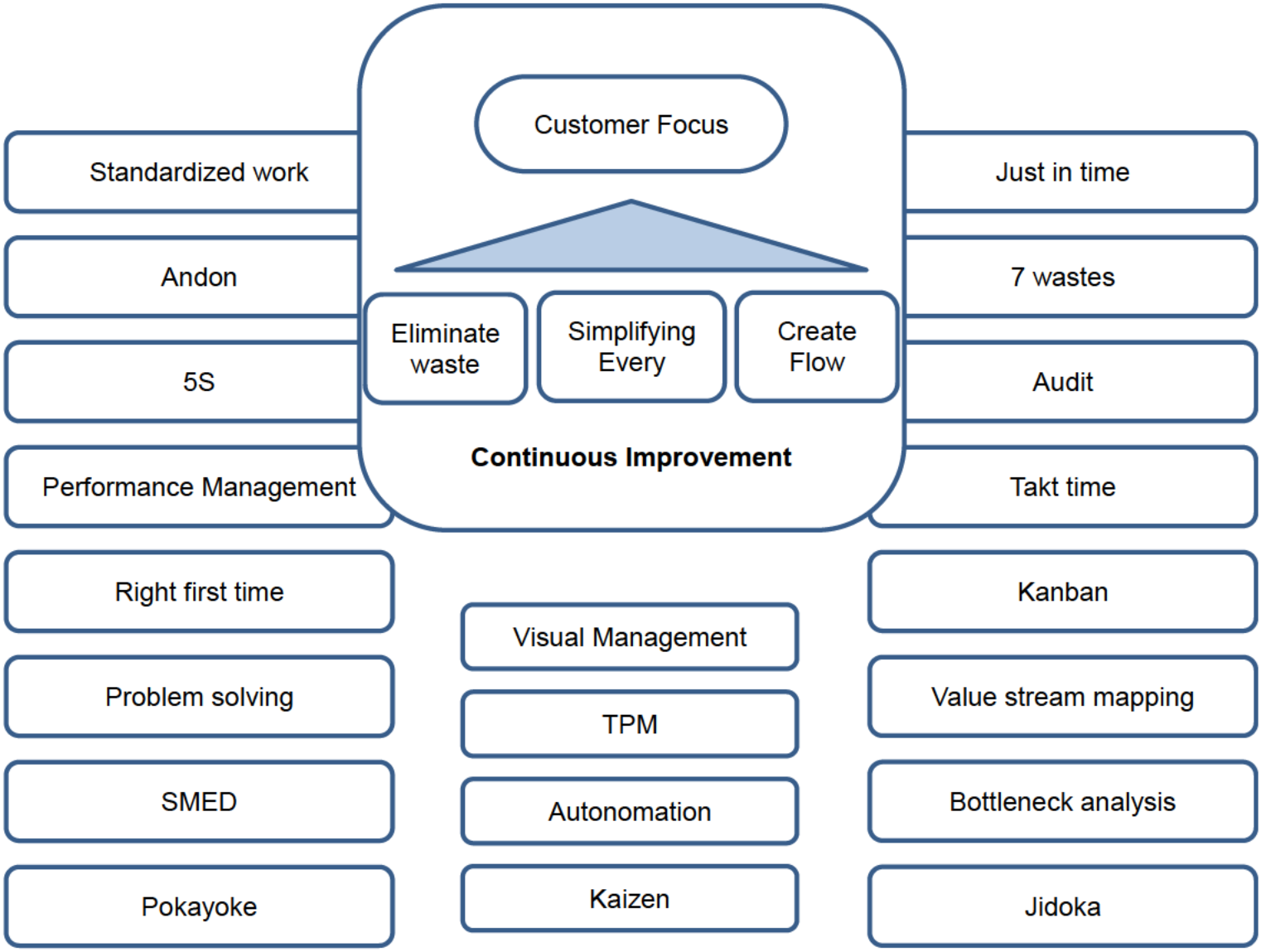

Figure 2-6: The Lean Production Tools

Adapted from EARLY, T. 2015. *Lean Manufacturing Tools* [Online]. leanmanufacturingtools.org. Available: http://leanmanufacturingtools.org/category/lean-manufacturing-tools/tpm/ [Accessed 19 May 2015].

Just in Time (JIT)

One of the main practices in LP is JIT. Liker (2004) defines JIT as a set of principle, tool and technique that allows an organization to produce and deliver products in small quantities, with short lead times to meet specific customer needs. In shortest and simplest terms, JIT delivers the right item at the right time in the right amounts. As far as JIT is concerned, nothing will be manufactured until it is demanded (Santos et al., 2006). JIT is regarded as a LP tool that assists organizations in making more of what the customer wants with fewer resources (Rich et al., 2006).

Looking at JIT from a supplier perspective, it is considered as a process that focuses on carrying cost reductions and order cost reductions, such as setup time reduction, which results in a decrease in the total cost of inventory and thereby reduces the order size. The key elements of JIT are Flow, Pull, Standard Work and TAKT time (Plenert, 2007). To simplify JIT concept, it can be stated that, JIT entails receiving parts, material or product precisely at the time it is needed. By so doing, this avoids inventory pile-up (Smith and Hawkins, 2004).

5S

5S is one of the basic building blocks of LP, one of the first lean tools that an organization will start lean implementation with. Five S is a system to reduce waste and optimize productivity through maintaining an orderly workplace to achieve more consistent operational results. Five S refers to the five steps for improving the work place Smith and Hawkins (2004) and these are regarded as the starting point for shop-floor transformation. The five terms are utilized to create a workplace suited for visual control and LP (Plenert, 2007). Each S has a different interpretation and function value and these are detailed below in a sequential order as they would be implemented in a workplace:-

- Sort, means to remove unnecessary items, separate needed tools, parts, and instruction from unneeded materials and to remove that which is not required.

- Straighten / Simplify, means to organize, neatly arranging and identifying parts and tools for easy access and use.
- Scrub, this step focuses on the necessary tasks to clean the working area. It refers to conducting a cleanup campaign to cleaning everything from equipment to work benches etc.
- Standardize, is the fourth step meaning the first three steps must be conducted at regular intervals in order to maintain the workplace in perfect condition. The work already done cannot go to waste. Furthermore, identifying irregularities from what has been set becomes easier.
- Sustain, is the last step in the process which means that the new working procedure or method needs to be enforced until it becomes a habit (Plenert, 2007, Smith and Hawkins, 2004, Santos et al., 2006).

Five S provides the foundation on which other lean methods such as TPM, Cellular manufacturing, JIT etc. can be introduced effectively.

Total Productive Maintenance (TPM)

TPM was first developed in Japan, as a new maintenance management philosophy included in Toyota's improvement process. This lean equipment maintenance strategy maximizes overall equipment effectiveness. The objective of TPM is zero breakdowns within production processes (Santos et al., 2006). TPM has many different titles and there are many schools of thought when it comes to its implementation and environment which it may be applicable. Nonetheless, here we intend to give a slight overview of what it entails. TPM is a manufacturing led initiative for optimizing the effectiveness of manufacturing equipment. TPM is team-based productive maintenance and involves every level and function in the organization, from top management to the shop floor. The goal of TPM is what is so called "profitable PM". This requires that the organization does not only prevent breakdowns and defects, but it must do so in ways that are efficient and economical (Smith and Hawkins, 2004). Another interpretation of TPM indicates that TPM is a series of methods, originally pioneered to ensure that every

machine in a production process is always able to perform its required tasks so that production is never interrupted (Plenert, 2007). To consolidate this concept, Womack and Jones (1996), accurately and concisely describe TPM as an organization-wide approach to the management and operation of all the factory assets, both human and equipment, in such a manner as to achieve the optimization of the conversion process and the generation of customer 'value' over the economic working lifetime of the assets employed.

Single Minute Exchange of Dies (SMED)

The SMED methodology was developed by Shigeo Shingo in Japan from 1950 to the 1980s. With this methodology, it is possible to achieve good results without costly investments, which makes implementation in many factories an easy decision to make. The SMED methodology is a clear easy to apply methodology that has produced good results in many cases very quickly (Santos et al., 2006). In manufacturing this method allows for changeovers to be less than one minute (Plenert, 2007).

Cellular Manufacturing

In cellular manufacturing production work stations and equipment are arranged in a product-aligned sequence that supports a smooth flow of materials and components through the production process with minimal transport or delay (Robertson and Jones, 1999). Cellular manufacturing aims to move products through the manufacturing process one-piece at a time, at a rate determined by customer demand. To enhance the productivity of the cellular design, an organization must often replace large, high volume production machines with small, mobile, flexible machines to fit well in the cell.

Kaizen (Continuous Improvement)

Kaizen is well known as one of the lean tools which relates to continuous improvement. It is also commonly called breakthrough kaizen. According to Melton (2005), kaizen is an improvement activity to create more value and remove waste. Toyota's basic philosophy is that any operating system can be improved if enough people at every level are looking and experimenting closely to improve their own work system (Mohanty et al., 2007). In their own perception, however, still following on the same view as other authors, Smith and Hawkins (2004) relate to Kaizen as a philosophy for continual improvement, in which every process can and should be continually evaluated and improved in terms of time required, resources used, resultant quality and other aspects relevant to the process. Kaizen method uses other lean tools in a small scale project, and is applied to a specific area of interest for a defined duration within the overall manufacturing operation. The Kaizen tools and methods used in the execution of these projects include; 5S, 7 Wastes, VSM, JIT etc. Kaizen workshops are a more practical way of introducing improvement changes. A kaizen process would start with data collection and continue to do some data analysis, design and even implementation. Kaizen is an excellent tools because it is not only limited to manufacturing systems but it is can also be used in one's personal life experiences at home, social life and working life.

Total Quality Management (TQM)

TQM is a managerial approach aiming at achieving quality in a broad sense. TQM method and style is required for organizations to achieve customer satisfaction and global competitiveness. TQM is based on a number of principles like; quality first, customer satisfaction, continuous improvement etc. Various authors have different comprehension of TQM; however, they are in agreement with the view that above all, TQM is a philosophy and set of principles directed at emphasizing continuous improvement, meeting customer requirements, customer focus or driven, reducing rework, increasing employee involvement and teamwork, process design, competitive

benchmarking, team based problem solving, constant measurement of results and closer relationship with suppliers (Flynn et al., 1995, Dean and Bowen, 1994, Ross and Perry, 1999). At this level quality looks outside boundaries of the organization to its customers and suppliers. The focus is mainly guided by the customer and therefore all processes of the business and activities which are influenced by suppliers must be incorporated into the drive of quality. At this level, continuous improvement is the responsibility of all those who can influence improvement. It is important to note that every tool or method has its successes and failures; hence, it is crucial that the right approach and application is used in implementation of any tool in order to reap the benefits associated with it. Quality requires consistent and continuous review to enable further improvement and change to occur (Rich et al., 2006). There are numerous practices that can be applied under LP. This is one reason why one finds different individual practices though the focus on LP is the same (Sohal and Egglestone, 1994, Oliver et al., 1996, White et al., 1999).

2.4.5 Implementation of Lean Production

When implementing lean systems, there must be a specific logic of approach. Rich (2001), suggests that the logic of lean implementation is quite straightforward and common to all organizations. It must be easy to communicate, focus on practical issues of relevance to the very work environment and should use 'learning by doing' not 'death by computer presentation' (Rich et al., 2006). To sustainably implement lean, there are various stages in which improvement programs are structured. These programs are highly visual and endeavor to integrate workers with the change program by improving the workplace and conditioning the teams, in an easily understood process, to the stage of problem solving (Rich et al., 2006). If employees are well integrated in the change process the quality of the process will improve. Implementing programs such as 5S methodology improves the entire visual organization of the workplace. When change is visible it also aids as a motivating factor for employees. A lot has been written and revealed on the subject of LP; nonetheless, methods and strategies used for

implementation are somewhat different. The key characteristics of lean implementation is to combine lean principles, practices and tools with a strong commitment to drive change through organizational learning (Mohanty et al., 2007). Many organizations have tried to imitate Toyota's tools as opposed to its principles; as a result, many have ended up with rigid, inflexible production system that worked well in the short term but could not be sustainable. This demonstrates that there is more involved in lean implementation than the mere tools. Fixation on tools is an indication of weakness on the lean approach as this only promotes isolation improvement rather than optimization of the entire production system (Pearce and Pons, 2013). Senge (1990) cited by (Mohanty et al., 2007) stated the mere implementation of lean tools lacking an integrative systems as a foundation is not sufficient and will not help transform the organization into a learning organization. To successfully implement lean, lean tools and practices must be led by organizational transformation. Importantly to note is that, all identified lean principles cannot be implemented independently; they are basically a symphony that must be harmonized.

Researchers have identified some interesting approaches towards lean implementation. Larteb et al. (2015) discusses two classifications namely hard and soft practices; soft practices being the organizational and human side in operations, quality and performance management, whereas, hard practices relate to the methodological and technical side of the LP as preventative maintenance, cellular manufacturing, continuous flow, reduced lot sizes, quick handover change times, kanban etc. Lean authors express that success on lean implementation is rooted on the application of tools and principles towards achieving superior performance. Moreover, intellectual stimulation and inspirational motivation, and impeccable influences within interdisciplinary teams are as much vital to gaining all the benefits lean practices have to offer (Mohanty et al., 2007, Larteb et al., 2015). Most attempts to implement lean have been fairly superficial based on the previous studies. The reason is that most organizations are only one sided and have focused enormously on tools without an understanding of lean as an entire system that must permeate an organizations culture

(Liker, 2004). Literature provides a common understanding by various authors indicating that effective implementation of lean practices is hard to achieve and in other to accomplish the set desires on lean implementation, organizations must have a significance organizational and culture change. This entails total support and commitment from top management in ensuring success and sustainability of LP system. Changing from traditional to LP may be though, Saad et al. (2006) cited by (Nordin et al., 2010) suggested that the success of LP implementation depends on four critical factors: leadership and management; finance; skills and expertise; and supportive organizational culture. Employee involvement and support is another crucial factor towards achieving positive results. Motivation and empowerment of employees is essential as people are the key element to any change envisaged by the organization. As a well-known cliché "team work, makes the dream work", this is very true in lean implementation, team work is regarded as the heart of LP implementation. Team culture and sharing common goals and attitudes, training of employees is fundamentally imperative towards the implementation of lean.

Trainings should be designed to change employees' perspective, giving them thorough understanding of LP systems and the ability to grow in their work functions (Roslin and Ahmed, 2012). Vienazindiene and Ciarniene (2013) consolidate most research work done on LP and concluded that implementation of LP systems can be described as a set of actions and processes including planning the change, lean tools and techniques, defining the success factors and barriers and finishing by implementation and measuring the progress. This was done in a form of a model and it is presented on figure below.

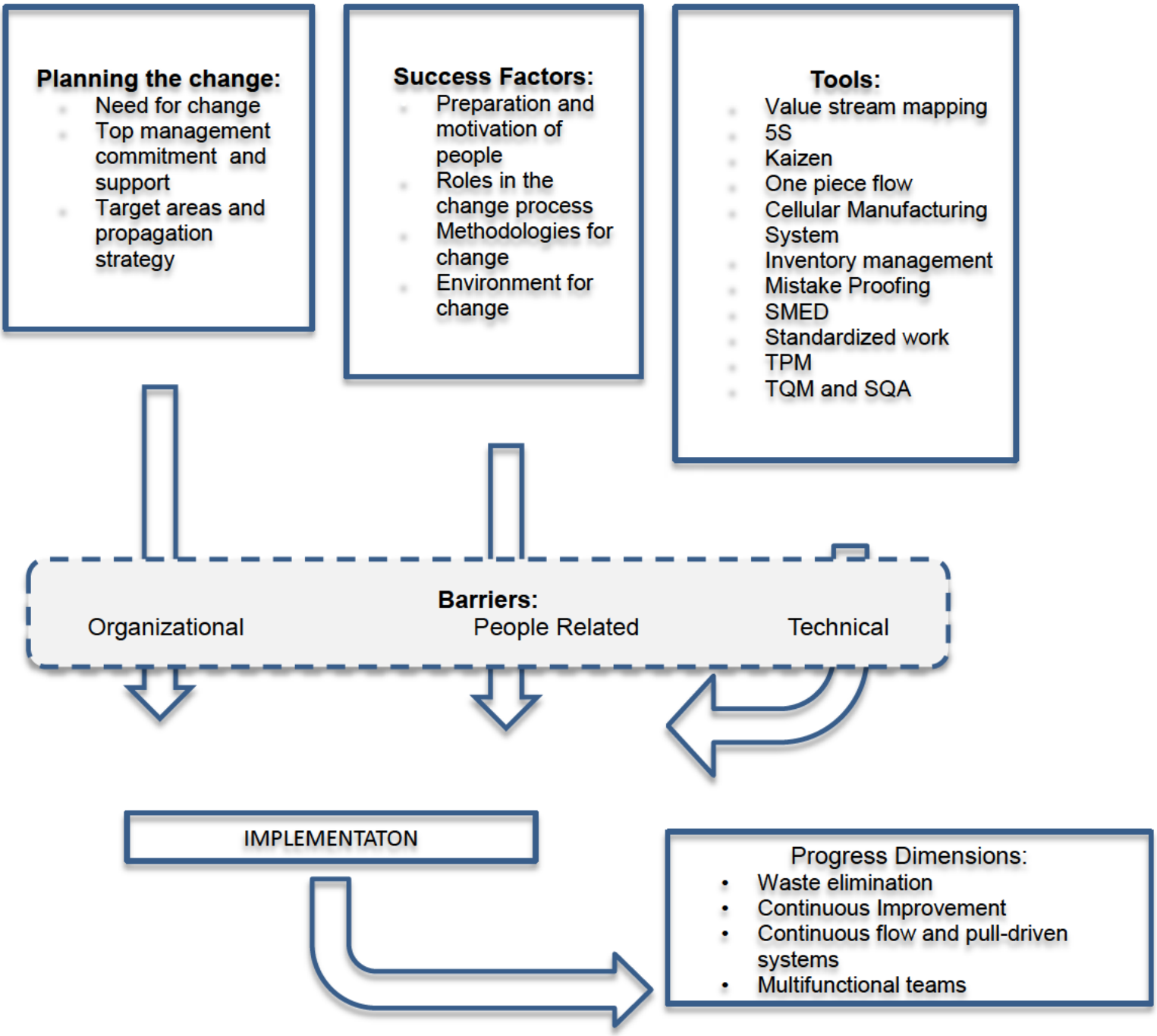

Figure 2-7: The model for successful Lean Implementation

VIENAZINDIENE, M. & CIARNIENE, R. 2013. Lean manufacturing implementation and progress measurement. *Economics and Management,* 18**,** 366-373.

The activities presented on the displayed model in figure 2-5 should lead to improvement in five dimensions: Elimination of waste; Continuous Improvement; Continuous flow and Pull-driven Systems; Multifunctional teams and information systems (Vienazindiene and Ciarniene, 2013). LP systems can produce amazing successes when applied and implemented properly and are not limited to any specific industry.

2.4.5.1 Challenges and barriers

Implementing continuous improvement strategies can be difficult at times. There are quite a number of obstacles or challenges that organizations face during transformation irrespective of the magnitude. The global competitive environment has not made it easy for survival and therefore organizations are always in an endless quest for methods to improve processes, producing more with less, yielding higher productivity. Despite the huge benefits gained from LP systems, in reality many organizations struggle to be successful with the implementation. Numerous authors give various explanations to cause of failure, others relating to misunderstanding of the real concept and purpose of LP as a primary contributor (Nordin et al., 2010). Whilst others associate such failure to cultural issues, most believe this is significantly due to employee resistance (Roslin and Ahmed, 2012, Sim and Rogers, 2008). Vienazindiene and Ciarniene (2013) discusses findings on research work conducted by (Radnor et al., 2006) where three issues that organizations normally face as challenges are illustrated. These can /are be defined as follows:

- The people issue: which relates to employee buy-in to change, persuading them to engage in planned changes even though it may disrupt their current state of work.
- The process issue: this focuses on the actual lean tools and techniques that are mostly applicable to the work environment.

- The sustainability issue: this supports the implementation of lean by ensuring that it is not regarded as just a tool but as an inherent way of working.

On the other hand is important to highlight that, the presentation of such barriers is relatively very general. Barriers may vary depending on the business sector and organization. It can then be expressed that every lean implementation process is more unique and accustomed to each organization. On the contrary, there are benefits to a certain degree that can be associated with lean implementation. These are further described on the next paragraph.

2.4.5.2 Benefits of lean implementation

According to Early (2015), the implementation of lean through instituting value flow at the pull of the customer prevents and eliminates waste in every process within the organization. Literature has documented a number of benefits associated with lean implementation; some of these benefits can be described as; decreased lead times for customers; reduce inventories for manufacturers, robust processes and improved knowledge management. Furthermore, these benefits are depicted in figure 2-7 below (Melton, 2005);

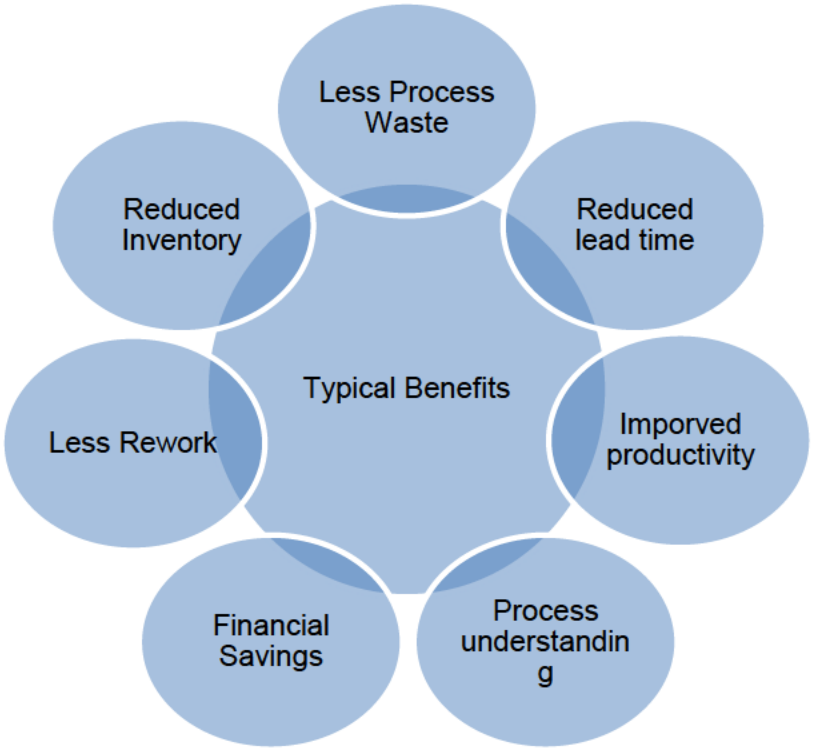

Figure 2-8: The benefits of Lean

MELTON, T. 2005. The benefits of lean manufacturing: what lean thinking has to offer the process industries. *Chemical Engineering Research and Design,* 83**,** 662-673.

