Measuring the prevailing lean culture at a South African aviation organisation

MO Alabi

25756982

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Supervisor: Mrs Rojanette Coetzee
Co-supervisor: Dr KR van der Merwe

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It all starts here ™

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Abstract

In recent times, the aviation industry has needed continuous improvement to raise customers' satisfaction levels and Lean philosophy is one of the managerial procedures that an organisation can use to achieve continuous improvement efficiency. In South Africa, the aviation industry is playing a significant role in the national economy and in the economies of other Southern African states and serves as a means of job creation for numerous South African. The commercial aviation industry is contributing ZAR50.9 billion (2.1%) to South African Gross Domestic Product (GDP). A South African aviation organisation is well-positioned to support this industry and to assist with regional growth emanating from related maintenance and manufacturing activities, and through this platform a South African aviation company will remain competitive. The purpose of this study was to contribute to more successful implementation of Lean manufacturing and continuous improvement philosophy in an aviation environment in South Africa and a South African aviation organisation was used as the case study for the research.

The primary aim of this research was to measure the prevailing Lean culture at a South African aviation company and to assist the aerospace company Lean culture implementation. Lean manufacturing has become a new production philosophy for many organisations to employ. An effective Lean culture implementation improves organisational competitiveness and sustainability by eliminating waste and creating organisational value. An in-depth literature study was conducted to gain insight into Lean philosophy and Toyota Production System (TPS). The literature study covers the evolution of Lean production, Lean culture, culture itself, and organisational culture. The fourteen management principles of the Toyota way were also reviewed in the literature study because the management principles of the Toyota way could help Lean organisations to shape their understanding of the Lean culture. The literature study revealed that most Lean culture failures have to do with inability of the management to monitor the Lean implementation journey.

This research employed a quantitative research method. A measuring instrument (i.e. structured questionnaire) was used to carry out a survey at a South African aviation company. The questionnaire was divided into both dependent variable (prevailing Lean culture) and independent variables (Awareness, Engagement, Consistency, and Accountability). The data was collected, analysed and interpreted appropriately. All the results returned acceptable reliability coefficient Cronbach alpha 0.70 above and this suggests that all items have a relatively high

internal consistency. The entire null hypotheses (H0) were accepted based on the effect size and the significant value *P* (i.e. *P* >.05).

The research results identified both the weakness and strength of the prevailing Lean culture at a South African aviation company and showed areas of improvement as relating to Lean culture. Based on the data interpretation, conclusions and recommendations were drawn. Suggestions for future research were provided.

Key Words

Prevailing Lean culture, Lean manufacturing, Continuous improvement, Learning , Lean thinking, Toyota's organisational learning, Organisational culture, Employee perception, Lean transformation, Statistical consultation service, measuring instrument, reverse scored, Toyota Production System, Toyota Way, Management principles, Lean philosophy.

Declaration

I hereby declare that this dissertation being submitted in partial fulfilment of the requirements for the degree of Master of Engineering in *Development and Management Engineering* at the Potchefstroom Campus of the North-West University is my own work and has been language-edited in accordance with the requirements.

The research has not been submitted before for any degree or examination in any other university in South Africa and abroad. I understand and accept that the copies that are submitted for examination become the property of the North-West University.

Micheal O. Alabi
November 2015.

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GDP:	Gross Domestic Product
IATA:	International Air Transport Association
JIT:	Just-in-Time
LE:	Lean Enterprise System
MRO OPS:	Maintenance Repair and Overhaul Operations
NUMMI:	New United Motor Manufacturing, Inc.
NWU:	North-West University
SOC:	State Owned Companies
SAAF:	South African Air Force
SARA:	South African Regional Aircraft
TPS:	Toyota Production System

Chapter 1

1. Introduction

This chapter presents the background information for the study, problem statement, research aim, objectives, questions and research methodology are presented in the chapter. In summary, the research layout is described briefly.

1.1 Research background

According to Graham-Jones *et al.* (2014), the aviation industry currently requires continuous improvement to raise customer satisfaction levels and such can be achieved through Lean management philosophy. Through the literature review, it was realized that limited research was conducted on Lean implementation in the aviation industry in South Africa and this led to the motivation for this research study using a South African aviation company as case study. The key challenge facing the chosen South African aviation company at the moment is "low volume" in production and as a result of this; the company is striving to reduce waste and to operate more efficiently in a low volume and high technology environment in South Africa.

The chosen South African aviation company for this research purpose decided to embark on the Lean Journey in 2008 because the company needed to be more competitive among other aviation companies in South Africa and globally. Besides the automobile industry, many organisations have embarked on the Lean journey in order to improve their competitiveness and create sustainability especially in a very competitive (and capital-intensive) industry.