To obtain maximum benefits and ascertain stability of lean processes, organizations must roll-out lean practices throughout all aspects of the business or value chain. Lean practices have been shown to improve performance and drive efficiency within any business. A lean business will improve productivity and produce more products or services using the exact same resources used prior implementation of lean systems, this also helps yield better profits. One of acclaimed benefits of lean implementation is; improved customer service. This is achieved by delivering exactly what the customer wants and at the time they want it. Simply put, this means that the organization is able to deliver the right product or service to the right customer at the right time and place. Taking all these facts into consideration, it can be concluded that, by implementing lean systems, organizations are at advantage to remain competitive both in terms of prices and effectiveness of the services offered (Arindam, 2011).

2.4.5.3 Success factors in implementing Lean

Although certain success factors are suggested by different authors and many scholars have attempted to formalize the critical factors for successful LP implementation, there has not been an agreement on what the main success factors are in the literature reviews. Pedram (2011), deliberated on 9 success factors outlined by various authors in different available literature. These are defined as follows: Management involvement and support, Finance, Full authority of implementation coordinator, All employees' involvement, Proper planning before implementation, Training, Organizational culture, Becoming lean is a progress, Performance measurement and lastly, Proper sequence on implementation of lean principles.

According to Lila (2012), the success of LP implementation is based on four factors namely; Leadership and management, Finance, Skills and Expertise and Supportive organizational culture. In their argument, (Manotas Duque and Rivera Cadavid, 2007) maintain that the four key factors for success in the implementation of lean are; Preparation and motivation of people, Roles in the change process, Methodologies for change and Environment for change. Whatever the case may be, it is apparent that there are quite a number of statements drawn and considered as key success factors for lean implementation. In essence it is true that an organization will be dissatisfied with its current state and set out a vision for the future that is driven by change. This kind of change requires full management commitment. Although applying lean best practices is a responsibility for everyone within the organization, management should ensure that all concepts are applied collectively in order to reap the full benefits of lean (Kovacheva, 2010).

2.5 Summary

This chapter demonstrated the key focus areas of lean and reviewed its application in a business environment. A broader understanding of the topic and its principles has been displayed through research literature. Lean systems have been around for decades and have been implemented in its different abilities by various organizations, in various fields. On a global scale, lean has been implemented successfully; however, some limitations have also been experienced. Lean overall is seen as a necessity for every organization in order to maintain competitiveness. The next chapter will present the methodology that will be adopted in this research to achieve the study objectives.

Chapter 3 : Research Methodology and Design

3.1 Introduction

Previous chapters have observed an introduction of the study, defined problem statement of the research and further examined the literature review on lean manufacturing systems implementation. Sequentially, defining the methodology that was adopted for conducting this research, it is critical to understand the principal objective of the research. Sekeran and Bougie (2009) states that, business research is an organized, systematic, data-based, critical, objective, scientific inquiry or an investigation into a specific problem, undertaken with the purpose of finding solutions to it. Therefore, the objective of this chapter is to explore the options and techniques that are available for conducting research and justify how the research process was developed for this study.

This chapter will provide an outline of research design, methodology and techniques that are available for conducting research. It begins by explaining the aim and objectives of the research and then further discusses the research design, validates the research process that was established for the study. It will also discuss extensively the design of data collection instrument, recruitment of participants and the sampling method adopted during the research. Methods of validation and practicality tests that were performed to support credibility of the study are also addressed. Lastly, it discusses the data collection, the research survey instrument, the sampling of data and techniques used in data analysis.

3.2 Research question, Aim and Objectives of the Study

Research can be simply defined as a process of finding solutions to a problem after a thorough study and analysis of the situational factors or it can be defined a process that involves obtaining scientific knowledge by means of various objective methods and procedures (Chris et al., 2005). Research is a fundamental element in how we learn, and it provides a systematic exploration of a focused question, problem or hypothesis, using underpinning theories and concepts (Gina, 2009). When conducting research one must keep in mind that, research is not about finding evidence to corroborate an instinct, but, it is about finding evidence that will answer research questions one way or the other (Gordon, 2007). Research aim discusses a broad statement of desired outcome.

It states the intentions of the research, which emphasizes what needs to be accomplished. The fundamental research area is therefore indicated, including main questions for examination (Gina, 2009). It is imperative that the researcher clearly indicates the objectives of the study stating the necessary steps required to answer the research questions. The current research is conducted at a heavy commercial automotive organization. The automotive industry is considered to be leaders in partial or full implementation of Lean Production Systems. Most authors who make reference to organizations that have implemented lean changes have revealed that, in most cases organizations will usually focus purely on cost reduction and replicate TPS, forgetting that lean is not just about the tools, but a philosophy or culture that is adopted by organizations in order to remain globally competitive, reduce costs and produce more with less. This study is conducted in a work environment, an assembly plant at MAN Truck and Bus, precisely.

3.2.1 Research Aim

The aim of the study is to evaluate the implementation status of lean production systems at the assembly plant, highlighting the benefits of the system or otherwise.

3.2.2 Research Objectives

Based on the theoretical discussion on the literature review, the four main research objectives of the study are defined as follows:

1. To evaluate the status of lean production systems implementation within the assembly plant
2. To establish the challenges faced by management and employees during implementation
3. To identify the benefits of lean production systems implementation within the assembly plant
4. To determine strategies or interventions that can be adopted for future projects and provide recommendations

3.2.3 Research Questions

From the objectives stated above, the following main research questions have been developed:

1. What is the level of knowledge and use of lean production systems by employees?
2. What is the status of lean implementation within various operations of the organization?
3. What are the main barriers or challenges that management and employees are faced with during implementation?

4. What are the suggested success factors that can be attributed to lean production systems implementation within the organization?

3.3 Significance of the study

The results of this study will demonstrate the status of lean implementation in the organization. It will also express the extent at which the lean tools and techniques that are in place have benefited the organization. This will help the organization to identify the problems or gaps in the implementation of an effective lean production system.

3.4 Participants and location of the study

As research progresses it is important for a researcher to deliberate on how to choose participants for the study, clarifying what type of people are to participate. This is one of the vital steps in the research process (Dawson, 2002). Success of the research study will depend on the successful engagement and retention of participants involved. When considering types of people to be included in research, the criteria used should allow for a broad scope encompassing diversity, however, it must also be narrow enough to ascertain a yield of information conducive to build relevant knowledge as purposed by the study. Not only are the participants of the research study critically fundamental, but, the location of the study or the study setting is also of great significance. (Sekeran and Bougie, 2009) asserts that organizational research can be done in the natural environment where work proceeds normally, that is known as non-contrived settings, whereas, when research is done in an artificial environment, this is referred to as contrived settings.

3.4.1 Location

Study location refers to the setting in which the research is being conducted (Collis and Hussey, 2003). This study is conducted at MAN Truck and Bus assembly Plant, Pinetown based in the province of Kwa-Zulu Natal. Studies conducted at a work environment of such nature, where employees generally function are called field experiments. In such experiments the researcher has little or no interference at all with the natural occurrence of the events. This research is being conducted on a similar type of environment, considered to be a natural work environment. We can therefore confidently state that the research location for the study is prescribed as a non-contrived setting and is deemed as a field study (Sekeran and Bougie, 2009).

3.4.2 Participants

In simplest terms a research participant, is a person who participates in human subject research by being the target of observation by researchers (Wikipedia, 2015). Participants are targeted elements recruited and invited from the selected population to participate in a study (Kubheka, 2013). Sekeran and Bougie (2009) refers to a unit of analysis as a level of aggregation of data collected during data analysis, whilst classifying the sources of data as individuals, dyads, group, organizations, and cultures. As implied by Blumberg et al. (2008), the unit of analysis describes the level at which the research is performed and which objects are researched. This research addresses issues relating to an organization as an object, however, the factors of interest are influenced by individuals within the organization. Therefore, the unit of analysis for this study was every single employee at all levels under the employ of MAN Truck and Bus SA, Pinetown assembly Plant as potential participants for the study.

3.5 Data collection strategies

Data refers to known facts or things used as a basis for inference or reckoning (Collis and Hussey, 2003). One author defines data as the facts presented to the researchers from the study's environment. It is stated that capturing data is indefinable; this is based on the understanding that there are complications drawn, posed by the speed at which events occur and the time-bound nature of observation (Cooper et al., 2006). It is imperative to mention that collecting of data may vary from a simple observation to a complex survey of multinational corporations at locations in different parts of the world. In both qualitative and quantitative research methods, researchers are mainly interested in collecting data about the variables under study (Collis and Hussey, 2003).

There are two main sources of data termed, primary data and secondary data. Primary data refers to data that is original, which is collected at source, whereas, secondary data refers to data which already exists. Examples of sources of primary data are survey data, focus groups, and panels of respondents to name a few. On the other hand, sources of secondary data are company records, archives, government publications, websites etc.(Sekeran and Bougie, 2009, Collis and Hussey, 2003). When data is collected through use of interviews, administered questionnaires, focus groups, it is considered to be primary data. This information is mainly obtained first hand by the researcher on the variables of interest (Sekeran and Bougie, 2009). Data collection methods are known to be an integral part of research design and are utilized in that part of research process which is concerned with the collecting of data. The main methods of data collection can be listed as; Critical incident technique, Diaries, Focus groups, Interviews, Observations, Protocol Analysis and Questionnaires. Sekeran and Bougie (2009) asserts that data can be collected in various methods, including, interviews, questionnaires, observations and a variety of other motivational techniques such as projective tests, however, the first three are reckoned to be the main methods preferred by most researchers.

It is important to understand the difference between the two main approaches of data collection. A clear understanding will facilitate deriving an appropriate method that will be used to answer the research question (Cooper et al., 2006). The two broad types of evaluation methodologies are described as qualitative and quantitative. As purported by Collis and Hussey (2003), it is immaterial whether a researcher follows a qualitative or quantitative method of data collection, there will always be a combination of both inputs into a data generating process. However, both these methods will always present a mixture of advantages and disadvantages. One of the main advantages of a quantitative approach to data collection is the relative ease and speed with which the research can be conducted, whereas, qualitative data collection methods can be expensive and time consuming. Table 3-1 displays the main distinguishing characteristics between qualitative and quantitative research methods (Lichtman, 2006).

Table 3-1: Qualitative vs. Quantitative Research

Adapted from LICHTMAN, M. 2006. *Qualitative research in education: a user's guide,* Thousand Oaks, Sage Publications.

Criteria	Qualitative Research	Quantitative Research
Purpose	To understand and interpret social interactions.	To test hypotheses, look at cause and effect, and make predictions.
Group Studied	Smaller and not randomly selected	Larger and randomly selected
Variables	Study of the whole, not variables.	Specific variable 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 and reflections.	Quantitative data based on precise measurements using structured and validated data-collection instruments.

Types of Data Analysis	Identify patterns, features and themes.	Identify statistical relationships.
Objectivity and Subjectivity	Subjectivity is expected.	Objectivity is critical
Role of Researcher	Researcher and their biases may be known to participants in the study and participant characteristics may be known to the researcher	Researcher and their biases are not known to participants in the study and participant characteristics are deliberately hidden from the researcher (double blind studies)
Results	Particular or specialized finding that is less generalizable	Generalizable or top-down: the researcher tests the hypothesis and theory with the data
Specific Method	Exploratory or bottom-up the researcher generated 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 and personal.	Regular and predictable.
Most Common Research Objectives	Explore, discover and construct.	Describe, explain and predict.
Focus	Wide-angle lens: examines the breadth and depth of phenomena.	Narrow-angle lens: test a specific hypothesis.
Nature of Observation	Study behavior in a natural environment.	Study behavior under controlled conditions.
Nature of Reality	Multiple realities; subjective.	Single reality; objective.
Final Report	Narrative report with contextual description and direct quotations from research participants.	Statistical report with correlations, comparisons of mean and statistical significance of findings

According to Creswell (2013), one of the major elements in the research method framework is the specific research methods that involve the forms of data collection, analysis and interpretation that researchers propose for their own studies. Table 3-2 below classifies research methods available and further illustrates the range of possible data colleting methods considered under these topics.

Table 3-2: Qualitative, Quantitative and Mixed data Collection Methods

Adapted from CRESWELL, J. W. 2013. *Research design: Qualitative, quantitative, and mixed methods approaches,* United States of America, Sage publications.

Quantitative Methods	Qualitative Methods	Mixed Methods
Pre-determined	Emerging methods	Both pre-determined and emerging methods
Instrument based questions	Open-ended questions	Both open and closed-ended questions
Performance data, attitude data, observation data, and census data	Interview data, observation data, document data, and audio-visual data	Multiple forms of data drawing on all possibilities
Statistical analysis	Text and image analysis	Statistical and text analysis
Statistical interpretation	Themes, patterns interpretation	Across databases interpretation

Selecting data collection methods for instance, surveys, mail questionnaires, interviews is essential because it has a bearing on the quality of data collected. Specifically, Cooper et al. (2006) concede that questionnaires are very good for gathering factual information but they are less effective when sensitive and complex data are required.

Sekeran and Bougie (2009), states that questionnaires are an efficient data collection mechanism when the researcher knows exactly what is required and how to measure the variables of interest. A questionnaire is also regarded as one of the popular methods for collecting data. Table 3-2 deduces that a questionnaire may be appropriate as an approach for collecting quantitative data in a study. This can be accomplished through the use of instrument based questions focusing on performance, observation and census data in order to arrive at rational conclusions.

Data collection strategies for the study

In view of all theoretical information presented here, it is much relevant to bring to light the methods applicable for the current study. The fundamental background on lean manufacturing systems was acquired through the use of secondary data by collecting information from various sources such as academic journals, academic textbooks, internet websites, research thesis, newspapers articles etc. The use of this secondary data supports the understanding of the research problem and helps refine the research questions. Collecting primary data, a survey technique was adopted based on the points stated on the research questions. Data was obtained by collecting the response received from distributed questionnaires. The respondents included employees at various levels from managers, engineers, specialist to shop floor operators. Due to the nature of the population being investigated, it was found more suitable to conduct an interviewer administered questionnaire face to face with the respondents, as well as a self-administered electronic questionnaire, web based.

3.6 Research design and methods

Research design can be defined as a 'science or art of planning procedures for conducting studies so as to get the most valid findings' (Vogt, 1993) cited by (Collis and Hussey, 2003). Research design serves as the scientific foundation that connects all activities involved in a research project. It provides a logical sequence of activities that links a study's initial research question and the plan of investigation that should be employed to obtain the empirical evidence from which conclusions towards the study can be drawn (Yin, 2013). Research design involves a series of rational decision making choices (Cavana et al., 2001). Selecting an appropriate research design may prove to be a complicated process due to a number of methods, techniques and methods available (Rathilall, 2015). Cooper et al. (2006) also states the fact that in research, different design approaches do exist, however, there is no simple

classification system defining the types of variations that need to be considered. The function of research design is to facilitate a process or method of enquiry that will provide evidence adequately objective to answer all research questions clearly.

Research design is vital and should be considered prior any activity within the study. When research design is disregarded at the beginning of the study, results or conclusion drawn is said to be weak and unconvincing (Kirshenblatt-Gimblett, 2015). According to Sekeran and Bougie (2009), the following are the key critical elements to be taken into account when constructing research design, the purpose of the study, the types of investigation, the extent of researcher interference, the study setting, the unit of analysis and the time horizon of the study. Building on the understanding of the theoretical considerations presented above, the current study follows the research design depicted in figure 3-1 to manage each step of the research project. This gives and overview of a step by step approach of strategies utilized to collate this research study.

3.6.1 Description and purpose

According to Sekeran and Bougie (2009), research studies may either be exploratory, descriptive in nature or may be conducted to test hypotheses. This is normally based on the stage to which the level of knowledge about the research topic has advanced. At an exploratory stage, research will attempt to explore new areas of organizational research; while descriptive considers research a stage where certain characteristics of the phenomena of interest are described. Hypotheses testing on the other hand refers to a stage where knowledge about the research topic has advanced (Sekeran and Bougie, 2009). Furthermore, an exploratory study is conducted when not much is known about the problem. This type of study is carried out with an intention to understand better the nature of the problem since it may be regarded as unknown or

unfamiliar. A descriptive study on the other hand is conducted in order to define the characteristics of the variable of interest in a situation.

When literature is analyzed in consistent with lean systems implementation at various organizations, a considerable degree of theory is found to be available in support of this concept. This clearly indicates that focus and attention has been assigned into establishing and understanding this subject matter. In the literature we learn of various tools, techniques and methods adopted for implementation of lean systems. We also discover challenges, barriers, and success factors associated with this concept. Derived from the reasoning suggested by the illustrations stated above, it is observed that since exploratory research involves investigating unfamiliar areas of research, descriptive analysis was found to be the most appropriate method for gathering all the available information from the current literature on Leans Systems Implementation. The selection of this method was encouraged by the desire to gain knowledge from what is already available in this field and reveal any correlation that may exist towards the drive of implementing lean systems within various organizations, especially in the automotive industry.

3.6.2 Questionnaire Design

Once a researcher has decided on the most appropriate data collection method for the study, it is important that the researcher is clear about what it is exactly that they are aiming to achieve by conducting the research (Collis and Hussey, 2003, Dawson, 2002). It is crucial that the potential audience is considered prior construction of the questionnaire. Constructing a questionnaire can be regarded as a very complex process requiring special attention to detail in order to allow for simplicity and easy collection of data (Cooper et al., 2006). According to Chris et al. (2005), the decision to conduct a questionnaire survey should itself be the culmination of a careful process of thought and discussion, involving consideration of all possible techniques.

Questions selected must be examined within the context of which it is written instead of the entire abstract to ensure that it is not misinterpreted by the participants (Rathilall, 2015). Most authors recommend that certain aspects should be avoided when designing a questionnaire. (Sekeran and Bougie, 2009, Collis and Hussey, 2003, Dawson, 2002) are in accord with the understanding that questionnaires should avoid the use of jargon and technical terms whenever possible, vague and descriptive words, using words which may have a double meaning or be misinterpreted, questions which will cause annoyance, frustration and are offensive and lastly, avoid the use of emotive words. Some other factor that must be considered during question design is whether the researcher intends to construct an open or closed ended questionnaire or a mix of both. The open ended type of questions are used when participants are expected to use their own words in response, however, for closed ended questions, the participants are provided with pre-written response categories for selection.

In order to evade occasions that may lead to misunderstanding or misinterpretation of questions, there are somewhat general rules that have been prescribed as guidelines for designing questions. These fundamental aspects of question design are important because once the questions are asked; there is little that can be done to enhance the quality of answers (Collis and Hussey, 2003). Sekeran and Bougie (2009), expresses that comprehensive questionnaire design principles should focus on three areas namely, the wording of questions, classification of data or personal information and general appearance of the questionnaire. Equally (Chris et al., 2005, Collis and Hussey, 2003, Dawson, 2002), have a common understanding of the major guidelines for consideration during question design. Stating a few, these can be consolidated as follows: firstly, explain the purpose of the questionnaire to all participants, keep questions short and simple, take the respondents literacy level into consideration, phrase questions so that only one meaning is possible, avoid leading questions and include relevant questions only.

3.6.2.1 Research Questionnaire

The current research has taken into account all the above mentioned principles during questionnaire design to avoid unnecessary constraints. The questionnaire design for the key variables of this study integrated questions based on already existing literature which is closely linked to survey type questions developed by other researchers. The questionnaire was designed with an intention to establish corroboration between the existing literature and the performance that is observed at the study location. This particular research study adopted close-ended questions in the survey type questionnaire design. The questionnaire was apportioned into seven sections in order to collect information according to the following categories.

Section A: this section required information regarding the participants within the employ of the organization. The main elements of interest included, gender, age, educational level, qualification and more.

Section B: contained questions that were set out to establish the need for the organization to implement lean production systems with an intention to abstract key drivers for the implementation at the organization.

Section C: describes questions which were determined to verify knowledge and use of lean production principles by employees within the organization.

Section D: was designed to determine the status of lean implementation within the organization, by defining all tools and techniques that have been adopted by the organization.

Section E: focused questions on product development and supplier relations and their involvement in product design in line with organizational processes.

Section F: encompassed questions pertaining to barriers or challenges experienced in general when organizations implement lean systems to determine whether these may be applicable at the current organization.

Section G: consisted of a list of critical success factors that have been proven to be relevant for consideration by organizations for a successful implementation of lean systems.

Questions formulated in the questionnaire were constructed using easy, understandable and clear words. The structure of questions followed a chronological order ensuring that participants are kept focused. Clear guidelines were issued to participants; an introduction detailing conduct prior engaging and also ascertaining anonymity and confidentiality was distributed.