Lean implementation was carried out at a South African aviation company (the case study for this research) in 2009 by a group of aerospace and defence consultants from CPMIL (Counterpoint Market Intelligence Limited, United Kingdom). According to the manager of engineering training and development at the aviation company, he says "The topic (Lean) was researched and planned during 2008 with the final plan in November 2008. The implementation started in April 2009 and the bulk of the changes were completed by end of 2009". In the light of the Lean implementation at the case study company, the aviation company was chosen as the case study for this research. Besides the automobile industry, many organisations have embarked on the Lean journey in order to improve their competitiveness and create sustainability especially in a very competitive (and capital-intensive) industry.

The purpose of this study is to contribute to more successful implementation of Lean manufacturing and continuous improvement philosophy in an aviation environment in South Africa with distinct reference to a South African aerospace company. The commercial aviation industry is a critical strategic component of the South African economy and more so the economies of all the states in Southern Africa (IATA/defenceweb, 2011). The commercial aviation industry is contributing ZAR50.9 billion (2.1%) to the South African Gross Domestic Product (GDP). The case study company is well-positioned to support this industry and to assist with regional growth emanating from related maintenance and manufacturing activities, and through this medium the aviation company will remain competitive (Oxford Economics, 2011:p3-4).

According to Kariuki (2013) Lean reduces manufacturing cost, shortens development and manufacturing cycle times and enhances enterprise competitiveness and sustainability. Besides the automobile industry, Lean manufacturing philosophy has been extended to construction, health systems, machinery manufacturing, engineering, electronics, consumer goods, aerospace and shipbuilding and so on. Lean philosophy has become another milestone of the 21st century production method after mass production method (Kariuki, 2013). Due to the degree of challenges from global competitors, Lean manufacturing has become a production philosophy for many s to pursue (Kariuki, 2013). One of the reasons why the case study company for this research needed to embark on a Lean journey is to improve competitiveness and create sustainability.

This study employed a diagnostic tool designed by Dr Karl van der Merwe (2011); a Lean researcher and manager for the Unit for Lean Process Development (ULPD) at the Nelson Mandela Metropolitan University, South Africa. This study is an extension of his research work on Lean culture and leadership behaviour. In recent years, Dr Karl van der Merwe has conducted research on Lean culture and among his research works are *Lean culture causal framework to support the effective implementation of Lean in automotive component manufacturers in South Africa (2011), the development of a Lean culture diagnostic tool (2014), the development of a theoretical Lean culture causal framework to support the effective implementation of Lean in automotive component manufacturers (2014), and leadership behaviour and Lean*.

Dr Karl van der Merwe's (2011) diagnostic tool (questionnaire) has been utilised in an automobile environment in South Africa. The questionnaire was designed based on one

dependent variable (to examine the prevailing of Lean culture in the organisation) and four categories of independent variables namely:

- **Awareness:** The degree to which managers have successfully implemented Lean culture with an aim to create a shop floor environment that responds to situational awareness.
- **Engagement:** The degree to what extent the management has actively engaged and challenged the employees within the Lean department.
- **Consistency:** The degree to determine the consistency of the management actions, if it guided and supported by the vision and mission of the organisation Lean culture.
- **Accountability:** This considered the two factors in the development of a Lean culture; namely exercising corrective actions and corresponding follow-up processes.

According to Straub (2010) the concept behind Lean is simple but sustaining a Lean system is a long term problem which is problematic. He describes Lean as a process of removing waste from any process throughout the organisation. Straub (2010) illustrates that to sustain long term Lean practices is an ambitious goal and a proven way to achieve and maintain it, is through developing an effective Lean culture. A Lean culture encourages all workers to contribute ideas, respond quickly to suggestions for improvement, provide a collaborative learning environment, seek perfection in its products, services and processes, and enjoy the visible support of all employees and leaders (Straub, 2010).

Straub (2010) explains further that the benefits of Lean culture and Lean leadership include retention of good employees, an improved bottom line, sales and revenue growth and sustainable improvements. Companies can realize short-term gains by spending money on training and new equipment but without building a Lean culture, sustaining long-term gains are unlikely. Therefore, "*Lean culture is crucial in generating long-term results and continuous improvement. It is more than a technique; it's a way of life"* (Straub, 2010).

Oliver *et al.* (1996) conducted a large cross-country analysis and demonstrated that Lean manufacturing can create high-performance companies and that transition from a traditional manufacturing system to a Lean manufacturing system is not an easy exercise. Oliver *et al.* (1996) maintain that such a transition requires attention that will have an influence on both the people and processes. Existing research studies and findings from numerous researchers as shown in figure 1.1 below and identified various barriers contributing to the failure of Lean

manufacturing implementation in many modern Lean organisations and such barriers can delay or prevent the success and progress of Lean culture.

	Authors										
	Sohal and Eggelestone (1994)	Mathaisel and Comm (2000)	Bamber and Dale (2000)	Stewart (2001)	Crute et al.(2003)	Melton (2005)	Bonavia and Marin (2006)	Worley and Doolen (2006)	Real et al.(2007b)	Lee-Mortimer (2008)	Scherrer-Rathje et al.(2009)
Misunderstanding the concept and purpose of lean	×		×		×		×			×	
Lack of resource availability (time, expertise, financing)	×				×	×	×		×		
Cultural differences	×	×				×		×			
Lack of clear communication			×					×			×
Lack of top management support for change			×	×						×	×
Lack of interest in and commitment to lean				×							×

Figure 1.1 Barriers to Lean manufacturing implementation
Source: Nordin and Baba (2013)

According to Nordin *et al.* (2013) misunderstanding of the real concept and purpose of Lean culture is the major barrier to Lean implementation. In most cases, the reason for this misunderstanding is to be found in the cultural differences that arise while changing to Lean philosophy (Herron & Braiden, 2007). According to Jorgensen *et al.* (2007) the misunderstanding of the Lean philosophy can result in failure to develop a Lean culture that can support effective Lean implementation in the organisation. From figure 1.1, four researchers (Bamber & Dale, 2000; Stewart, 2001; Lee-Mortimer, 2008; Scherrer-Rathje *et al.*, 2009) identify lack of top management support for Lean culture as a barrier to successful Lean implementation.

Lean implementation is a systemic and continual effort; therefore, it is important to identify and understand the barriers to a smooth transition (Nordin *et al.*, 2013). As Lean manufacturing requires new knowledge and culture change during the transition, it is essential to approach implementation correctly, (Nordin *et al.*, 2013). The transformation to a Lean manufacturing system requires both radical and gradual change involving a total reshaping of the purpose,

system and culture of the (Nordin *et al.,* 2013). There are many variables that can influence a Lean culture as listed below:

- Lean training for employees;
- situational awareness;
- employees engagement;
- managers involvement at shop floor;
- consistency in leadership behavioural patterns; and
- Accountability from employees and managers.

According to Womack and Jones (2003) successful Lean implementations have shown that leadership, commitment and participation by top management are the most critical factors in s embarking on Lean implementation, as they ensure a smooth management and system rollout. Not only is the requirement for setting the vision and developing a solid strategic plan, but it is also for boosting the energy, creativity and involvement of employees to a self-sustaining (Womack & Jones, 2003 as referenced by Simões, 2008). *Therefore, the top management needs to constantly monitor the progress of the Lean implementation and provide direction to the implementation teams* (Simões, 2008).

1.2 Problem statement

In a Lean organisation, the management (top, middle and operational management) might say they are experiencing continuous improvements on Lean implementation while the employees might see management actions as a major barrier to the Lean implementation in the organisation.

When it comes to Lean implementation the employees' perceptions of managerial actions or behaviours are more important than espoused managerial actions (i.e. the behaviours managers think or say they are exhibiting), van der Merwe (2015).

The problem is that *in most Lean organization, the management and employees are not always aware of the impact that their influences have on Lean transformation and these actions are standing as strong barrier or obstacles to their Lean journey in the organization and the reason is that such actions are not being measured either qualitatively or quantitatively.*

1.3 Research questions

A research question is the fundamental core of a research project, study, or review of literature, (Biddix, 2009). Biddix, (2009) further explains that a research question begins with a research problem, an issue someone would like to know more about or a situation that needs to be changed or addressed". Therefore, this research study will answer the following questions:

- What is Lean and more specifically what is a Lean philosophy? Why do lean implementations fail? What role does organisational culture play in this regard?
- What is organisational culture? Could the fourteen management principles of Toyota way help shape the Lean culture transformation? Are the fourteen management principles so important in Lean culture management?
- Can culture be measured qualitatively and quantitatively?

1.4 Research aim

Therefore, the aim of this research study is to measure the prevailing Lean culture at an aviation company in South Africa.

1.5 Research objectives

There are three objectives for this research study as listed:

- To conceptualise Lean management according to the literature study that could answer the research questions mentioned above.
- To apply an existing tool (a questionnaire) to measure and analyse the prevailing Lean culture at a South African aviation company.
- To provide conclusions and recommendations thereby contributing to more effective Lean culture implementation.

1.6 Research scope

Due to the large amount of information and tools within the Lean philosophy, the project is limited to Lean culture and the focus will be kept within a South Africa aviation company.