3.6.3 Measuring instrument and scale

Measuring can be defined as an act to discover the extent, dimensions, quantity or capacity of something especially in comparison with a standard. Research measurement consists of assigning numbers to empirical events in compliance with a set of rules (Cooper et al., 2006). According to Sekeran and Bougie (2009), measurement of the variables in the theoretical framework is an integral part of research and an important aspect of research design. There are for widely used classifications of measurement scales that are referred to as nominal, ordinal, interval and ration scales (Sekeran and Bougie, 2009, Cooper et al., 2006, Cavana et al., 2001). The characteristics of these measurement scales are briefly reviewed in Table 3-3 below. A researcher needs to decide on the appropriate data type to be used for research in order to accomplish research needs.

Table 3-3: Types of data and their measurement characteristics

Adapted from COOPER, D. R., SCHINDLER, P. S. & SUN, J. 2006. *Business research methods*, McGraw-Hill New York.

Type of Data	Characteristics of data	Basic empirical operation	Example
Nominal	Classification but no order, distance or origin	Determination of equality	Gender (male, female)
Ordinal	Classification and order but no distance or unique origin	Determination of greater	Or lesser value Doneness of meat (well, medium-well, medium-rare, rare)
Interval	Classification, order and distance but no unique origin	Determination of equality of intervals or differences	Temperature in degrees
Ratio	Classification, order, distance and unique origin	Determination of equality of ratios	Ages in years

Viewing the scales depicted in Table 3-3, the nominal scale emphasizes the difference by classifying objects and providing the least amount of information on the variable. The ordinal scale presents additional information by rank-ordering the categories of the nominal scale. The interval scale on the other hand does not only rank the information, however, it also provides information about the magnitude of the differences in the variables. Lastly, the ratio scale focuses not only on the magnitude of the difference but also their proportion (Sekeran and Bougie, 2009).

There are other common forms of rating scales that exist which are often used in research; these include dichotomous scale, category scale, sematic differential scale, numerical scale, itemized rating scale, Likert scale, fixed or constant sum rating scale, staple scale, graphic rating scale and consensus scale. According to (Sekeran and Bougie, 2009, Cavana et al., 2001) it must be noted that the Likert scale is somewhat one of the most frequently used scale for the measurement of attitude and behavior in

organizational research. Research paradigm should be designed and controlled for precise and unambiguous measurement of the variables (Cooper et al., 2006, Blumberg et al., 2008).

The selection and construction of a measurement scale should take into account the research objectives, the type of that are required, the data properties that will be used for analyses, the number of dimensions that are used to describe an event and the number of scale points to rank an event (Rathilall, 2015). This study was constructed in a manner which undertook all the elements recommended by literature to ensure relevant data was collected. The questionnaire used for data collection was developed incorporating various measurement scales. The main consideration for the survey questionnaire design was to keep it short, focused and easy to understand in order to obtain adequate response.

Section A, B, C and F integrated a nominal, ordinal, ratio and interval scale. The questions here were designed to collect information such as personal information, understating of lean concepts and tools, as well as challenges and barriers for effective implementation of lean. Section D, E, and G used mainly the rating scale, particularly, the Likert scale. The questions for these sections were set up on a five point Likert scale. The scale was ranged from 1 to 5 representing the perception levels ranging from strongly disagree to strongly agree.

3.7 Recruitment of study participants

When research is conducted it is aimed at collecting information from the objects of investigation in order to resolve the problem concerned. The outcome of the investigation should be sufficient enough to enlighten the researcher on the tenability of the hypothesis and it should give an indication whether to accept or reject the

hypothesis (Chris et al., 2005). In order to accomplish this dimension, the researcher must choose participants. Some research projects will accommodate a small number of people within the research population in which it might be possible to contact everyone and in this particular case, this may be referred to as a census. A population refers to a body of people or any other collection of items under consideration for research purposes. It may be rather impossible to conduct research on the entire population unless there is a huge budget or limitless timescale (Dawson, 2002). This can be overcome by choosing a smaller sample of people to take part in the research, which can be more manageable. A sample can be defined as a subset of the population comprising of some and not all of elements of the population (Sekeran and Bougie, 2009). When sampling is conducted it is crucial that the sample is defined and chosen for a reason because it will have an consequence on the results and the applicability of the results and findings (Gina, 2009).

There are various methods that can be adopted when choosing a sample. However the method used will depend on the area of research, research methodology and as well as preference of the researcher (Dawson, 2002). The two main types of samples can be distinguished as probability samples and non-probability samples. In probability samples, all people within the research population have a specifiable change of being selected. In contrast, non-probability sampling is arbitrary and subjective. In this type of sample it not possible to specify the possibility of one person being included in the sample (Blumberg et al., 2008, Chris et al., 2005, Dawson, 2002) . Within the probability and non-probability sample category, there are various methods that can be used to select a sample, Table 3-4 classifies the different approaches that can be undertaken within sample design and it reflects the representation basis and the element-selection technique.

Table 3-4: Types of sampling design

Adapted from BLUMBERG, B., COOPER, D. & SCHINDLER, P. 2008. Business research methods: second European edition, 2nd European ed. *Maidenhead: McGraw-Hill Higher Education*.

Element Selection	Representation basis	
	Probability	Non-probability
Unrestricted	Simple random	Convenience
Restricted	Complex random	Purposive
	Systematic	Judgment
	Cluster	Quota
	Stratified	Snowball
	Double	

According to Collis and Hussey (2003) a good sample must be chosen at random, large enough to satisfy the needs of the investigation being undertaken and unbiased. The sample must be representative of the population in order to be able to generalize the results obtained. By representative, this implies that the sample has the exact properties in the exact same proportion as the population from which it was drawn, but smaller in numbers (Chris et al., 2005). A sampling process defined by (Sekeran and Bougie, 2009, Collis and Hussey, 2003) includes a number steps that are crucial for selecting a sample, these can be define as follows:

- Define target population
- Obtain or construct sampling frame
- Determine how to select sample members
- Decide how to convert sample estimates into population estimates.

A probability simple random sampling method was adopted for the study. Simple random sampling refers to a process where every element in the population has a known and equal chance of being selected as a subject (Sekeran and Bougie, 2009). There was no specific selection criteria used since the study was based on a general impression on the topic from every single employee within the organization at all levels. The target participants included every single employee within the organization irrespective of level.

3.7.1 Sample Size

Generally, sample size will depend on what the researcher wants to do with the results. The question of the appropriate number of subjects to include in a sample is very complex. Essentially, it is a question of the researcher having to decide on how accurate the results must be and how much confidence should be based on the results (Collis and Hussey, 2003, Dawson, 2002). Consistent to this view Chris et al. (2005) also acknowledges that the choice of sample size should be governed by; the confidence required in the data, the margin of error that can be tolerated, the type of analyses to be undertaken and lastly the size of the total population from which the sample is to be drawn.

At the time of sampling 140 employees were listed on the organization payroll, that number was then considered as the total population available for the study. A sample size was then decided upon based on Krejcie and Morgan table specifying sample size for a given population size. It is indicated that for a population of 140, a sample size of 103 will be appropriate for conducting the full research. Expanding on this notion a mathematical equation can also be applied in order to derive an appropriate sample size for the study. This is further elaborated as follows:$n = N/(1 + Ne\text{^}2\,)$; N refers to Population, n refers to sample size and lastly e refers to margin of error. The degree of confidence was estimated to be 95% with 0.05 margin of error. This sample included all employees from top management to shop floor operators.

3.8 Pretesting, Reliability and Validation

Proceeding from the construction of the questionnaire, researchers instruct that a process of pretesting and validation of the questionnaire should be conducted. In order to obtain valid and reliable data to answer the research questions the measuring instrument should be tested to identify and opportunistic weaknesses in the design before main research is conducted. This means that a questionnaire must be tested to identify any ambiguity that might be prevalent (Dawson, 2002). According to Sekeran and Bougie (2009), pretesting survey questions can be referred to as a test of the understandability and appropriateness of the questions planned to be included in a regular survey, using a small number of respondents. The credibility of the study depends on the characteristics of the measuring instrument and the nature of the data collected. There are vital tests that must be taken in order to ascertain credibility of the study. Validity and reliability are metrics that can be instituted in order to test and determine such credibility. These tests are commonly performed on the measuring instrument to establish the quality of the research and to ensure that the data obtained is a true reflection of what is being measured and investigated (Yin, 2013). Reliability tests how consistently a measuring instrument measures whatever concept it is measuring, while, Validity tests how well an instrument that is developed measures the particular concept it is intended to measure (Sekeran and Bougie, 2009) .

A questionnaire was sent out to a few employees at various occupation levels, that is, managers, engineers and a few operators. The pilot survey was utilized as a measure to determine if respondents would encounter any challenges answering the questionnaire and also verify if the methodology in use will facilitate objectives of the research being met. Feedback and all other contributions received from participants were deliberated on in order to improve the practicality of the main questionnaire. The pilot survey was conducted purely for the purpose of identifying any shortcomings inherent in the questionnaire and therefore no analysis was done from the results or feedback received. It must be highlighted that, all deficiencies identified were adjusted.

This process allowed for thorough scrutiny of the questioning method and improving of the wording for easy understanding of some technical terms. None of the questions asked were omitted, except structuring of the questions, rewording and revising of measurement scales. Reliability is commonly assessed in three forms: test-retest, alternate-form and internal consistency. Internal consistency reliability is the commonly used psychometric measure in assessing survey instruments and scales and it is an indicator of how well the different items measure the same issue (Vujica Herzog and Tonchia, 2014). A key construct in maintaining the reliability of a study is to document all procedures that are followed in the research process to assist in repeating a similar study (Rathilall, 2015). Sekeran and Bougie (2009) asserts that, Cronbach's Alpha reliability analysis is commonly used to test the internal consistency of the measurement scale and it indicates how well the questions measure the concept. As a result, attaining a Cronbach's Alpha value close to 1 specifies high reliability. The Cronbach's Coefficient Alpha test was used to verify the reliability of the data collected in this study.

3.9 Administration of the questionnaire

Questionnaires are most useful as a data collection method, especially when large numbers of people are to be reached in different geographical regions (Sekeran and Bougie, 2009). According to Bowling (2005) one of the main primary data collection instruments in research is the survey questionnaire. There are several ways of administering questionnaires. Modes of data collection by questionnaire vary in the method of contacting respondents, in the channel of distributing the questionnaire, and in the way in which questions are administered. These variations can have different effects on the accuracy and quality of the data obtained (Bowling, 2005). Questionnaires can either be personally administered to respondents, mailed to respondents or electronically distribute through e-mail, either via the internet or an intranet (Sekeran and Bougie, 2009). In their opinion Hardré et al. (2007) stated that there are three basic administration methods that are in broad and increasing use by

researchers and practitioners these are defined as paper-based (PBA), computer-based (CBA) and web-based (WBA) administration.

PBA is the traditional use of a printed questionnaire instrument, given in individual hard copy to each research respondent and is completed using a conventional writing implement, a pen or pencil and returned to the researcher in its original paper form. WBA questionnaires are completed online by navigating the experimental site then logging into the interface, reading the items and then responding by clicking on buttons, selecting menu items and typing into the fields provided (Hardré et al., 2007). For the purpose of this research both these methods were adopted as administration approaches. The employee composition comprises of 30%/70% distribution, being between employees with access to computer and employees without access to computer respectively. A self-administered paper questionnaire was delivery face to face to those responds without access to computers and a self-administered web based questionnaire link was sent out on e-mail to all those respondents who have computer access. The software used for administration of web based survey is QuestionPro.

3.10 Analysis of Data

Analysis and interpretation of research data is one the core objectives of research projects. Once data has been collected the researcher is now in a position to analyze the information presented in order to make conclusions about the entire study and determine whether all research questions have been answered. Data collected can be of no practical use if presented in its raw format, in actual fact, it would be very difficult to interpret the study. The main objective of data analysis is to gather data and statistically analyze to see if the hypothesis that were generated have been supported (Sekeran and Bougie, 2009). Data analysis by means of statistical techniques helps in the investigation of variable as well as their effect and relationship (Chris et al., 2005). The method used for data analysis will depend on the type of research conducted, either qualitative or quantitative research. The two are analyzed in different ways

(Dawson, 2002). For qualitative data, the researcher might analyze as the research progresses, continually refining and reorganizing in light of the emerging results. However, for quantitative data, the analysis can be left until the end of the data collection process. For large surveys, statistical software can be employed as this has proven to be the easiest and most efficient method to use for data analysis (Dawson, 2002).

For the purpose of this study, a quantitative research method was adopted and the research instrument was denoted as a survey questionnaire. A well designed questionnaire will allow for a well-executed survey with minimal error and hence, validity. According to (Cavana et al., 2001), Before analyzing the data there are some preliminary steps that need to be completed and these steps help to prepare the data for analysis ensuring that the data obtained are reasonably good. Figure 3-2 identifies the four important steps in quantitative data analysis. The quantitative data analysis process defines the four steps as follows: getting data ready for analysis, getting feel for the data, testing the goodness of data and testing the hypotheses. After collecting data through use of various collection methods, data will then require to be edited.

It will have to be coded and categorized according to various schemes. For current research, the data was collected using a questionnaire and before use it was verified for errors. A coding system was used to acquire raw data from questionnaires administered through electronic software Questionpro. Data was imported into electronic format on an excel spreadsheet. Likert scale were given numerical values from 1 to 5 representing specific responses ranging from strongly disagree to strongly agree and other. For the purpose of this study descriptive and inferential statistics was applied using SPSS. Frequencies, average mean, cross tabulations, significance tests (Kruskal-Wallis test) and standard deviations were used to evaluate various data. Correlation matrixes were found to be practical in various analyses and for checking data reliability Cronbach's Alpha was used.

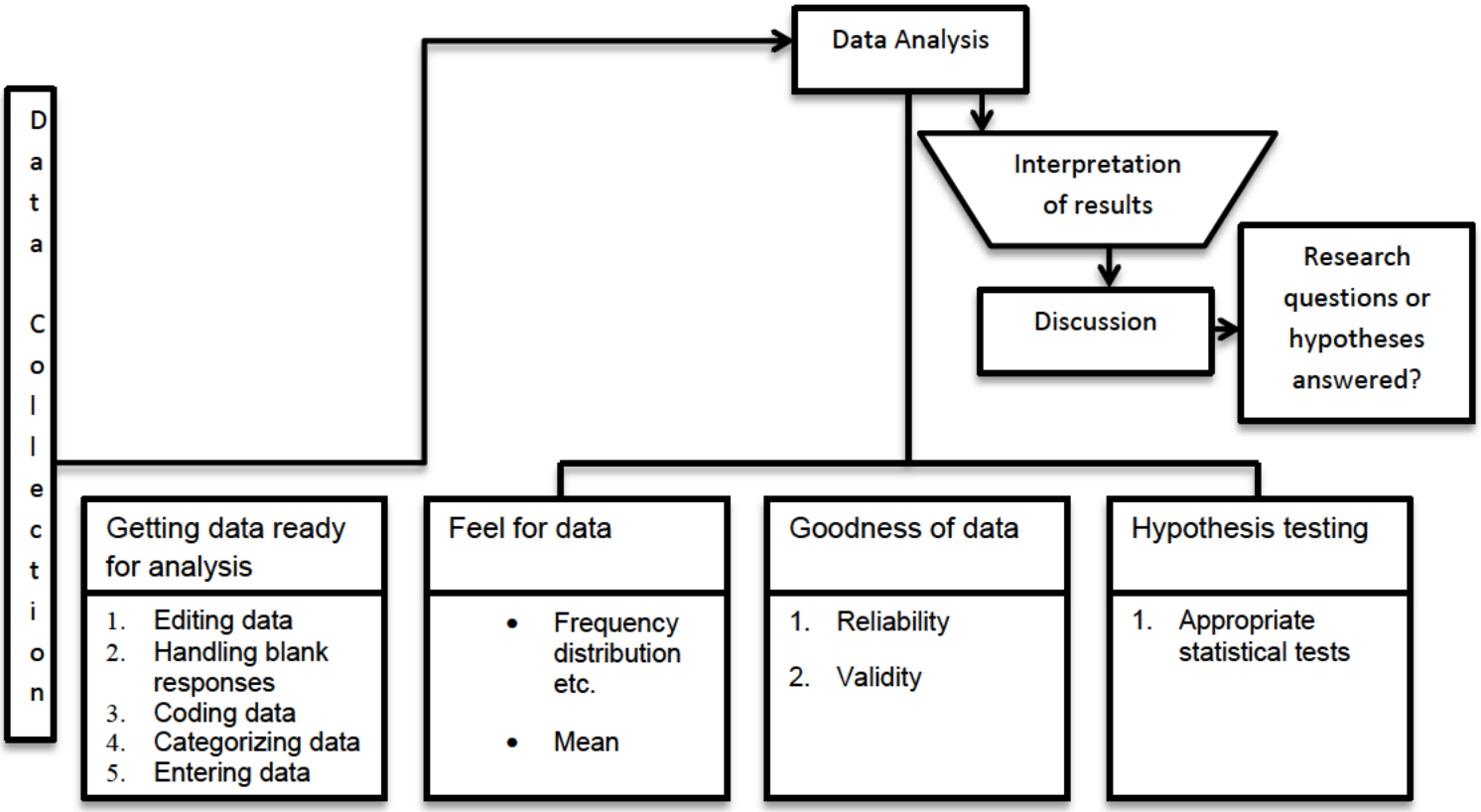

Figure 3-1: The quantitative data analysis process

Adapted from CAVANA, R., DELAHAYE, B. L. & SEKERAN, U. 2001. *Applied business research: Qualitative and quantitative methods*, John Wiley & Sons Australia.

3.11 Summary

This chapter outlined the methodical approach of the research design adopted to accomplish the key objectives of the empirical study. The research methodology encompassed quantitative data gathering techniques using the survey method. The importance of sampling and the target population; and the choice of selecting the appropriate measuring scale and instrument were also defined.

A questionnaire served as the main data gathering instrument and was validated prior application to the main study. Because this research focuses on studying one organization, the sample was derived from a population of 140 complementary staff. The pilot study conducted highlighted the important aspects of the questionnaire design and detailed how the research addresses the validity, reliability and practicality of the study. The analysis of the data will be based on the quantitative methods that have been described in this chapter. The next chapter will present the results obtained from the survey and discuss the key findings related to this study.

Chapter 4 : Presentation of Results

4.1 Introduction

The research design and research methodology were detailed in the preceding chapter. This portion of the research report presents the data that was collected and further outlines the process that was utilized to extract the data from the questionnaire. As discussed in previous chapters, for the purpose of this study, a questionnaire was used as a tool to collect primary data within the organization. This chapter allows the researcher to examine the raw data using various construals in order to determine association between the research objectives and the outcomes, making reference to the original research questions. Data collected from the respondents will be analyzed using Questionpro and excel software. Descriptive statistics and statistical analysis will be used to interpret and present the data. The descriptive statistics will comprise of graphs, tabulations and figures. It must be stated that the presentation of the results will be done in a sequential format as was portrayed in the questionnaire.

Factors determined from the survey through the use of a questionnaire where levels of agreement (strongly agree or agree) and disagreement (strongly disagree or disagree) towards various elements was established using a 5 point Likert scale rating will be combined and minimized to a single category. This is done in order to concede accurate analysis of the results regarding these expressions. Although these will still be visualized appropriately, only three categories will be presented in the detailed analysis form i.e. “agree”, “neutral” and “disagree”. This is permissible due to the acceptable levels of reliability and consistency in the factor analysis. The responses are more convincing when they are merged together and also promote an ease of analysis, understanding and easy interpretation of the findings.

4.1.1 Results overview

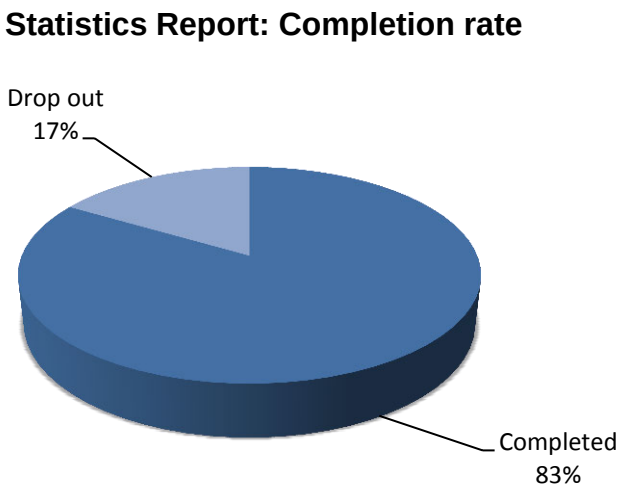

Figure 4-1: Survey Completion Rate

A total of 74 survey questionnaires were manually distributed to various departments, the number issued was suggested by the total headcount within each department. 56 questionnaires were completed, 18 were unaccounted for and 2 of the 56 were spoilt. Therefore, in total 54 questionnaires were captured into Questionpro at a later stage, for analysis. Another fraction of 52 surveys were completed online making a total of 106 respondents. Table 4.1 below gives an overview of the survey completion rate.