1.7 Research procedures and experimental facilities

For effective data collection, the maintenance repair and overhaul (MRO OPS) and Depot Level workshop environment within a chosen aerospace company will be considered for a questionnaire survey. In order to meet the aim and objectives of this study, the current research methodology is further divided into two main parts, namely pre-study, which is the preliminary phase in the research study and main study which is the pre-eminent phase in the research study. The research design is diagrammatically described in figure 1.4 and was clearly explained in detail in chapter 3.

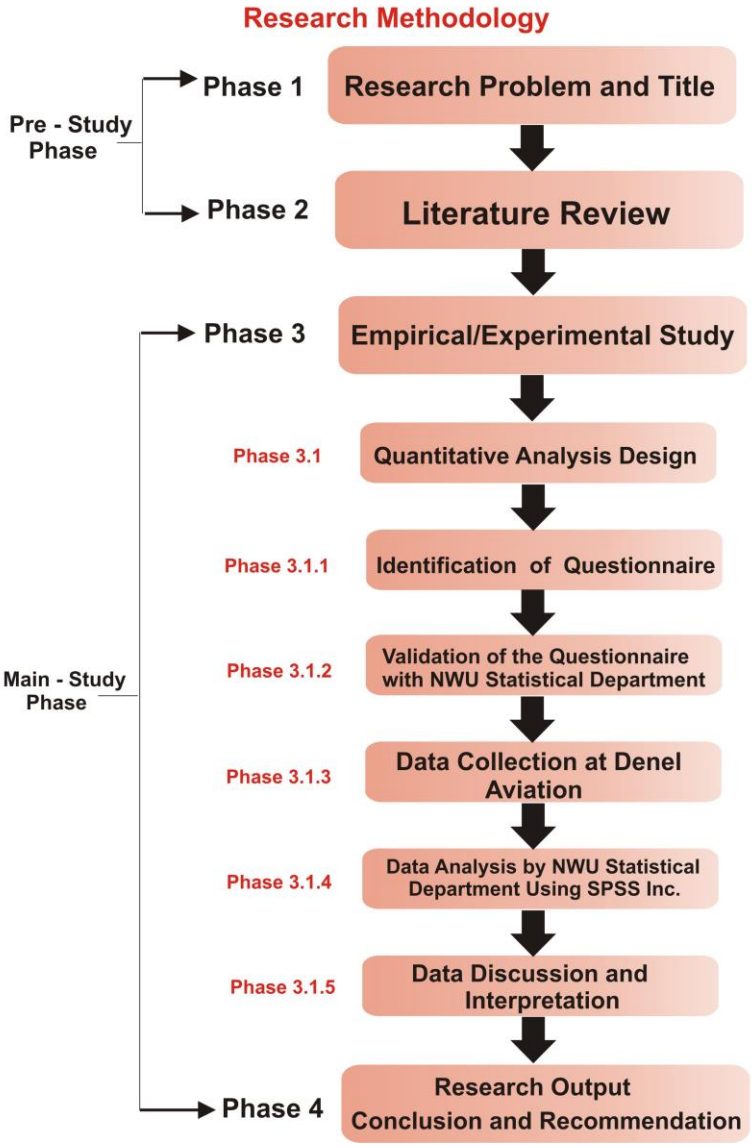


Figure1.2 Research design

1. 8 Research layout

This dissertation is divided into six chapters from the introductory chapter to a conclusion.

Chapter1: Introduction:

This chapter presents the research background, problem statement, research aim and objectives, method of investigation (research methodology) and the research layout is described with a brief explanation.

Chapter2: Literature review

This chapter explores Lean as a philosophy and the importance of organisational culture change within organisations attempting to adopt Lean philosophy. This chapter further contains an in-depth review of the fourteen management principles of the Toyota way which have helped many Lean organisations to shape their understanding of Lean culture as explained by Liker (2004).

Chapter3: Empirical investigation

This chapter provides an in-depth explanation of the method of investigation employed in the research study. This chapter covers the process of analysing the data, the criteria for selecting the appropriate questionnaire and identification of unit of analysis.

Chapter4: Empirical results and finding

This chapter explains the results and findings in line with the empirical investigation stated in Chapter 3. The variables used in the measuring instrument (questionnaire) were clearly explained and the most widely used statistical terminologies were briefly explained.

Chapter5: Discussion and interpretation

This chapter presents the discussion of the result and interpretation of the empirical findings based on the statistical analysis of data collected at a South African aviation company. The descriptive statistics were explained. A hypothesis testing was conducted and the appropriate hypothesis was accepted.

Chapter6: Conclusion and recommendation

This chapter finalized the research by means of a concluding statement and recommendations. The future research study was suggested as well.

1.9 Chapter summary

This chapter provided an insight into the broader perspective of the research study and serves as the introductory chapter for the remaining five chapters. The research problem was identified; the research questions, the aim and the objectives were listed accordingly.