Table 4-1: Survey questionnaire completion rate overview

	Count	**Completed/ Started**	**Completed/ Viewed**	**Started/ Viewed**
Completed	106	83.46%	71.14%	
Started	127			85.23%
Viewed	149			

4.1.2 Chapter presentation layout

The presentation layout of this chapter has been apportioned into 7 sections as follows:

- Section A (4.2), Profile analysis of the sample through the provision of general information
- Section B (4.3), Need for implementation of lean production systems
- Section C (4.4), Knowledge and use of lean practices
- Section D (4.5), Status of lean implementation
- Section E (4.6), Product development and supplier relations
- Section F (4.7), Barriers and challenges for lean implementation
- Section G (4.8), Success factors and recommendations

4.2 The profile of the sample

4.2.1 Gender distribution

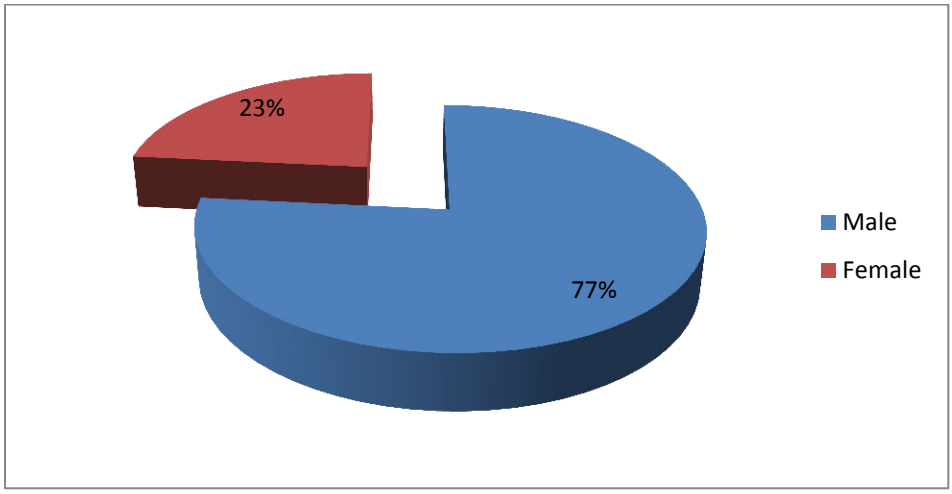

Figure 4-2: Gender Profile

In order to establish the gender distribution amongst the study participants, a question was presented to each respondent which required them to state their gender as either male or female. From the data obtained it can be clearly seen that the majority of the respondents were males (77%) compared to females (23%).

4.2.2 Age distribution

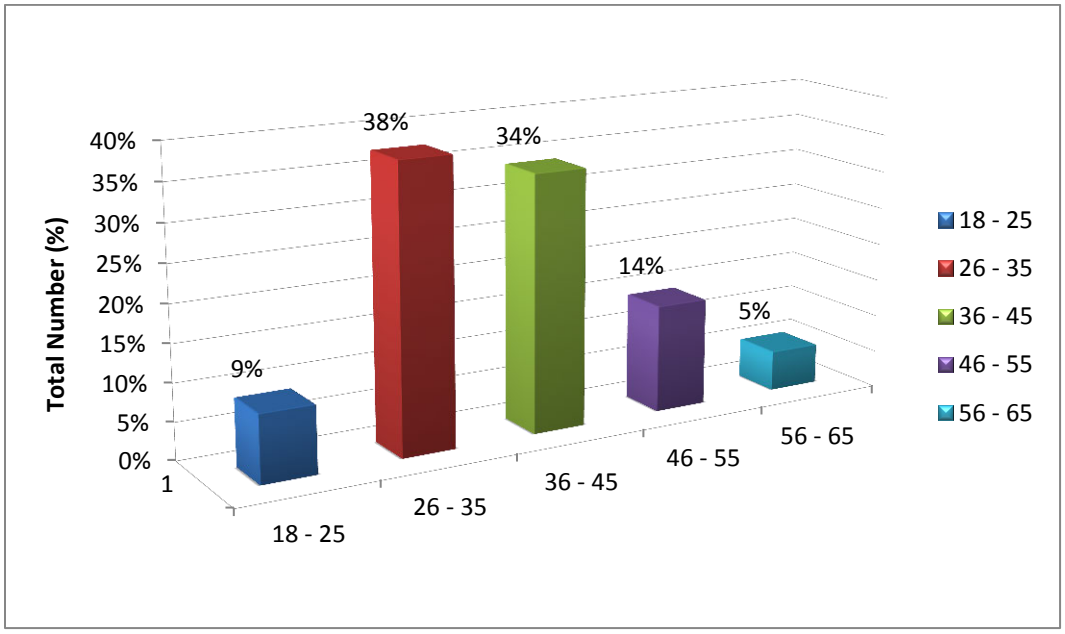

Figure 4-3: Age of respondents

Exploring the representation of the respondents in line with the prescribed age groups, figure 4-3 reveals that, the majority of the participants range between ages 26 and 45. When the two age groups are combined, that is, 26-35 and 36-45, they give a total representation of 72%. The next age group is 46-55, which represents 14% of the participants. This is followed by age group 18-25, which on its own, only 9% of the participants are represented. Finally, the least participants are found to be between the age group 56-65, where only 5% of the participants are represented. This provides a

precise overview of the sample and also reflects a good representation of the ratio of the current labor force within the South African automotive manufactures.

4.2.3 Educational Qualification Level

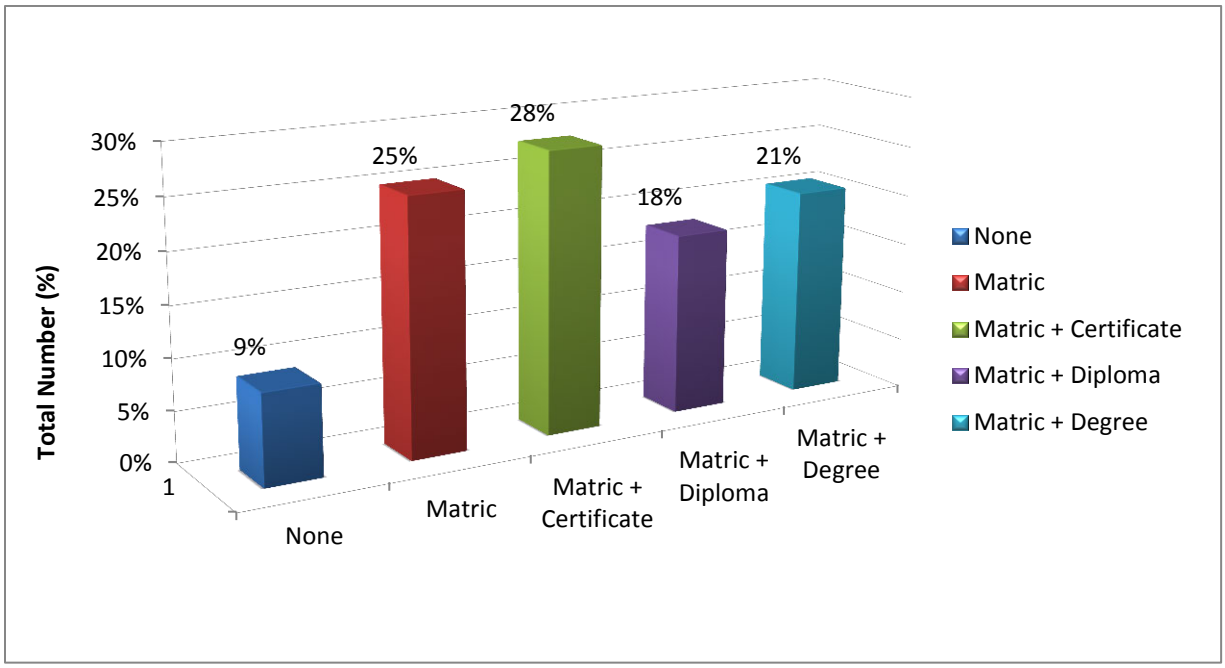

Figure 4-4: Educational qualification level

In order to determine the skills associated with performance within the organization, it was observed important to establish the status of the educational qualification levels of the respondents. Each participant was asked to indicate their education qualification in line with the most common levels defined in the context of South African Qualifications Authority (SAQA). The representation in figure 4-4 depicts that at least 9% of the participants are below the minimum required qualification level which is referred to as matric, meaning they have no qualification at all. This proved to be a limitation during

questionnaire administration due to illiteracy and lack of understanding of some of some of the concepts investigated. 25% of the participants possess a matric, which is a minimum qualification requirement. From the information displayed it can be concluded that 67% of the total participants have acquired a matric and another qualification whereby; 28% of those hold a certificate, 21% hold a degree and 18% hold a diploma.

A good illustration of educated and skilled personnel facilitates efficiency and good organizational performance as employees are empowered to recognize their necessary input towards organizational growth and sustainability.

4.2.4 Department representation

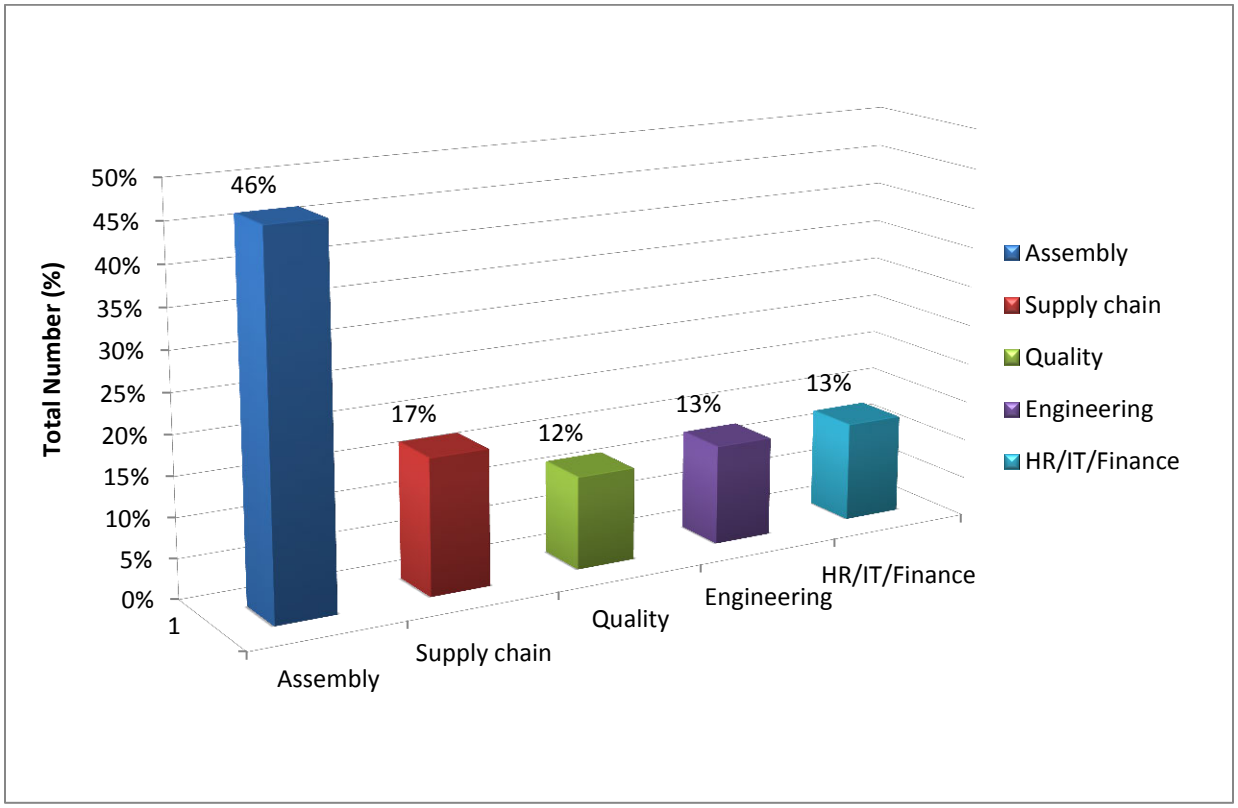

Figure 4-5: Department Representation

The study respondents comprised of participants from various departments within the organization. Figure 4-5 depicts an image where the assembly department is represented by 46% of the participants followed by supply chain department with 17% representation.

The two divisions are regarded as core of the organization operations and when combined together they represent 63% of the participants which is more than half of the population. The other supporting departments are defined as human resources; information technology and finance, together these combined represent 13% of the participants. Engineering on the other hand also accounts for 13% of the participants and lastly is quality which represents 12% of the participants.

4.2.5 Position within the organization

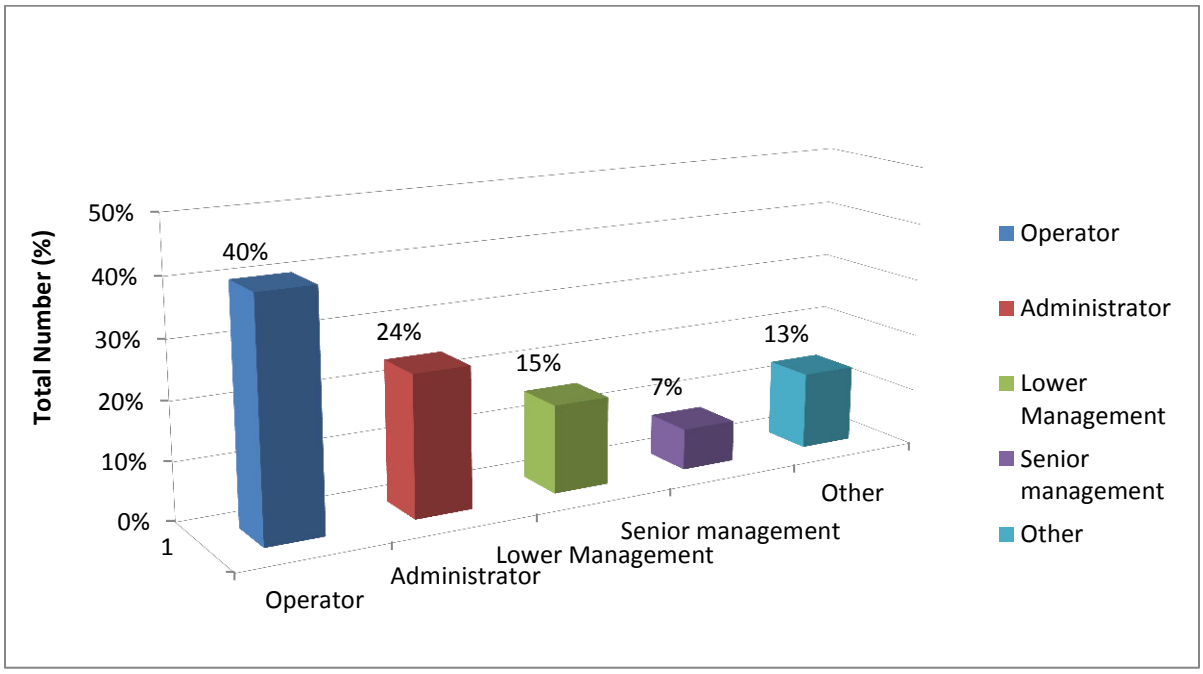

Figure 4-6: Job Position

In coherence with the visual exhibited in figure 4-6, it is observed that the majority of the participants are operators representing 40% of the participants. The next high number of participants is administrators at 24%. According to the questionnaire, administrators were regarded as various job functions including engineers, material planners, controllers, field specialists etc. The management category was segregated into lower and senior management where these were represented at 15% and 7% respectively.

A field where none of the functions were presented, respondents were required to specify such function. This was categorized as the “other” positions. To name a few, these were defined as trainees, creditors, quality inspectors, vehicle auditor and auto electrician. All together this group represents 13% of the participants. According to the research conducted by benchmarking and manufacturing analysts, employment composition levels in the South African automotive sector will be apportioned at 69% production and 31% other supporting functions (Barnes and Meadows, 2008). In this particular instance this attests to be true as operators and administrator functions are represented by approximately 64% of participants whose core functions are production related.

4.2.6 Employment status

The organization classifies worker status of employment as permanent and contract. This is expressed in Table 4-1 which displays worker representation according to each classification. 71% of the work force is regarded as permanent employees, whilst 29% refers to contract employees. In the same light, workers are also categorized as white collar, blue collar and labor broker. 51% of the workforce is considered to be blue collar, 44% white collar and 5% labor broker. What can be concluded from the information provided is that out of the represented workforce, 56% of the workers are mainly blue collar inclusive of labor brokers; this can be also viewed in figure 4-7.

Table 4-2: Employment Status interpretation

Employment status	White Collar	Blue Collar	Labour Broker	Total
Permanent	38%	33%	0%	71%
Contract	6%	18%	5%	29%
Total	44%	51%	5%	100%

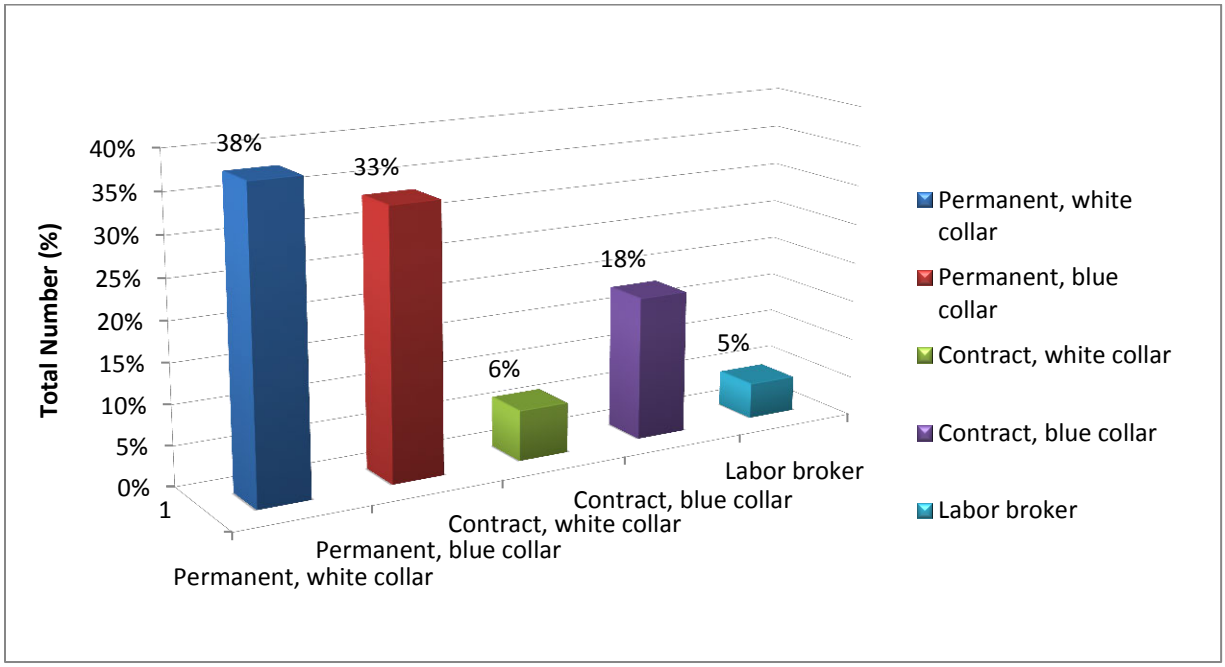

Figure 4-7: Employment Status

4.2.7 Number of years of employment

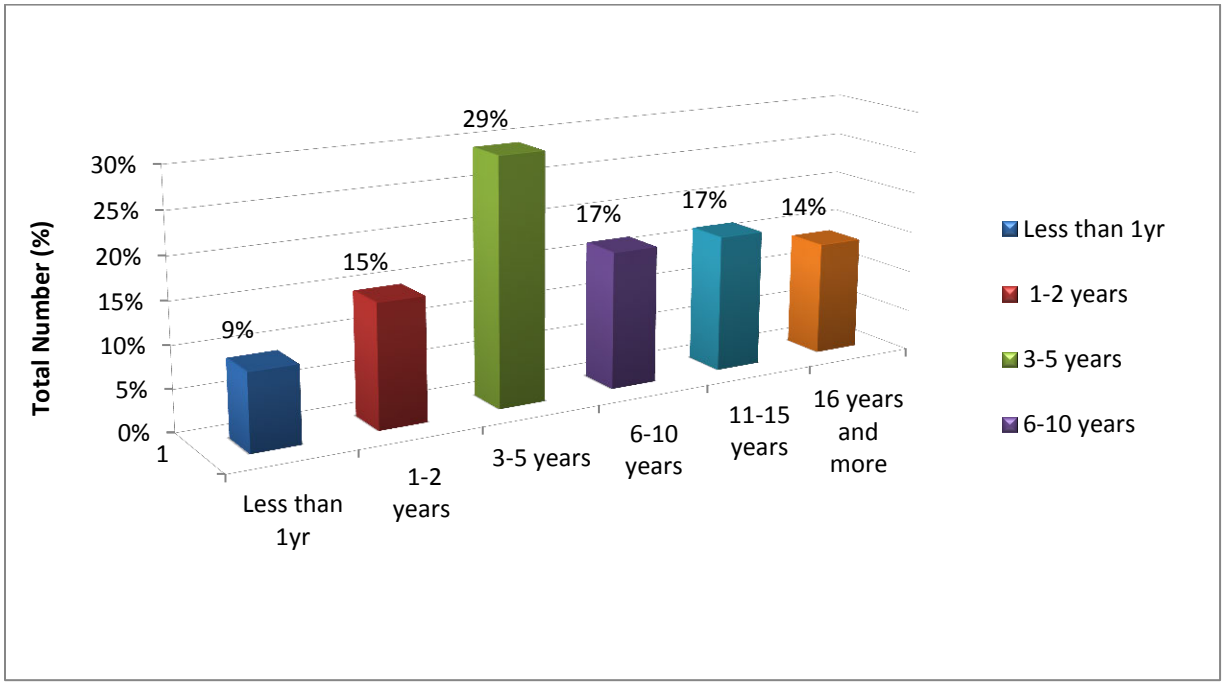

Figure 4-8: Years of employment

Analyzing years of employment by employees within the organization, figure 4-8 indicates that 53% of the employees have been with the organization for less than 5 years with the following representation; 29% between 3-5 years, 15% between 1-2 years and 9% with less than 1 year. The other 47% represents employees who have been with the organization for 6 years and more, 34% refers to those who have been there for more than 6 years but less than 15 years, whereas, 14% of those have more than 16 years of experience within the organization. This kind of representation is relatively fascinating as it fosters a new perspective of employees, at the same time learning from the old.

4.3 Need for implementation of lean production systems

4.3.1 Becoming Lean

There are various reasons that drive organizations to adopt lean production systems or desire to become lean. The level of importance may vary from one organization to the next. To understand the lean production implementation driving factors at the organization, participants were asked to indicate the main factors that influence them their decision to implement lean production systems. Analyzing the responses, the Kruskal-Wallis test was used test the significance using departments as base. The Kruskal-Wallis test is thought to be the most appropriate to use for non-parametric data (Likert scale date etc.) when comparing across more than 2 categories. In this particular case, we had more than one departmental category with which to compare the responses.

The question was directed as follows:

Question B1. How essential is it for your organization to become lean?

Table 4-3: Significance test

Null Hypothesis	Test	p-value*	Decision
The distribution of "How essential is it for your organization to become lean?" is the same across categories of Department	Independent-Samples Kruskal-Wallis Test	0.0198	Reject the null hypothesis.

*statistically significant if $p < 0.05$

Based on the p-value of 0.0198 there is a statistically significant difference between the responses to how essential it is for the organization to become lean among the different departments at the 5% level of significance (i.e. p-value < 0.05). This means that differences of opinion exist between at least 2 departments in respect to their responses to this question. Further investigation needs to be entered into to identify the departments that had differing views. The results presented in figure 4-9 illustrate the importance of becoming lean at the organization under study as confirmed by the participants. It can be observed that 96% of the participants deem lean implementation fundamentally important for their organization.

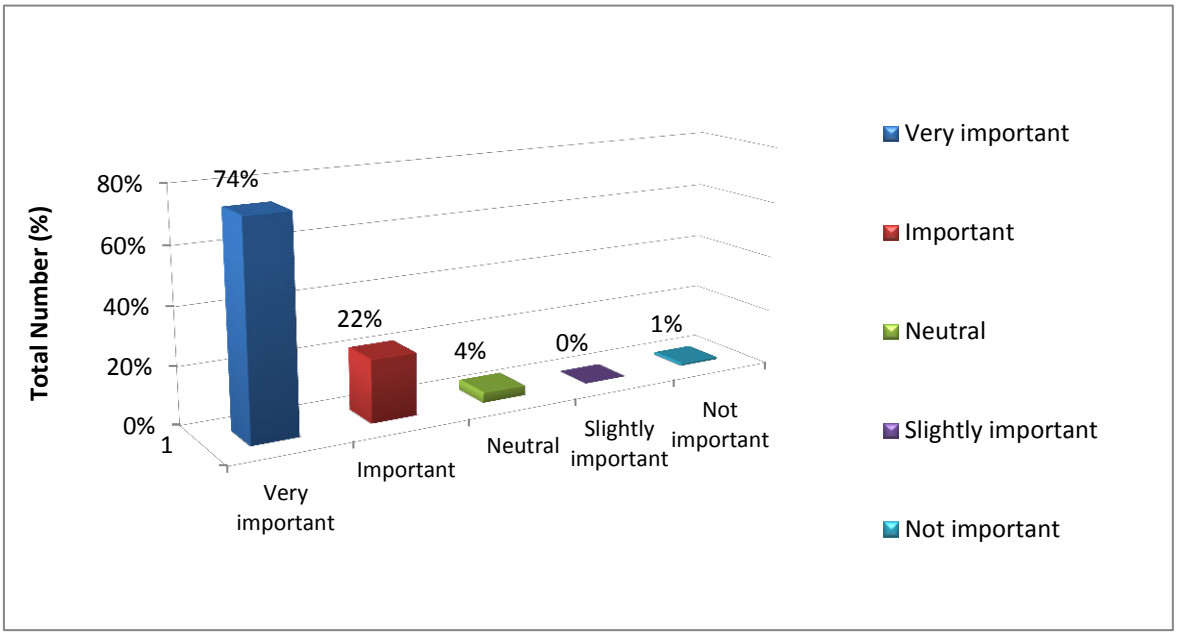

Figure 4-9: Need to become Lean

Question B2: What are the main driving factors for the implementation of lean in your organization?

Table 4-4: Driving factors for Lean Implementation

Driving factor	Department					Total
	Assembly	Supply chain	Quality	Eng.	HR / IT / Fin	
Quality improvement	40	14	12	12	13	91
Reduce rework and scrap	28	11	10	11	9	69
Higher productivity	21	10	9	10	9	59
Reduce work in progress	22	7	10	10	8	57
Reduction in lead time	20	5	11	7	7	50
Improvement in Flexibility	27	5	10	5	4	51
Cost reduction	24	8	11	12	9	64
Customer satisfaction improvement	26	3	11	5	8	53
Increase in staff motivation	13	5	8	7	4	37
Increase staff contribution to decision making	15	4	9	6	5	39

In Table 4-4 respondents' statements are sorted according to the frequency of response selection of each of the ten items. This is further portrayed in figure 4-10 below where 10 key drivers that compels organizations to implement lean as outlined by the existing literature are listed. In this segment, the respondents were required to select from a list of items all that they consider being the main drivers for their organization embarking on the lean implementation journey.

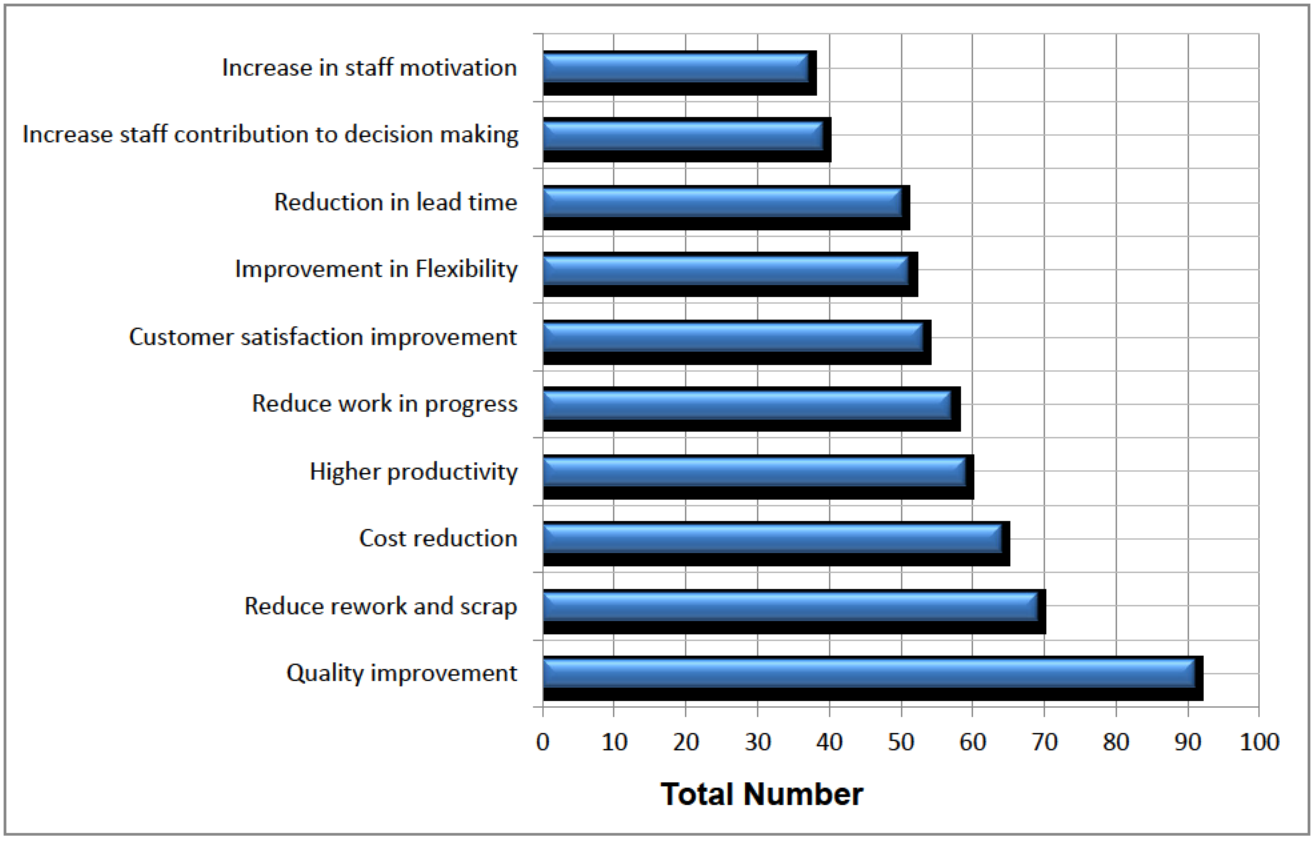

Figure 4-10: Driving Factors for Lean Implementation

In this view, it can be suggested that 80% of the listed items span at a range above the 50 indicator mark with only 20% ranging below the 50 indicator mark. The top five key factors as suggested by the number of responses can be pronounced as; quality improvement (91), reduce rework and scrap (69), cost reduction (64), higher productivity (59) and reduce work in progress (57). Increase in staff motivation (37) and increase

staff contribution towards decision making (39) was found to be the least essential drivers.

4.4 Knowledge and use of lean practices

To gauge the knowledge, understanding and use of lean concepts inside the organization, the respondents were addressed with questions that would enable the researcher to establish the level of awareness regarding lean practices and principles at an individual level. Section C of the questionnaire was therefore designed with an intention to abstract such information from the respondents by expounding on the application of lean methods at an organizational level.

4.4.1 Lean expressions and terminologies

6 lean expressions were defined and therefore a question was constructed as follows:

Question C1: Which of the following lean expressions / terminologies have you heard of?

Table F (b) appendix F displays participants' response according to each department and this is further expressed in the figure below.

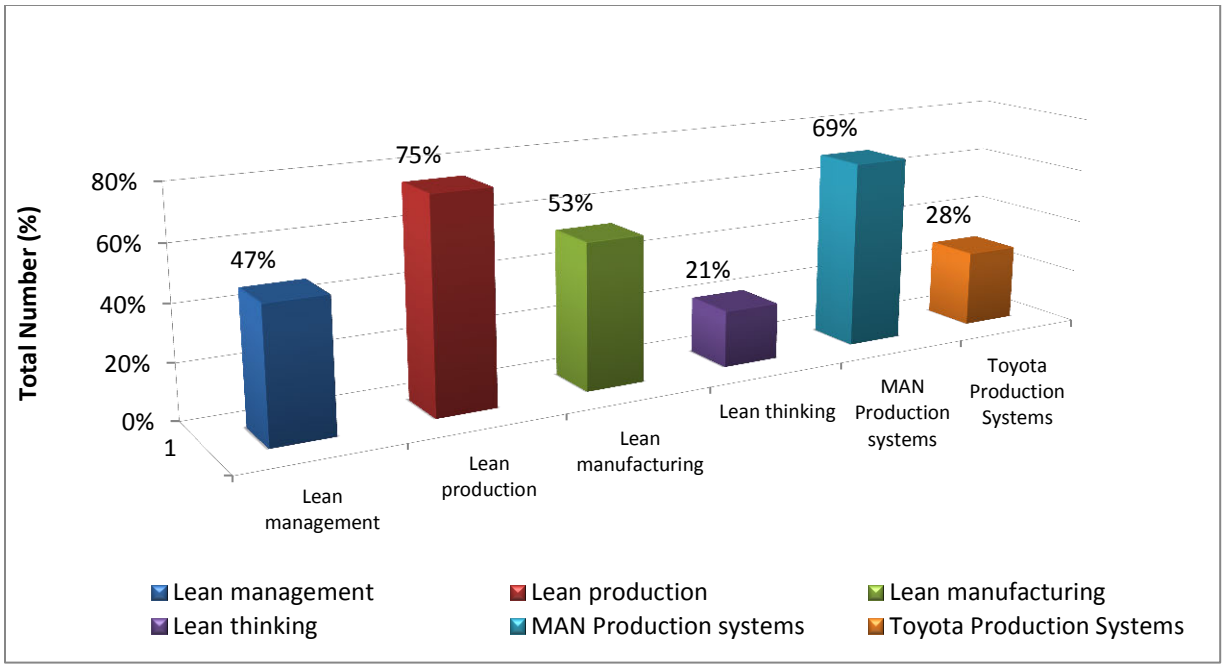

Figure 4-11: Lean Expressions

The graphical results presented in figure 4-11, display the awareness of the respondents to at least more than one of the lean expressions specified. The respondents indicated that lean production and MAN productions systems are the most well-known expressions with a response ratio of 75% and 69% respectively. This is then followed by lean manufacturing (53%) and lean management (47%). Knowledge of Toyota production systems (28%) and lean thinking (21%) as lean expressions has been perceived to be the slightest amongst the employees. This picture reveals that there is a fairly good knowledge of these expressions, however this does not guarantee good comprehension and hence this is revealed through further investigations. It must also be highlighted that although these may not be common, it does not nullify the fact that there are a number of similarities in the application of lean and therefore, concept knowledge cannot be ruled out completely.

4.4.2 Lean tools and techniques

To avoid enormous data expressions presented within this report, for ease of reference, table F (b), figure F (a) and figure F (b) elaborating on lean tools and techniques are contained in appendix F. Figure 4-12 however gives a consolidated outlook of the respondent's opinion about lean tools and techniques.

Assessing a number of empirical studies on lean production lead to the identification of 13 key lean tools required for successful adoption of the system. A question was then propounded as follows:

Question C2: Which of the following lean tools/techniques have you heard of? Which ones are already in use at your workplace?

Evaluating employee involvement and consciousness about these lean tools and techniques, Table 4-3 presents responses by participants specifying the level of knowledge of each tool. The responses have been divided appropriately to display an indication whether the participants have "heard of" or "never heard of" these tools. It also stipulates the status of each tool bearing as "already in use", "not-in-use" and the ones that they are "not sure" of. In figure 4-12 below it is evident that 70% of the sample population is familiar with the stated tools as most indicated having "heard of" while 30% have presented an opposite view to that. Lean tools such as 5S, kaizen, standardized work, TPM an 5 why analysis were considered to be the top 5 well known tools than pokayoke, VMS and cellular workplace layout which were found to be the least 3. An insight on the usage of the tools within the organization was also measured and the results indicate that 63% of the respondents believe most of the tools are already in use, whilst 37% are of a different view with 24% indicating that they are not sure of the use and 13% indicating that some of the tools are not in use at all.

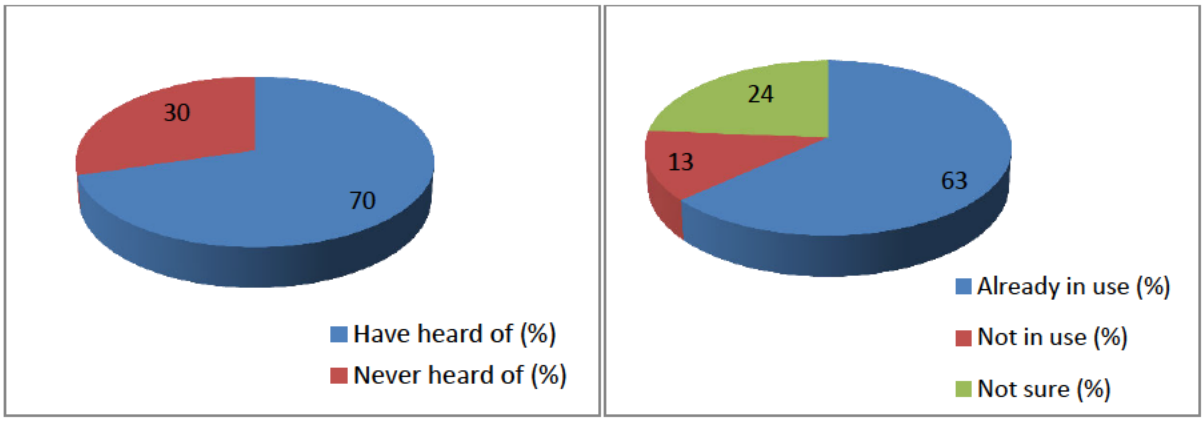

Figure 4-12: Lean tools / techniques overview

4.4.3 Lean tools and techniques meeting employee expectations

Most organizations implement lean methods with an intention to get more from their resources. These methods aid in identifying and eliminating waste caused by non-value adding activities within internal processes. There are particular deliverables that are expected to yield specific results. Measuring the extent of the effectiveness of lean inside the organization, participants were required to indicated whether the intended purpose for lean implementation according to their views was fulfilled or not.

Question C3: Examining the tools / techniques that have been implemented at your workplace, have these met your expectations?

Figure 4-13 displays a summary of all participants' responses. To allow for a better interpretation of the results, the scale was combined into two boundaries, that is, fulfilled or not fulfilled. 84% respondents indicated that the implementation of lean tools has met their expectations whilst 16% had a differing response. Having observed the two extremes, appropriate questions were then directed to the participants requiring them to indicate the influence towards their sense of response as either fulfilled or not fulfilled.

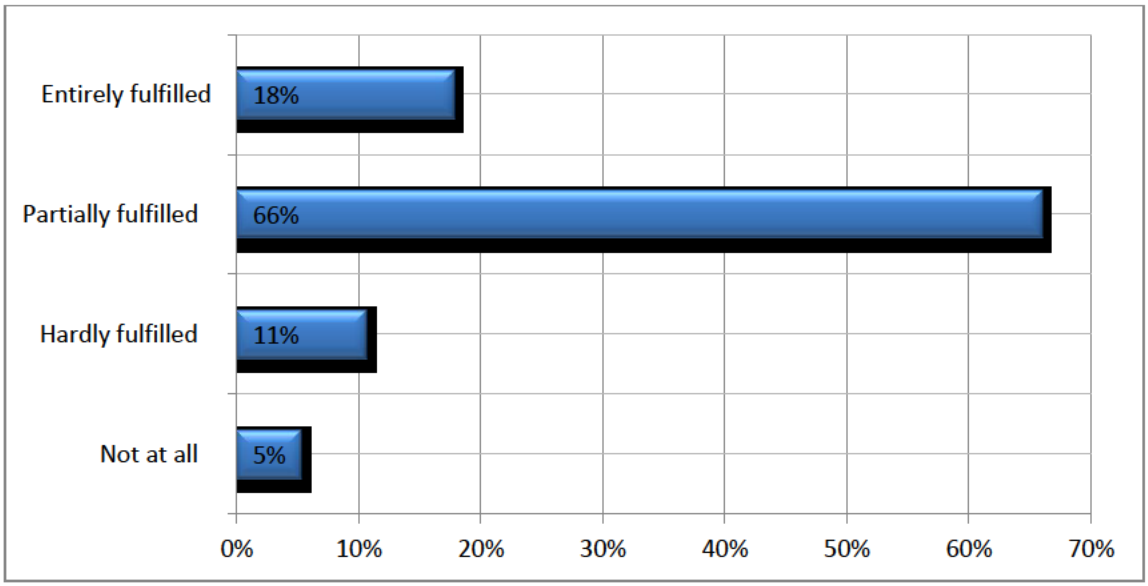

Figure 4-13: Overview on Lean Implementation expectations

A selection list of probable causes for dissatisfaction during lean implementation within organizations as prescribed by literature was provided and each responded was asked to indicate why certain lean improvement expectations were not fulfilled. The question was phased as follows:

Question C3.1: Please indicate why your expectations were not met referring to the indicators stated.

Figure 4-14 exhibits the frequency of the responses given by the participants. According to the selection of items in the order of frequency, Lack of communication within the organization was highlighted as the biggest contributor to employee dissatisfaction, followed by lack of leadership, employees not trained and time frame for transformation not appropriate, all these varied between 50%, 39%, 39% and 28% respectively. If these elements are not met this is likely to result in employee dissatisfaction and hence their expectation may not be fulfilled. Management not trained enough was not classified as one of the contributing factors as the results indicated 0% response in line with this particular element.

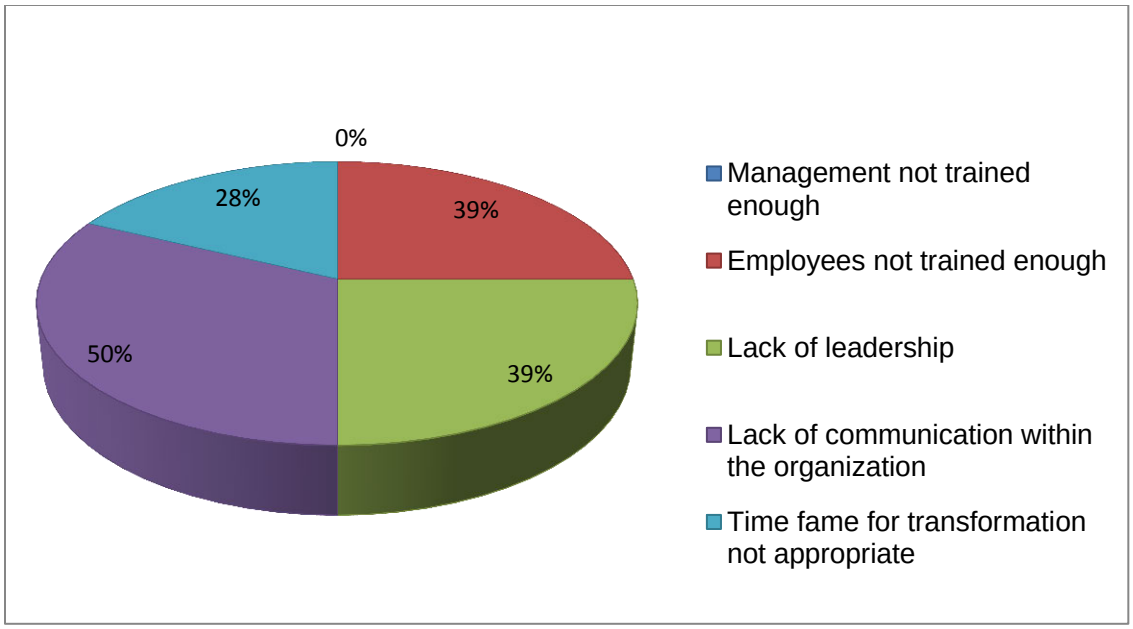

Figure 4-14: Lean expectations not fulfilled

In contrast, the majority of the participants believed that through lean implementation their work environment has improved significantly. To expand on this notion, participants were asked to indicate the elements that they found to be the main motivating factors for their sense of fulfillment.