The next chapter explores Lean as a philosophy and the importance of organisational culture change when organisations attempt to adopt Lean philosophy. Chapter 2 further contains an in-depth review into the fourteen management principles of the Toyota way which has helped many Lean organisations to shape their understanding of Lean culture.

Chapter 2

2. Literature review

This chapter presents the literature review from various articles, reports, publications and books on Lean culture, Lean concepts, Lean transformation, Lean Implementation, Lean tools, organisational culture and etc. An in-depth review of the entire fourteen management principles of the Toyota way was done, and the purpose of the fourteen management principles is to assist Lean organisations to shape their understanding of Lean culture especially for organisation trying to adopt Lean philosophy. The majority of the literature reviewed centred on the Toyota way, the Toyota culture and the Lean philosophy owing to the fact Lean philosophy was invented by the Toyota Company.

2.1 The history of Lean

According to Salinas-Coronado *et al.* (2014) Lean is a continuously developing philosophy because it has different applications for each and every organisation. Most people think that Lean manufacturing began with Toyota while some people traced it as far back as Ford with his Model T Ford when introducing production lines. Lean has a very long history as described in the (Table 1.1).

The Term "Lean" has had a number of names over the years; originally Lean manufacturing was developed from the Toyota Production System known as (TPS) and was called World Class Manufacturing (WCM) and later called Continuous Flow Manufacturing, and Stock-Less Production etc. (Salinas-Coronado *et al.* 2014). After an in-depth research study at MIT the eventual name came from the book *The Machine that Changed the World* by Womack *et al.* (1990).

Womack *et al.* (1990) describe the Toyota Production System and the revolutionary influence that Lean had on the World's Car Manufacturing Industry. Toyota had an aim to compete on the world's car manufacturing stage, but at that time, Toyota lacked the necessary resources to do so. According to Womack *et al.* (2009) Toyota rethought their manufacturing process and thereby Toyota gained a competitive edge and cut the production costs drastically and improved the quality of their product,

Womack (2003) argues that Lean thinking can be applied to all kinds of processes and organisations (such as logistics, health care, government establishment, construction project,

engineering, service delivery, administration, IT and etc.) and not limited to manufacturing environments alone. The table 1.1 below elaborated on the history and timeline of Lean.

Table 1.1 Lean manufacturing history and timeline

2000 – 2010	**2007:** Application of Lean manufacturing concepts in the manufacturing industry mass production increased, concepts like SMED (Single-Minute Exchange of Die), TPM (Total productive Maintenance), VSM (Value Stream Mapping), Jidoka, Kaizen and etc. **2004:** Shingo Prize-winning "Kaikaku" published by Norman Bodek, Chronicling the history and personal philosophies of the key people that helped developed TPS (Toyota Production System) **2003:** Shingo Prize-winning "Better Thinking, Better Results" published, case study and analysis of The Wiremold Company's enterprise-wide lean transformation.
In the 1990s	**1996:** Lean Thinking by Womack and Jones **1990:** The Machine That Changed the World by Womack and Jones
In the 1980s	**1988:** Kaizen Institute of America holds Kaizen seminars at Hartford Graduate Center (Hartford, Conn) with TPS sessions taught by principals from Shingijutsu Co. Ltd. **1988:** Shingo Prize for Manufacturing Excellence created by Norman Bodek and Professor Vern Buchler of Utah State University
1960s	**1969:** Start of Toyota operations management consulting division **1965:** Toyota wins Deming Prize for Quality **1961:** Start of Toyota corporate wide TQC (Total Quality Management) Program
1950s	**1956:** Shgeo Shingo begins regular visits to teach "P-Course" **1951:** J.M. Juran publishes his seminar work "The Quality Control Handbook"
1940s	**1946:** Ford adopts GM management style and abandons Lean manufacturing **1943:** Taiichi Ohno transfers from Toyoda Auto Loom to Toyota Motor Corporation **1940:** Deming develops statistical sampling methods
1930s	**1939:** Walter Shewhart publishes Statistical Methods from the view point of Quality Control. This book introduces his notion of the Shewhart improvement cycle Plan-Do-Study-Act. In the 1950s his colleague W Edwards Demming alters the term slightly to become the Plan-Do-Check-Act cycle. **1938:** Just-in-time concept established at Koromo/Honsha plant by Kiichiro Toyoda. JIT was later severely disrupted by World War II
1920s	**1929:** Sakichi Toyoda sells foreign rights to loom and Kiichiro Toyoda visit Ford and European companies to learn the automotive business **1926:** Henry Ford publishes Today and Tomorrow
1910s	**1914:** Ford creates the first moving assembly line, reducing chassis assembly time from over 12 h to less than 3 h **1912:** The Ford production system based on the principles of accuracy, flow and precision" extends to assembly.