Question C3.2: Please indicate what benefits have been achieved referring to the indicators stated?

Figure 4-15 below illustrates the frequency of responses corresponding to that each participant perceives as organizational achievements based on lean implementation. The statement relating to quality performance: scored the highest at 66% respondents supposing it to be one of the areas that have advanced after implementation of lean improvement methods. Other 2 top elements that received a relatively high scoring were; higher productivity at 59% and fewer tool, machine & equipment breakdown at 47%. Higher turnover was the least contributing factor with a response rate of 17%. Supposedly these results reveal that which general employees will consider being more relevant in their respective work functions whereas issues relating to turnover and

supplier relations will be more a management related function and this will be more applicable at their level.

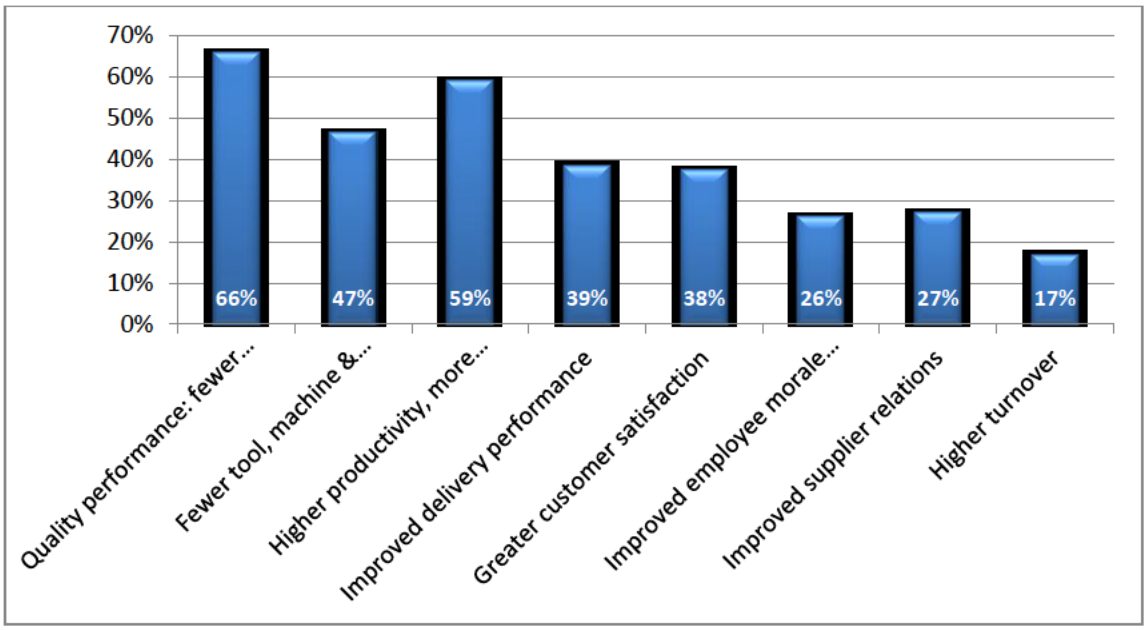

Figure 4-15: Achievements based on Lean Implementation

4.5 Status of lean implementation

In order to determine the lean status and its effectiveness inside the organization, each participant was required to state in their own opinion, the level of integration of their department towards fully implemented lean methods. The following questions were directed to all respondents in this order:

Question D1: Is your department strategically integrated in lean processes?

Question D2: Referring to the lean tools/techniques that have been implemented at your workplace, Are they effective?

Question D3: In your opinion, would you say they are sustainable?

Figure 4-16 displays responses from all the participants in reference to the 3 questions stated above. It is apparent that there is a positive response regarding the status of lean implementation within the organization.

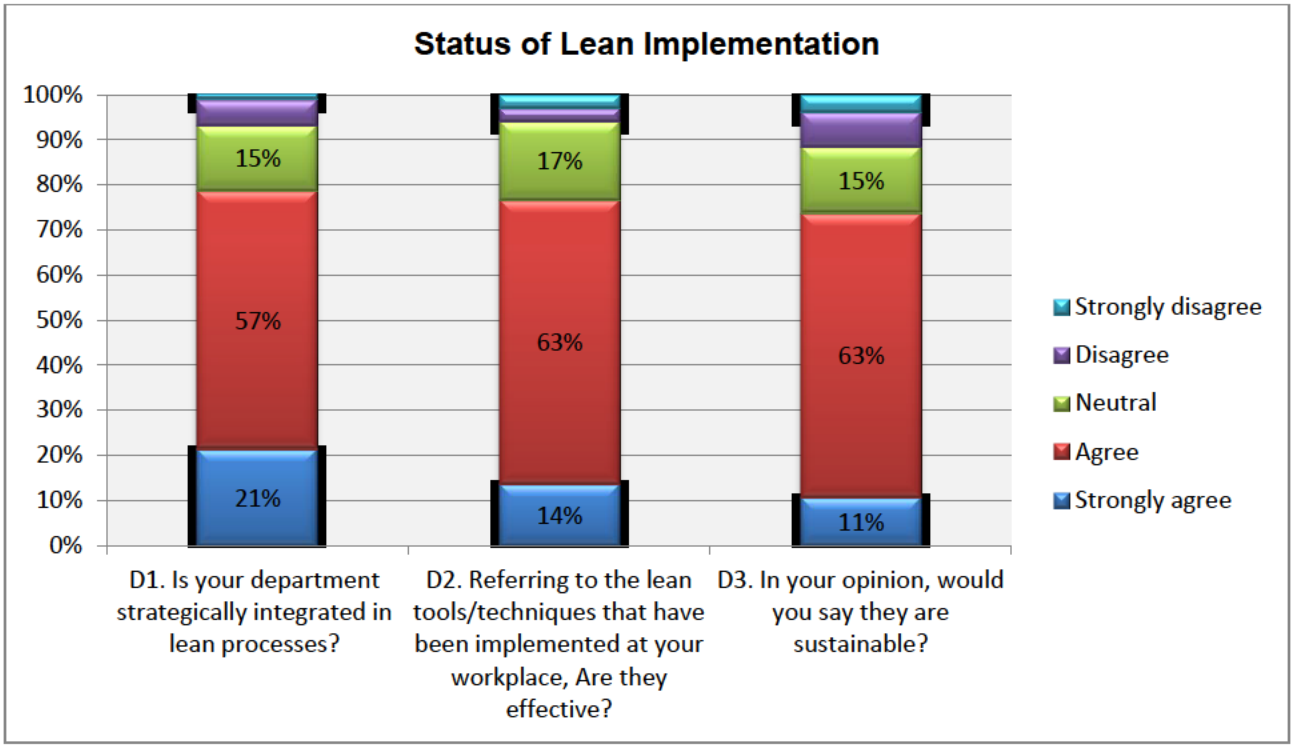

Figure 4-16: Status of Lean Implementation

To compress the results overview displayed, we will deliberate only on the positive responses taking into account the fact that at least 75% of the respondents mainly highlight positive feedback. However 15% of the respondents indicated neither negative nor positive response by opting to remain neutral, meanwhile less that 10% consider the implementation in a negative light. The results denote that 78% of the employees believe that their departments are strategically integrated in lean processes, 77% felt that the lean tools and techniques implemented are effective and another 74% considers lean methods to be sustainable within the organization.

It was also essential to determine the extent at which lean implementation has affected the employees and how they have received the changes that the organization has been

undergoing. To establish their perception a question was on the questionnaire as follows:

Question D4: With the changes at your workplace towards lean systems, how would you say these changes have affected you?

The responses displayed in figure 4-17 below, shows that 62% of the employees observed the change to be positive, whilst 23% remained neutral indicating change to be neither positive nor negative, and 15% felt that the change has affected them negatively.

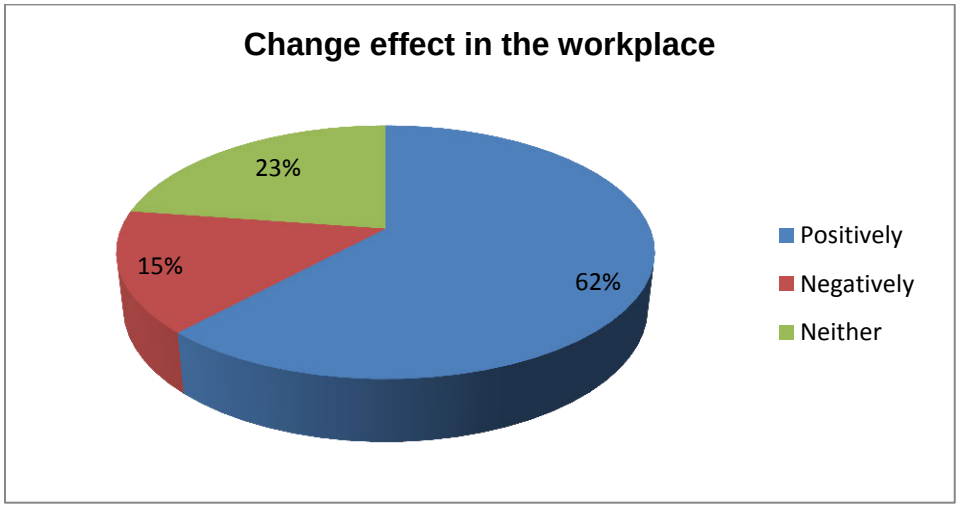

Figure 4-17: The effect of change in the workplace

4.6 Product development and supplier relations

Questions relating to product development were predominantly formulated to evaluate the organizations lean production capabilities in the area of development. Good supplier relationships are very important for businesses and therefore this was also considered crucial for analysis in order to determine the organizations state of relations to its associates. The questions were devised as follows:

Question E1: Are your suppliers involved in product design and development?

Question E2: Are your suppliers involved in product quality improvements?

Question E3: How would you rate the quality of your suppliers?

Question E4: Is there a method used to share information between your organization and its suppliers?

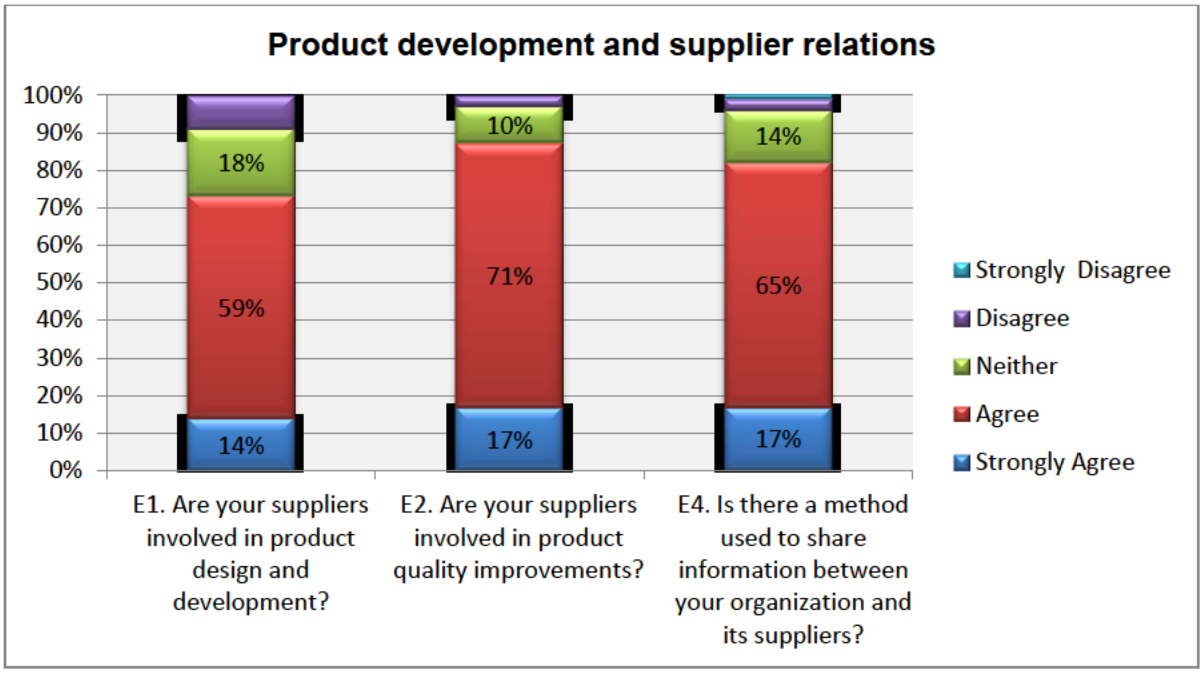

Figure 4-18: Product development and supplier relations

(Sohal and Egglestone, 1994) stated that organizations that have fully implemented lean pride themselves on quick turnaround times on new concepts by means of adopting strong leadership, effective teamwork and good communication. Information gathered from the respondents as displayed in figure 4-18 affirms that this is true, 73% indicated that suppliers are involved in product design and development, 88% indicated that suppliers are involved in quality improvements and 82% indicated that there is a method used to share information with the suppliers. This is in relation to the all those that have either "agreed" or "strongly agreed" to the statements in question.

A successful product development process will certainly involve all relevant associates and stakeholders. Trust, honesty and an open relationship with suppliers is vital for any organization. Sharing of information is a fundamental feature of lean production approach and it should be motivated (Sohal and Egglestone, 1994).

In addition to this product quality is regarded as one of the important factors especially for organizations who aspire to have competitive advantage. Participants were required to indicate in their own perception, how they rate the quality produced by suppliers. The results are depicted in figure 4-19 below:

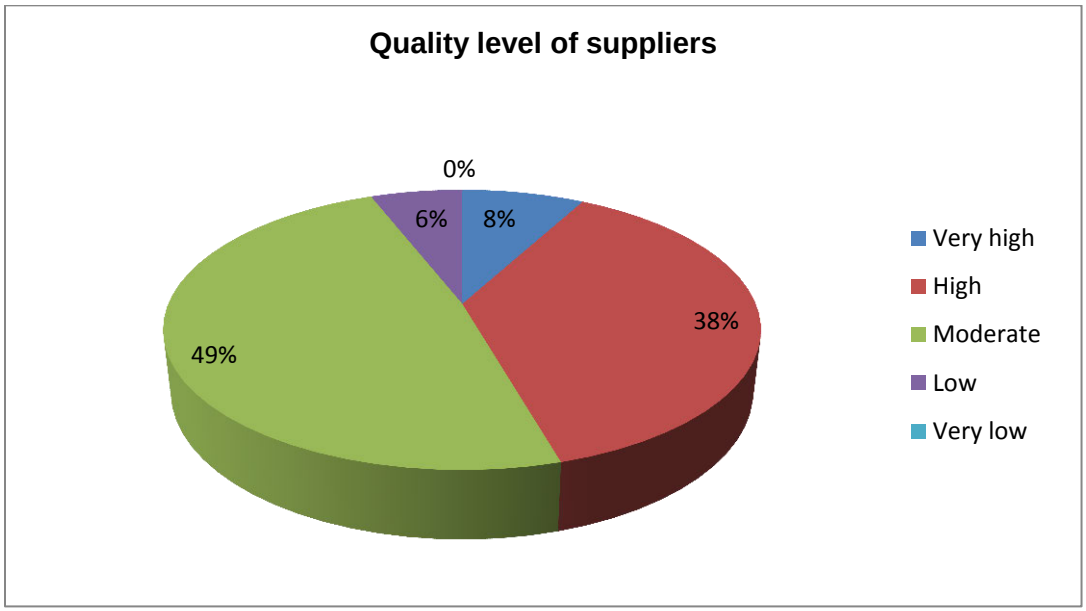

Figure 4-19: Quality level of suppliers

The response received indicates that, features of product quality are inherent in the lean processes implemented, 49% felt that the quality of the suppliers is rather moderate, 38% equally believe that the quality is high and 8% regard quality as very high. Only 6% of the respondents consider quality to be low. Although one may say that an effort

is required to bring the quality to a state where it will be measured to be at a very high level, one also cannot rule out that at the present state of supplier quality is acceptable. By ensuring product quality at a design stage and stakeholder involvement, this promotes stability within the organization and its partners. In turn this also assures better quality and consequently a superior product.

4.7 Challenges and barriers for lean implementation

Organizations that have implemented lean production systems will guarantee that this is not an easy journey. For any change undertaken by the organization in the word of success, management must be on guard for resistance or barriers that may possibly arise. Dealing with resistance to change requires a lot of risk and hard work (Stanleigh, 2008, Barker, 1998). The ability of people to respond and adapt to change is critical in any change in situation. Establishing subjects that could be viewed as barriers or challenges for successful implementation of lean, questions concerning this were presented to the participants. Based on the factors identified in the literature review, a list of eight possible barriers which are often faced by organization when implementing lean was formulated and therefore the questions were devised in a manner to establish if these had any influence during the internal implementation process. The questions were defined as follows:

Question F1: Which of the following have been the main barriers for adoption of the lean improvement methods?

Question F2: What were the biggest challenges during lean implementation at your workplace?

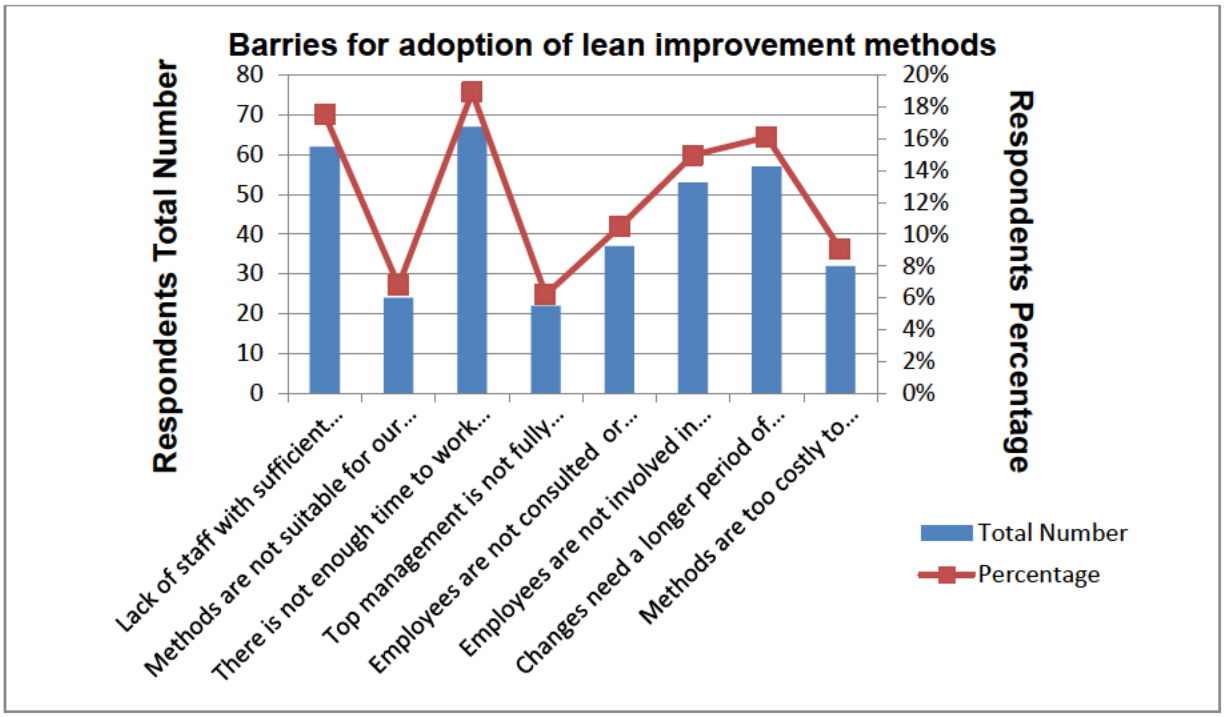

Figure 4-20: Lean Implementation Barriers

To interpret the barriers usually encountered by organizations during lean implementation figure 4-20 above highlights a complete view about what participants perceive to be the main impediments. 19% respondents believe that there is not enough time to work on lean improvements; whilst 18% respondents consider lack of staff with sufficient knowledge of lean methods as a major barrier. 16% respondents state that changes need longer period of implementation to be profitable and therefore this may delay the progress. 15% respondents are of the view that employees are not involved in decision making process and another 10% feels that employees are not consulted or informed about the changes. This in turn results in lack of employee participation in facilitating the lean programs because they feel isolated from the activities. Some respondents regard lean methods as too costly to implement, while other express that the methods are not suitable for their work environment and others feel that top management is not fully supportive of the change. These views are presented at 9%, 7% and 6% respectively.

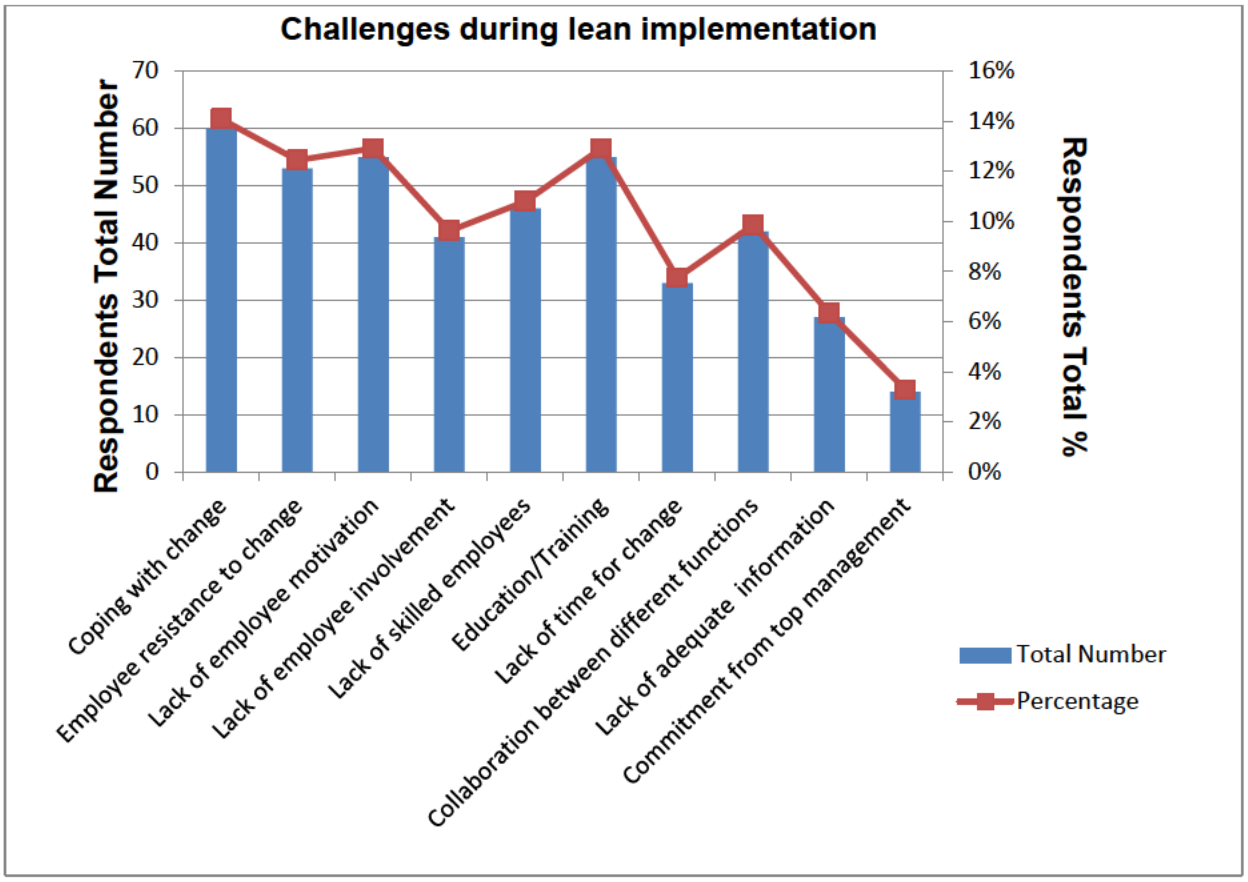

Figure 4-21: Lean Implementation Challenges

Figure 21 displays the top 5 biggest challenges experienced as indicated by the response received from the participants; 14% respondents believe that coping with change is one of the biggest challenges in the implementation of lean production systems within the organization. 13% respondents' consider the education and training methods as the second biggest challenge comparative to another 13% that assumes that the lack of employee motivation is evidently a big challenge. While 12% of the respondents regard employee resistance to change as a biggest challenge another 11% consents that lack of skilled employees is also a challenge. Collaboration between different functions and lack of employee involvement is also regarded as a challenge by at least 10% of the respondents respectively. Lack of time for change, lack of adequate information and commitment from top management are the least 3 challenges ranking at 8%, 6% and 3% respectively.

4.8 Critical Success Factors

Lean implementation affords an organization strategic advantage due to adoption of lean production improvement methods. Organizations that have fully implemented lean are observed to have a better market competitive positioning, effective customer relations and better service and product quality (Sohal and Egglestone, 1994). There are factors that have been recognized and denoted by literature and these are regarded critical to the achieving a successful lean implementations program within any organization. 9 key factors were identified for the purpose of this study and incorporated into the questionnaire. To grasp awareness by the employees of these factors and determining their level of importance, the question was phrased as follow:

Question G1: In your opinion, which of the following aspects are critical for successful lean implementation transformation?

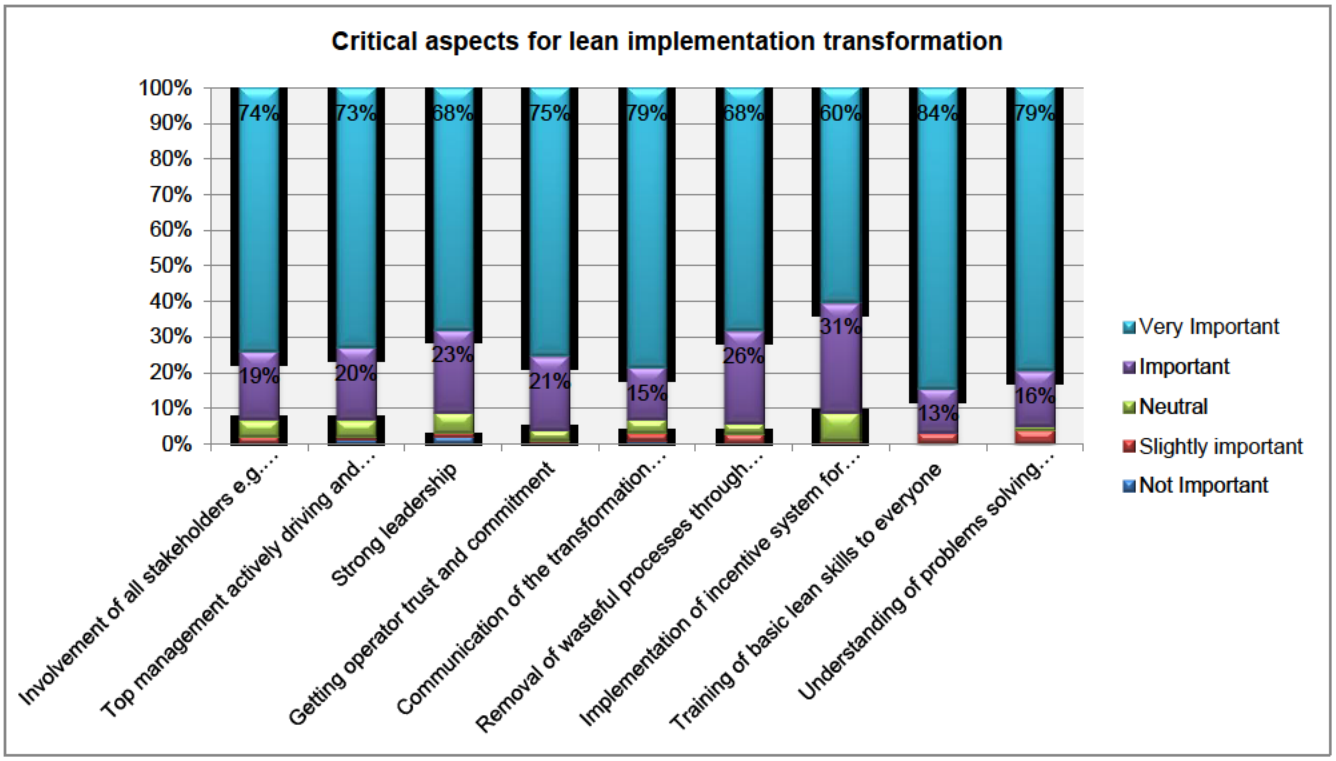

Figure 4-22: Overview of critical success factors for Lean Implementation

Respondents' results are displayed in table 4-4 which is attached in appendix B. Figure 4-25 gives an overview at a percentage rate. For a better analysis each extreme results will be combined and measured as; "not important", "neutral" and "very important". Due to the least number of negative responses (not important), the analysis will only focus on the positive responses with are classified as "very important".

At least 90% of the respondents consider these factors very important for successful implementation of lean within their organization. In the rating order of importance employees expressed their views in the following manner; training of basic lean skills to everyone (97%) is regarded as very important followed by getting operator trust and commitment (96%). According to (Liker, 2004), one of the P's in the 4P's model relates to people and partners stating that adding value to the organization requires developing employees and partners. A stronger team will yield a stable organization. It is evident in these results that the entire work force shares that same outlook in line with this principle. Understanding of problems solving methods for continuous improvement (95%), Removal of wasteful processes through use of Production Systems methods (94%) and Communication of the transformation process, goals etc. (94%) are also considered to be very important. This view corresponds with (Liker, 2004) problem solving principle, where it is stated that continuously solving root problems drives organizational learning. Employees at all levels need to be knowledgeable about these important factors as this promotes uprooting of problems at source whilst promoting consensus decision making amongst employees. Lastly, 4 other success factors were distinguished as; involvement of all stakeholders e.g. workers, unions, management, suppliers etc. (93%); top management actively driving and supporting change (93%); Strong leadership (91%) and implementation of incentive system for idea management (91%).

4.9 Summary

This chapter displayed the statistical data of the empirical study and deliberated on how these results relate to past research findings and existing theory. The responses were analyzed and interpreted to determine if the empirical study supports the research objectives. Each section of the questionnaire was designed to gather information that will steer the organization to a clear understanding of the status of lean implementation. This was also to acknowledge positive efforts expanded through lean, identify gaps and sought improvement measures.

There is to some degree a notable positive response that was displayed by the employees. Results displayed in 4.5 which reflect section D of the questionnaire reveals the status of lean implementation as perceived by employees and most indicated effectiveness and sustainability of the lean methods. Section F of the questionnaire was consolidated in 4.7 where a broader understanding of barriers and challenges experienced by the organization were mentioned. Although these were apparent, however it did not deter the organization in accomplishing its set goal(s) for lean implementation. This is demonstrated by the extent of knowledge the employees have on lean production systems.

Based on the analysis and presentation of the results obtained, the following chapter concludes this research and suggests recommendations and opportunities for further research.

Chapter 5 : Discussion

5.1 Introduction

This final chapter will provide an overview of the research achieved through the theoretical analysis and field work of the study. It is designed to provide a discussion on the research findings of the study and therefore will combine the different characteristics observed and documented throughout the research. Based on the results presented, an alignment will be drawn to the research objectives and questions in order to establish if any consistency exists to the current literature and previous research work done in this field. The questions to be answered by this research work were defined as follows:

1. What is the level of knowledge and understanding of lean production systems by employees?
2. What is the status of lean implementation within various operations of the organization?
3. What are the main barriers or challenges that management and employees are faced with during implementation?
4. What are the success factors that can be attributed to lean production systems implementation within the organization?

Each research question will be discussed within the context of the frame of literature presented in this research report. The findings will be based on the theories studied to ascertain practical application of lean production within the organization and the automotive environment in general. Furthermore, limitations of the study will be discussed in this chapter.

5.2 Discussion of results

Working towards the achieving the main research objectives the following questions had to be addressed; these will be discussed in detail and supported by theoretical literature articulated in chapter 2.

5.2.1 Outcome of research question number 1

- *What is the level of knowledge and use of lean production systems by employees?*

The results obtained in support to this question, demonstrate that the knowledge of lean within the organization is quite substantial. Educational level or qualification did not play any major influence in this aspect because it could be established that irrespective of the level, most employees have a clear understanding of about lean production concepts. This can be attested to the number of responses which ranged above 70%.

It was also noted that employees are informed about the renowned lean tools and techniques that are applied in their work environment. This was confirmed by an amount of at least 63% of the employees who are familiar with the tools that are in use during their daily functions. It was also validated that the understanding of these tools was related to their expectations about lean systems being fully met. The use of these tools has afforded employees a better work environment which supports the overall organization strategic goals, one being quality first. Literature revealed that the success on lean implementation results from the application of tools, principles and practices that are directed towards achieving superior performance. These relate to the soft practices namely, organizational and human side in operations, quality and performance management (Larteb et al., 2015).

5.2.2 Outcome of research question number 2

- *What is the status of lean implementation within various operations of the organization?*

This question addresses the core purpose of this research which was to determine the status of lean implementation within the Truck and Bus assembly plant. To measure reliability of responses regarding this question, Cronbach's alpha was calculated and found to be as follows:

Status of Lean Implementation Construct

Reliability Statistics	
Cronbach's Alpha	N of Items
0.776	6

Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability simply providing an overall reliability coefficient for a set of variables e.g. questions. Often an alpha from 0.7 and above is considered acceptable. Based on the Cronbach's alpha for "Status of Lean implementation" it was found to be 0.78. It can be said that the internal consistency, hence reliability, of the questions that were used to assess this construct is good (IDRE, 2015). The findings in research question 1 above provided support to this question which was regarded as the key question to this study. Determining the status of lean implementation involved various aspects of the business functions including supplier relations. According to Mohanty et al. (2007), influences within interdisciplinary teams are vital to gaining all benefits lean has to offer. Answering this question, departmental integration towards lean was investigated.

The results of the study validated that most departments have adopted lean process and these are effective and sustainable. Suppliers have also been involved in this lean implementation process with an aim to improve their overall quality and building closer relationships. TQM as a lean tool address all quality matters of the business intended for continuous improvement and keeping customers satisfied. Application of this tool facilitated a broader view of quality not only looking into internal processes but also external processes. This method is required for organizations to achieve customer satisfaction and global competitiveness.

5.2.3 Outcome of research question number 3

- *What are the main barriers or challenges that management and employees are faced with during implementation?*

Although the answers to research question 1 and 2 gave a positive outlook about lean implementation within the organization, it is understood from the literature that there are somehow challenges or barrier that impede the success implementation of lean. Findings towards this research question also highlight this idea; by indicating that barriers such as lack of staff with sufficient knowledge on lean methods coupled with time not enough to work on lean improvements influences the adoption of lean negatively. If employees lack knowledge more training may be required in order to bridge that gap, however due to implementation programs and timelines working on each lean concept may prove to be cumbersome and hence the “foundation laying” phase can be compromised. This could have a significantly negative impact towards the whole lean implementation process which may result in failure. What was also evident is that the key challenges to lean implementation are more related to employee resistance to change, lack of motivation and an inability to cope with change. According to Senge (1990), to successfully implement lean, lean tools and practices must be led by organizational transformation, merely implementing tools lacking an integrative systems as a foundation is not sufficient.

5.2.4 Outcome of research question number 4

- *What are the suggested success factors that can be attributed to lean production systems implementation within the organization?*

This research question has also been identified as one of the important ones for this study in particular. Identifying success factors is crucial for the organization as this might be used as a platform for any other future improvement projects. Testing the reliability of the questions, the Cronbach's alpha was calculated and found to be 0.88. Based on this, it can be said that the internal consistency of the questions that were used to assess this construct is good.

Success factors and recommendations construct

Reliability Statistics	
Cronbach's Alpha	N of Items
0.880	9

Considering that the results directed to answer this research question are far above 50% demonstrates that all the listed success factors are regarded important for the successful implementation of lean production systems. This then leads to the conclusion that, all the factors defined by the literature are true. However (Kovacheva, 2010) singles out one specific factor which is supposedly the most important one; that it, although applying lean practices is a responsibility for everyone, management should ensure that all concepts are applied collectively in order to reap full benefits of lean.

5.3 Achievements of research aims and objectives

5.3.1 To evaluate the status of lean production systems implementation within the assembly plant.

This was presented by the outcome of research question 2. It is evident that the organization has successfully implemented lean systems throughout its various functions.

5.3.2 To establish challenges faced by management and employees during implementation

The following factors were found to be the most predominant:

- Coping with change
- Employee resistance to change
- Lack of employee motivation
- Education and training

5.3.3 To identify the benefits of lean production systems implementation within the assembly plant.

The following were identified as the main benefits by the organization from the implementation of lean.

- Quality performance: fewer defects
- Higher productivity
- Fewer machine breakdown

5.3.4 To determine strategies or interventions that can be adopted for future projects and provide recommendations.

Gaps identified as areas of concern for improvement:

- Lack of communication
- Lack of leadership
- Training of employees
- Management training on lean principles

5.4 Summary

Answering the research questions, the results of this study indicated that lean production methods have been adopted throughout the organization although there are areas that required further attention. The following chapter will draw conclusions based on these findings and make recommendations for future research.

Chapter 6 : Conclusion and Recommendations

6.1 Introduction

Increasing global competitiveness worldwide has forced manufacturing organizations to produce high-quality products at a faster rate and at a competitive cost. In order to reach these goals, today's manufacturing organizations are forced to review the decisions taken at every organizational level and find new ways of working. To attain and sustain competitiveness in this business dimension, efficient organizational structures and workflows should be prioritized; this includes transparent costs and processes, qualified and motivated employees and processes that are controlled by the market and in response to customers' expectation of the service rendered (Kovacheva, 2010).

6.2 Summary of the empirical study

The aim of the study was to evaluate the implementation status of lean production systems at MAN Truck and Bus assembly plant. The need for lean implementation was desired in order to improve quality, reduce rework and scrap, reduce costs and improve productivity. The results obtained from the study demonstrate that lean has been fully implemented within the organization. Employees have shown that they are informed of the lean methods. It is usually hard to predict the consequences of change as it might have negative or positive influence toward the organization, however in this particular instance, the changes that have been implemented have affected employees and the work environment positively. Achieving competitive advantage requires that organizations develop close relationships with suppliers and customers. This research work has proven this notion to be true as the results illustrate that there are methods in place integrating suppliers into the business. Although there are certain drawbacks, this proved to be minimal and it can be concluded that lean implementation has been successful.

6.3 Recommendations

Throughout the lean implementation process within the organization, there are remarkable improvements noted. The positive response observed is due to commitment afforded by management and employees towards lean production systems adoption. The study has however identified areas that require improvement such as; communication, leadership and training. It is observed that lean implementation requires a good knowledge of the principles and therefore management needs to ensure that comprehensive training and education programs are available. Support by management and proper communication platforms are crucial towards achieving a common goal. This can be achieved through some form of workshops and other seminars. Management needs to be well knowledgeable about lean methods in order to be able to provide that necessary leadership that will facilitate sustainability.

6.4 Limitations

It is important to note that the study was confined into the boundaries of MAN Truck and Bus Pinetown Assembly Plant. Although implementation of lean was driven at an international world-wide strategic level, the focus was mainly at the local plant. The research instrument used for data collection was in a form of a questionnaire, this was administered electronically and manually. Those participants that conducted a manual survey had an opportunity to clarify any questions on the questionnaire that were misunderstood; however, those that conducted an online survey had no such opportunity. Literacy level was also identified as limited factor as this could have resulted in some of the questions being misinterpreted.

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Appendices

Appendix A: Ethical Clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

6 November 2015

Miss Lindiwe Mthunzi 211529166
Graduate School of Business and Leadership
Westville Campus

Dear Miss Mthunzi

Protocol reference number: HSS/1623/015M
Project Title: Evaluating the implementation status of lean production systems at MAN Truck & Bus Pinetown Assembly

Full Approval – Expedited Application

In response to your application received on 30 October 2015, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted FULL APPROVAL.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours [redacted]

.....
Dr Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

Supervisor: Dr Abdul Kader
Academic Leader Research: Dr M Hoque
School Administrator: Ms Zarina Bullyraj

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
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Website: www.ukzn.ac.za

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Appendix B: Consent letter

Informed Consent Letter 3C

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

Dear Respondent

MBA Research Project
Researcher: Lindiwe Mthunzi (082 299 5613)
Supervisor: Dr. Abdul Kader (082 901 0225)
Research Office: Ms. P Ximba 031-2603587

I, **Lindiwe Mthunzi,** an MBA student, at the Graduate School of Business and Leadership, of the University of Kwa-Zulu Natal. Invite you to participate in a research project entitled: **Evaluating the implementation status of lean production systems at MAN Truck and Bus Pinetown Assembly**. The aim of this study is to:

1. Evaluate the status of lean production systems implementation within the assembly plant
2. Establish what are the challenges faced by management and employees during implementation
3. Identify the benefits of lean production systems implementation within the assembly plant
4. Determine strategies or interventions that can be adopted for future projects

Through your participation I hope to understand your view or perception about the topic. The results of the survey are intended to contribute towards the overall drive to improve the organizations' process efficiency and gaining sustainable competitive advantage.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this survey/focus group. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Graduate School of Business and Leadership, UKZN.

If you have any questions or concerns about completing the questionnaire or about participating in this study, you may contact me or my supervisor at the numbers listed above.

The survey should take you about **10** minutes to complete. I hope you will take the time to complete this survey.