Source: Salinas-Coronado *et al.* (2014:6-7)

1900s	**1908:** Ford introduces the Model T **1906:** Italian economist Vilfredo Pareto creates a mathematical formula to describe the unequal distribution of wealth in Italy. He notices that 80% of the wealth is in the hands of 20% of the population. **1905:** Frank and Lillian Gilbreth investigate the notion of motion economy in the workplace. Studying the motions in work such as brick laying they develop a system of 18 basic elements that can depict basic motion.
1890s	**1890:** Sakichi Toyoda invents a wooden handloom
1850s	**1850:** All of the America armories were making standardized metal parts for standardized weapons, but only with enormous amounts of handwork to get each part to its correct specification. This was because the machine tools of that era could not work on hardened metal.
1800s	**1807:** Marc Brunel in England devised equipment for making simple wooden items like rope blocks for the Royal Navy using 22 kinds of machines that produced identical items in process sequence one at a time
1790s	**1799:** Whitney perfects the concept of interchangeable parts when he took a contract from the U.S. Army for the manufacture of 10,000 muskets at the low price of $13.40 each.
1760s	**1760:** French general Jean-Baptiste de Gribeauval had grasped the significance of Standardized designs and interchangeable parts to facilitate battlefield repairs.

Source: Salinas-Coronado *et al.* (2014:6-7).

2.1.1 The term 'Lean Production'

The Toyota Production System is often known as "Lean" or "Lean Production" outside the Toyota Company. The term was made popular in the two bestselling books *The Machine That Changed* the *World* by (Womack, Jones & Roos, 1991) and *Lean Thinking* by (Womack and Jones, 1996). Lean is originally known as Lean Manufacturing, but today, most organisations, engineers, people and Lean specialist simply call it Lean. Lean is precise and effective in breaking things down and making the waste easy to identify. It was recorded that the term "Lean" was coined by an MIT graduate John Krafcik in an article in 1988.

According to (King, 2009) the two pillars needed to support Lean are *Just-in-Time and auto-nomination, or automation* with a human touch. The components of Toyota Production System are often depicted in the form of a house as shown in figure 2.1 (King, 2009).

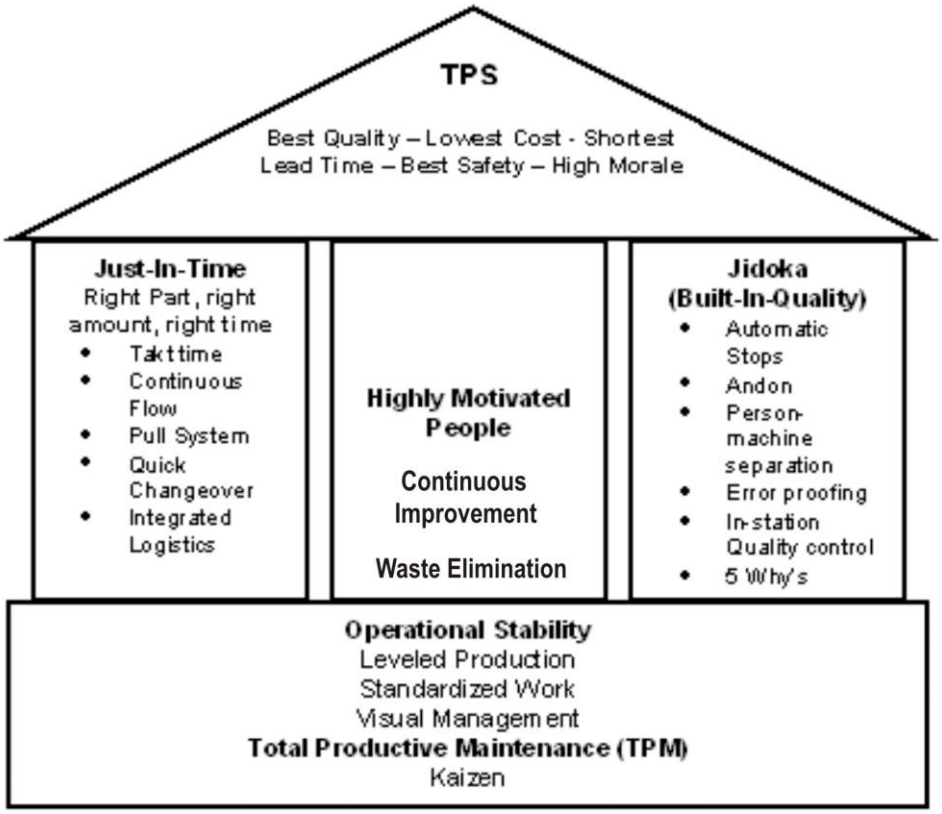


Figure 2.1 Toyota Production System house

Source: (http://www.emsstrategies.com/dm050104article2.html)

Taiichi Ohno is the inventor of Toyota Production System (TPS) and Lean Manufacturing. Taiichi Ohno explains the TPS house that the left pillar is *Just-in-Time*, which is defined as making just what the customer needs, when the customer needs it, in exactly the right amount (cited by King, 2009).

The *Just-in-Time* pillar needed some support which includes continuous flow, pull replenishment systems, integrated logistics and quick product changeovers. From the TPS house, the essence of Lean is to eliminate all wastes on an ongoing basis (King, 2009).

The *Jikoda* is the right pillar on TPS's house (i.e. building-in-quality) which means to ensure quality by sensing defects and therefore stopping the production until the root causes have been detected and fixed. The manufacturing rate must equal the exact customer demand at the time the customer wants it known as *JIT* (King, 2009).

2.1.2 The five Lean thinking principles

Womack and Jones' (2003) book titled *Lean Thinking* defines Lean manufacturing as a five-step process: defining customer value, defining the value stream, making it 'flow', 'pulling' from the customer back, and striving for excellence. According to Womack and Jones (2003) the five Lean principles should serve as a framework for any organisation in order to implement Lean thinking.

Womack and Jones (2003) further observed that only a small fraction of the complete time and effort usually adds value for customer production and service delivery. Therefore, it is important for a Lean organisation to clearly define value during production processes from the customer's perspective and thereby eliminating non-value activities step by step. Table 1.2 below gives a further illustration of the five Lean thinking principles.

Table 1.2 Five basic Lean thinking principles

Lean Principle	Definition
1. Value	**Value** defines what really matters to the external customer or end user. The paying customer defines the value of the product and the reason a company exists. Knowing what the customer values and understanding the business conditions for meeting this defines the day-to-day value-adding activities required for the company. Determining value is a critical stating point in thinking lean, as it determines the success of the other four principles.
2. Value Stream	**A value stream** represents all the value-added and non-value-added activities required for a company's product and services to flow from concept, development, transformation of raw material, and delivery to and payment from a customer. A perfect value stream ensures that every business activity adds value to the product (customer value). Lean thinking maps the value streams to facilitate eliminating wastes and achieving flow.
3. Flow	**Flow** eliminate the non-value-adding activities in the value stream so that products and services flow continuously from concept to delivery to the customer. Continuous flow through various operations is achieved by determining the needs of the customer and the pace (time) at which the value stream must flow to meet these needs with the least amount of delay or waiting. Just-in Time (JIT) or pull systems enable flow.
4. Pull	**Pull** is a material replenishment system initiated by consumption or by actual customer orders, wherein the upstream supplier produces something only when the downstream customer signals a need. Pull enables the value stream to produce and deliver the right materials at the right time in the right amounts with minimal inventory.
5. Perfection	Perfection is the ideal of eliminating all waste along the value stream to achieve continuous flow. Applying the other four Lean principles enables an operation to move toward perfection through continuous improvement (Kaizen).

Information source: King (2009)

2.1.3 The eight Lean thinking wastes

The father of Toyota Production System, Ohno (1988) identifies seven wastes of Lean manufacturing. These seven types of wastes are referred to as "unproductive manufacturing practices" and are integral part of the Toyota Production System. As thought and knowledge increases, the 8th waste was added to the original seven wastes proposed by Ohno (1988) which is the "Human Factor", i.e. wasting the potential or ability in people or team members such as unused creativity, human potential, skills, human intellect, and under-utilized talent.

In many manufacturing environments, the acronym DOWNTIME is being used to remember the eight Lean manufacturing wastes as shown in table 1.3.