Sincerely

Investigators signature_____ Date_____

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

MBA Research Project
Researcher: Lindiwe Mthunzi (082 299 5613)
Supervisor: Dr. Abdul Kader (082 901 0225)
Research Office: Ms. P Ximba 031-2603587

CONSENT

I……(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PARTICIPANT DATE

……

Appendix C: Survey Questionnaire

Evaluating the Implementation Status of Lean Production Systems: Survey Questionnaire

Section A: General Information:

Please indicate (Tick the applicable box)

1. What is your gender?

1.	Male	☐
2.	Female	☐

2. What is your age?

1.	18>25	☐
2.	26>35	☐
3.	36>45	☐
4.	46>55	☐
5.	56>65	☐

3. What is your highest educational qualification level?

1.	None	☐
2.	Matric	☐
3.	Matric + Certificate	☐
4.	Matric + Diploma	☐
5.	Matric + Degree	☐

4. Which department do you work for?

1.	Assembly	☐
2.	Supply chain	☐
3.	Quality	☐
4.	Engineering	☐
5.	HR/IT/Finance	☐

5. What is your current position?

1.	Operator	☐

2. Administrator (e.g. Engineer, planner, specialist, controller etc.) ☐
3. Lower Management (Team leader / Group leader / Supervisor) ☐
4. Senior management (Department Manager) ☐
5. Other (specify) _____

6. What is your employment status?

1. Permanent, white collar ☐
2. Permanent, blue collar ☐
3. Contract, white collar ☐
4. Contract, blue collar ☐
5. Labor broker ☐

7. How long have you been working for the organization?

1. Less than 1yr ☐
2. Between 1-2 years ☐
3. Between 3-5 years ☐
4. Between 6-10 years ☐
5. Between 11-15 years ☐
6. 16 years and more ☐

Section B: Need for implementation of lean production systems

1. Lean is a process of waste elimination throughout the organizations value chain resulting in waste free production. How essential is it for your organization to become lean? (Use the rating scale indicated)

Very important	Important	Don't know	Slightly important	Not important
☐	☐	☐	☐	☐

2. Based on your knowledge, what are the main driving factors for the implementation of lean in your organization? (Indicate all that is applicable from the listed items)
   1. Quality improvement ☐
   2. Reduce rework and scrap ☐
   3. Higher productivity ☐
   4. Reduce work in progress ☐

5. Reduction in lead time ☐
6. Improvement in Flexibility ☐
7. Cost reduction ☐
8. Customer satisfaction improvement ☐
9. Increase in staff motivation ☐
10. Increase staff contribution to decision making ☐

Section C: Knowledge and use of lean practices

1. Which of the following lean expressions or terminologies have you heard of? (Please indicate all that is applicable from the listed items)

1. Lean management ☐
2. Lean production ☐
3. Lean manufacturing ☐
4. Lean thinking ☐
5. MAN Production systems ☐
6. Toyota Production Systems ☐

2. Which of the following lean tools/techniques have you heard of? Which ones are already in use at your workplace? (Please indicate all that is applicable from the listed items)

Tools / Techniques	Never heard of	Have heard of	Already In use	Not in use	Not sure
1. 5S	☐	☐	☐	☐	☐
2. Visual Controls	☐	☐	☐	☐	☐
3. Total productive maintenance (TPM)	☐	☐	☐	☐	☐
4. Value stream mapping (VMS)	☐	☐	☐	☐	☐
5. Kanban System	☐	☐	☐	☐	☐
6. Just-In-Time (JIT)	☐	☐	☐	☐	☐
7. Cellular workplace layout	☐	☐	☐	☐	☐
8. Kaizen (Idea management)	☐	☐	☐	☐	☐
9. Standardized wok sheet and standard work	☐	☐	☐	☐	☐

10. Pokayoke	☐	☐		☐	☐	☐
11. Root cause analysis (Fish bone diagram)	☐	☐		☐	☐	☐
12. 5 why analysis	☐	☐		☐	☐	☐
13. Plan do check act (PDCA) cycle	☐	☐		☐	☐	☐

3. Examining the tools/techniques that have been implemented at your workplace, have these met your expectations?

Not at all	Hardly fulfilled	Partially fulfilled	Entirely fulfilled
☐	☐	☐	☐

If your answer was not at all or hardly fulfilled, please indicate reasons why your expectations were not met referring to the indicators below?

1. Management not trained enough ☐
2. Employees not trained enough ☐
3. Lack of leadership ☐
4. Lack of communication within the organization ☐
5. Time fame for transformation not appropriate ☐

If your answer was partially or entirely fulfilled, please indicate what benefits have been achieved referring to the indicators below?

1. Quality performance: fewer defects and rework (internal and at external customer) ☐
2. Fewer tool, machine & equipment breakdown ☐
3. Higher productivity, more output /man hour (efficiency) ☐
4. Improved delivery performance ☐
5. Greater customer satisfaction ☐
6. Improved employee morale and involvement ☐
7. Improved supplier relations ☐
8. Higher turnover ☐

Section D: Status of Lean Implementation

1. Is your department strategically integrated in lean processes? (Use the rating scale indicated)

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

2. Referring to the lean tools/techniques that have been implemented at your workplace, Are they effective?

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

3. In your opinion, would you say they are sustainable?

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

4. With the changes at your workplace towards lean systems, how would you say these changes have affected you?

Positively	Negatively	Neither
☐	☐	☐

5. Does your organization employ a lean specialist?

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

6. Does your organization use external lean consultants when required?

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

Section E: Product development and supplier relations

1. Are your suppliers involved in product design and development? (Use the rating scale indicated)

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

2. Are your suppliers involved in product quality improvements?

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

3. How would you rate the quality level of your suppliers?

Very high	High	Moderate	Low	Very low
☐	☐	☐	☐	☐

4. Is there a method used to share information between your organization and its suppliers?

Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
☐	☐	☐	☐	☐

Section F: Barriers /Challenges for lean implementation

1. Which of the following have been the main barriers for adoption of the lean improvement methods? (Select 5 most)

    1. Lack of staff with sufficient knowledge of these methods ☐
    2. Methods are not suitable for our work environment ☐
    3. There is not enough time to work on these improvements ☐
    4. Top management is not fully supportive of the change ☐
    5. Employees are not consulted or informed about the changes ☐
    6. Employees are not involved in decision making processes ☐
    7. Changes need a longer period of implementation to become profitable ☐
    8. Methods are too costly to implement ☐

2. What were the biggest challenges during lean implementation at your workplace? (Select 5 most)

    1. Coping with change ☐

2. Employee resistance to change ☐
3. Lack of employee motivation ☐
4. Lack of employee involvement ☐
5. Lack of skilled employees ☐
6. Education/Training ☐
7. Lack of time for change ☐
8. Collaboration between different functions ☐
9. Lack of adequate information ☐
10. Commitment from top management ☐

Section G: Success factors and recommendations

1. In your opinion, which of the following aspects are critical for successful lean implementation transformation? (Use the rating scale indicated: 1-not important; 2-slightly important; 3- Neutral; 4-important; 5-very important)

Aspects	Not Important	Slightly Important	Neutral	Important	Very Important
1. Involvement of all stakeholders e.g. workers, unions, management, suppliers etc.					
2. Top management actively driving and supporting change					
3. Strong leadership					
4. Getting operator trust and commitment					
5. Communication of the transformation process, goals etc.					
6. Removal of wasteful processes through use of MNPS methods					
7. Implementation of incentive system for idea management					
8. Training of basic lean skills to everyone					
9. Understanding of problems solving methods for continuous improvement					

Survey Report Data

Appendix D: Demographics

Cross tabulations

Cross tabulation of gender and position held

Position	Gender		Total
	Male	Female	
Operator	42	3	45
Administrator	15	12	27
Lower Management	12	4	16
Senior Management	7	1	8
Other	8	6	14
Total	84	26	110

Cross tabulation of department and gender

Department	Gender		Total
	Male	Female	
Assembly	48	3	51
Supply chain	13	6	19
Quality	6	7	13
Engineering	14	0	14
HR / IT / Finance	4	10	14
Total	85	26	111

Department	Age (years)					Total
	18 - 25	26 - 35	36 - 45	46 - 55	56 - 65	
Assembly	6	16	19	8	3	52
Supply chain	1	8	4	4	2	19
Quality	2	6	4	1	0	13
Engineering	0	6	5	2	1	14
HR / IT / Finance	1	6	6	1	0	14
Total	10	42	38	16	6	112

Department	Educational Qualification					Total
	None	Matric	Matric + Certificate	Matric + Diploma	Matric + Degree	
Assembly	7	21	15	6	3	52
Supply chain	2	3	7	1	6	19
Quality	1	2	4	2	4	13
Engineering	0	2	2	6	4	14
HR / IT / Finance	0	0	3	5	6	14
Total	10	28	31	20	23	112

Position	Educational Qualification					Total
	None	Matric	Matric + Certificate	Matric + Diploma	Matric + Degree	
Operator	10	22	13	0	0	45
Administrator	0	2	9	5	11	27
Lower Management	0	3	6	3	5	17
Senior management	0	0	0	3	5	8
Other	0	1	3	8	2	14
Total	10	28	31	19	23	111

Department	Employment status					Total
	Permanent white collar	Permanent blue collar	Contract white collar	Contract blue collar	Labor broker	
Assembly	5	23	1	18	5	52
Supply chain	10	5	2	1	0	18
Quality	5	5	3	0	0	13
Engineering	10	3	0	1	0	14
HR /IT /Finance	12	1	1	0	0	14
Total	42	37	7	20	5	111

Department	Years employed in the organization					
	< 1yr	1 - 2	3 - 5	6 - 10	11 - 15	≥ 16
Assembly	3	9	18	7	9	5
Supply chain	2	1	3	3	5	5
Quality	1	4	4	1	0	2
Engineering	4	0	2	1	4	2
HR / IT / Finance	0	2	5	6	0	1
Total	10	16	32	18	18	15

Appendix E: Need for Lean Implementation

Cross tabulation with department

Cross tabulation of department and lean implementation driving factors

Driving factor	Department					Total
	Assembly	Supply chain	Quality	Engineering	HR / IT / Finance	
Quality improvement	40	14	12	12	13	91
Reduce rework and scrap	28	11	10	11	9	69
Higher productivity	21	10	9	10	9	59
Reduce work in progress	22	7	10	10	8	57
Reduction in lead time	20	5	11	7	7	50
Improvement in Flexibility	27	5	10	5	4	51
Cost reduction	24	8	11	12	9	64
Customer satisfaction improvement	26	3	11	5	8	53
Increase in staff motivation	13	5	8	7	4	37
Increase staff contribution to decision making	15	4	9	6	5	39

Appendix F: Lean Knowledge

Table F (a): Lean Expressions

Cross tabulations with departments

Cross tabulation of knowledge of lean terminology and department						
Lean terminology	Department					Total
	Assembly	Supply chain	Quality	Engineering	HR / IT / Finance	
Lean production	34	12	9	13	12	80
Lean manufacturing	18	12	6	12	8	56
Lean thinking	9	2	3	4	4	22
MAN Production systems	30	12	9	11	11	73
Toyota Production Systems	8	9	5	7	1	30

Table F (b): Lean tools / techniques

	Response Type					Statistical Values		
Tools / Techniques	Have heard of (%)	Never heard of (%)	Already in use (%)	Not in use (%)	Not sure (%)	Mean	Standard deviation	Variance
5S	98	3	100	0	0	2	1	1
Kaizen (Idea Management)	95	5	97	2	1	2	1	1
Standardized Work	93	5	97	2	1	2	1	1
Total Productive Maintenance (TPM)	87	13	80	4	1	2	1	2
5 Why analysis	81	20	78	10	12	2	1	1
Just-In-Time	78	23	78	6	17	2	1	2
Visual Control	74	26	67	12	21	2	1	2
Root Cause Analysis (Fish bone diagram)	65	35	56	18	26	2	1	2
Kanban System	64	36	40	32	29	3	1	2
Plan-Do-Check-Act (PDCA)	58	42	47	13	40	3	1	2
Pokayoke	47	53	28	25	47	3	2	2
Value Stream Mapping	42	58	21	22	57	3	2	2
Cellular Workplace Layout	33	67	27	20	53	3	1	2
Average	70	30	63	13	24			

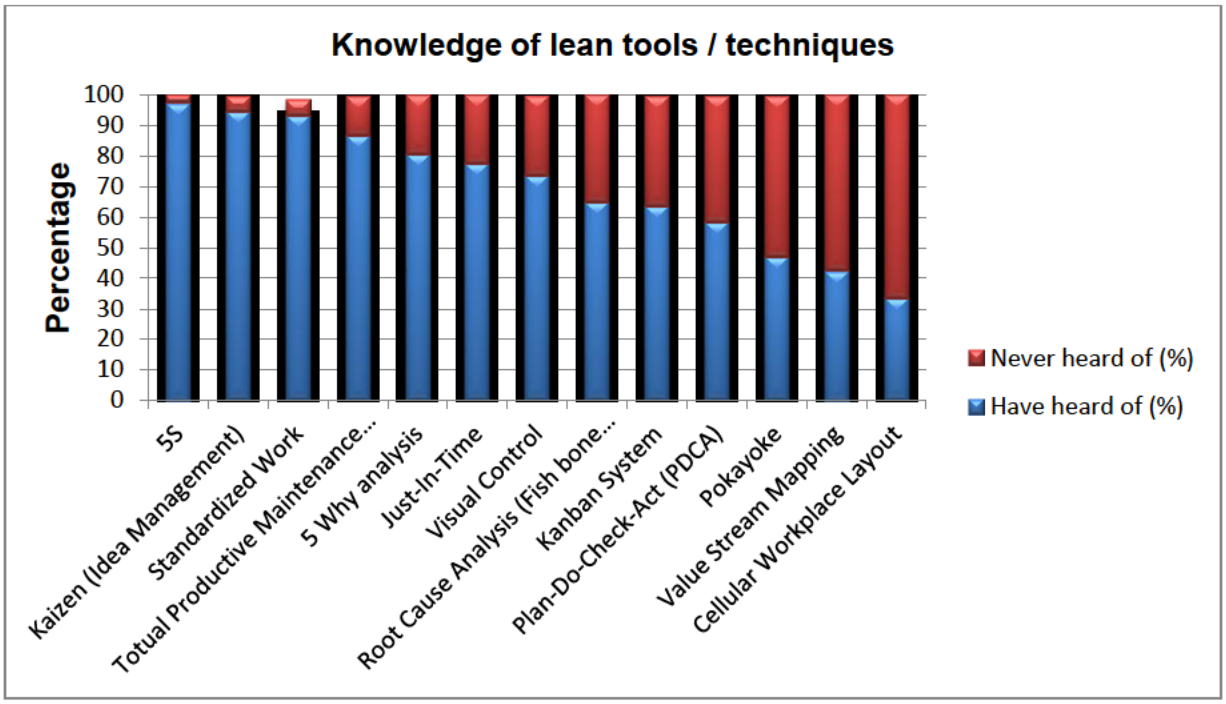

Figure F (a): Knowledge of lean tools

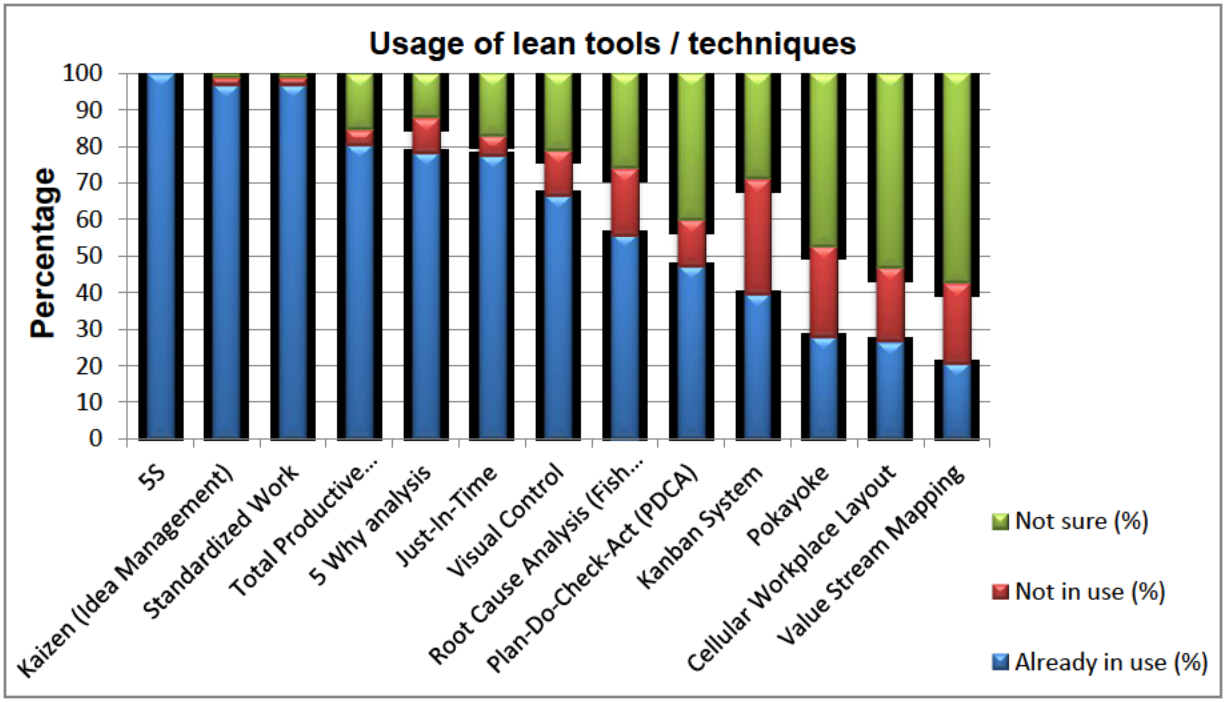

Figure F (b): Usage of Lean tools

Appendix G: Lean Implementation Status

Significance test using departments as base

Question #	Null Hypothesis	Test	p-value*	Decision
1	The distribution of "Is your department strategically integrated in lean processes?" is the same across categories of Department	Independent-Samples Kruskal-Wallis Test	0.7348	Retain the null hypothesis.
2	The distribution of "Referring to the lean tools/techniques that have been implemented at your workplace, Are they effective?" is the same across categories of Department	Independent-Samples Kruskal-Wallis Test	0.0784	Retain the null hypothesis.
3	The distribution of "In your opinion, would you say they are sustainable?" is the same across categories of Department	Independent-Samples Kruskal-Wallis Test	0.0726	Retain the null hypothesis.
4	The distribution of "With the changes at your workplace towards lean systems, how would you say these changes have affected you?" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.3146	Retain the null hypothesis.
5	The distribution of "Does your organization employ a lean specialist?" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.4514	Retain the null hypothesis.
6	The distribution of "Does your organization use external lean consultants when required?" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.7637	Retain the null hypothesis.

*statistically significant if $p < 0.05$

Appendix H: Product development and Supplier relations

Significance test using departments as base

Question #	Null Hypothesis	Test	p-value*	Decision
1	The distribution of "Are your suppliers involved in product design and development?" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.4761	Retain the null hypothesis.
2	The distribution of "Are your suppliers involved in product quality?" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.3420	Retain the null hypothesis.
3	The distribution of "How would you rate the quality level of your suppliers" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.5440	Retain the null hypothesis.
4	The distribution of "Is there a method used to share information between your organization and its suppliers?" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.4842	Retain the null hypothesis.

*statistically significant if $p < 0.05$

Appendix I: Barriers & Challenges

Cross tabulation with department

Cross tabulation of implementation barriers and department						
Barriers	Department					Total
	Assembly	Supply chain	Quality	Engineering	HR / IT / Finance	
Lack of staff with sufficient knowledge of these m	28	11	9	6	8	62
Methods are not suitable for our work environment	15	6	1	2	0	24
There is not enough time to work on these improvements	40	9	6	3	9	67
Top management is not fully supportive of the change	14	2	3	3	0	22
Employees are not consulted or informed about the	22	6	3	3	3	37
Employees are not involved in decision making process	30	9	5	5	4	53
Changes need a longer period of implementation to	31	9	5	5	7	57
Methods are too costly to implement	13	7	3	5	4	32

Cross tabulation of implementation challenges and department

Challenges	Department					Total
	Assembly	Supply chain	Quality	Engineering	HR / IT / Finance	
Coping with change	34	8	4	7	7	60
Employee resistance to change	20	9	9	8	7	53
Lack of employee motivation	23	11	8	7	6	55
Lack of employee involvement	16	8	5	7	5	41
Lack of skilled employees	23	6	6	4	7	46
Education and Training	26	9	8	4	8	55
Lack of time for change	21	4	4	2	2	33
Collaboration between different functions	21	9	4	5	3	42
Lack of adequate information	15	6	3	1	2	27
Commitment form top management	10	2	1	1	0	14

Appendix J: Success Factors

Table J (a): Significance test

Question #	Null Hypothesis	Test	p-value*	Decision
1	The distribution of "Involvement of all stakeholders is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.1533	Retain the null hypothesis.
2	The distribution of "Top management actively driving and supporting change" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.4601	Retain the null hypothesis.
3	The distribution of "Strong leadership" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.3913	Retain the null hypothesis.
4	The distribution of "Getting operator trust and commitment" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.8869	Retain the null hypothesis.
5	The distribution of "Communication of the transformation process and goals" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.3943	Retain the null hypothesis.
6	The distribution of "Removal of wasteful processes through use of MNPS methods" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.6399	Retain the null hypothesis.
7	The distribution of "Implementation of incentive system for idea management" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.0976	Retain the null hypothesis.
8	The distribution of "Training of basic lean skills to everyone" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.4947	Retain the null hypothesis.
9	The distribution of "Understanding of problems solving methods for continuous improvement" is the same across categories of Department.	Independent-Samples Kruskal-Wallis Test	0.3263	Retain the null hypothesis.

*statistically significant if $p < 0.05$

Table J (b): Statistical overview

	Not Important	Slightly important	Neutral	Important	Very Important	Mean	Standard Dev.	Variance
Involvement of all stakeholders e.g. workers, unions, management, suppliers etc.	0.00%	1.92%	4.81%	19.23%	74.04%	4.65	0.66	0.44
Top management actively driving and supporting change	0.96%	0.96%	4.81%	20.19%	73.08%	4.63	0.71	0.51
Strong leadership	1.94%	0.97%	5.83%	23.30%	67.96%	4.54	0.81	0.66
Getting operator trust and commitment	0.00%	0.99%	2.97%	20.79%	75.25%	4.70	0.58	0.33
Communication of the transformation process, goals etc.	0.97%	1.94%	3.88%	14.56%	78.64%	4.68	0.73	0.53
Removal of wasteful processes through use of Production Systems methods	0.00%	2.88%	2.88%	25.96%	68.27%	4.60	0.69	0.48
Implementation of incentive system for idea management	0.00%	0.97%	7.77%	31.07%	60.19%	4.50	0.68	0.47
Training of basic lean skills to everyone	0.00%	2.91%	0.00%	12.62%	84.47%	4.79	0.59	0.35
Understanding of problems solving methods for continuous improvement	0.00%	3.92%	0.98%	15.69%	79.41%	4.71	0.68	0.47

Turnitin Report

Turnitin Originality Report

Dissertation Second by Lindiwe Mthunzi

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