Table 1.3 Eight Lean manufacturing wastes

Type of Wastes	Definition	Examples From the Manufacturing Environments Perspective
Defects	Not meeting customer expectations the "first" time; abortive work, reworking or correcting work. The key point of Japanese quality achievement came with the switch from Quality Control to Quality Assurance – efforts devoted to getting the process right, rather than inspecting the results.	Scrap, rework, replacement production, inspection
Over-Production	Adding excess value to the product or service when the customer does not require it. Another Japanese guru who contributed to this change is Shigeo Shingo who led Toyota's move from long set-ups to Single Minute Exchange of Die (or SMED).	Manufacturing items for which there are no orders
Waiting	Idle time incurred as a result of waiting for another process, machine, tool, materials or information. Taiichi Ohno looked at the reasons for machines or operators being under-utilised and set about addressing them all	Stock-outs, lot processing delays, equipment downtime, capacity bottlenecks
Non-Utilized Intellect	Not utilizing the time and talents of people. Failing to tap into the human potential and creativity of your workforce. The greatest failures and "wastes" in manufacturing today	Lost time, ideas, skills, improvements, and suggestions from employees
Transportation	Wasted effort in moving from one place to another; wasted effort in transporting materials, work-in-progress and finished goods into or out of storage, or between processes	Transporting work-in-process (WIP) long distances, trucking to and from an off-site storage facility
Inventory	Building or storing extra products or services the customer has not requested. The element that Western industry immediately focused upon when confronted with JIT was the cost reduction available from holding less inventory	Excess raw material, work-in-progress (WIP), or finished goods
Motion	Extra physical/mental motion that does not add value to the product or service. people spending time moving around the plant is equally wasteful.	Reaching, bending or unnecessary motion due to poor ergonomics and office layout. searching for tools; lack of or sub-optimal standard operating procedures (SOP)
Excess- Production	Producing more than what the customer needs; producing faster than the customer requires it. Working harder than we need may be the most obvious form of waste. A basic principle of the TPS is doing only what is appropriate.	More parts, process steps, or time than necessary to meet customer needs

Information Source: (http://www.epa.gov/lean/environment/studies/types.htm) & (http://www.oeconsulting.com.sg/#!lean/cm8k, http://www.mlg.uk.com/html/7w.htm)

2.1.4 What is value

Womack and Jones (2003) define "value as a capability provided to customer at the right time at an appropriate price, as defined in each case by the customer", and further explain that Value is the critical starting point for Lean thinking, and can only be defined by the ultimate end customer. Therefore, all the activities in any organisation can be classified into two categories:

- Value-adding activities, and
- Non-value adding activities

Table 1.4 Value and non-value activities in 'Lean thinking'

Activities	Explanations	Examples
1. Value Adding	Activities that transform raw materials and information into products or services which the customer is willing to pay for	Examples include taking orders, ordering materials, laying foundations, creating codes, assembling parts and delivering of goods to customers.
2. Non-Value Adding	Activities that add costs, consume time, space, or other resources but do not create value for customers. Customers are not willing to pay for these activities.	Examples are waiting, moving, storing, searching, counting, checking, inspecting, testing, reviewing and obtaining approvals.

2.2 Lean thinking for sustainable competitive advantage

Barney (1991:102) defines the concept of sustained competitive advantage as follows "a firm is said to have a sustained competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy". Lewis (2000) explains that sustainable competitive advantage comes into play through the dynamic interplay between an organisation and its external environment. Lewis (2000) further defines "competitive advantage as the result of a business being either a particularly able player in its market (i.e. being better, which could mean being lower cost or more Lean) and/or, being differentiated in what it offers".

According to Standard and Davis (2004) from the Toyota Company perspective, it is believed that "productivity in the manufacturing sector is rising steadily and has increased by 35% since 1995 and this implies that manufacturers must improve continually just to keep pace with the competition". Standard and Davis (2004) explain that 21st century manufacturing companies can improve productivity and production performance with good profit and as well build sustainable strategic advantages over their competitors by simply implementing or inculcating Lean thinking into their organisational operations.

Crute *et al.* (2008) conducted research in the United Kingdom and the aim of the research was to explore competitive advantage through Lean implementation in the aerospace supply chain. Crute *et al.* (2008) used three small and medium-sized enterprises *(*SMEs) in the aerospace industry as a case study for the research, qualitative semi-structured interviews were conducted which resulted in an exploratory multi-case study. The research findings of Crute *et al.* (2008) indicate that small and medium-sized enterprises (SMEs) considered Lean implementation "as a necessity to meet the growing demands of their customers and to remain profitable in an increasing competitive environment".

Crute *et al.* (2008) stress that "the sustainability of Lean as a source of competitiveness requires that the firms make available adequate resources to maintain the momentum of its continuous improvement programmes". Crute *et al.* (2008) conclude their findings based on the interviews conducted at the three small and medium-sized enterprises that Lean implementation has led to diverse benefits for the small and medium-sized enterprises. The conclusion arrived at by Crute *et al.* (2008) says that the "assumption cannot be made that Lean initiatives directly provide sustainable competitive advantage, as this is dependent on a number of complex and interdependent issues". Some other literature sources such as (Lewis, 2000; Standard & Davis, 2004; Gort, 2008; Zurn & Mulligan, 2013) have also shown that Lean implementation can provide a sustainable competitive advantage.

2.3 Lean as a Philosophy

According to Bhasin (2015) it is very important to know that "Lean as a concept is considered as a philosophy rather than as a process". Globally, customers are becoming more demanding, markets are becoming more competitive. Ohno (1988) clearly emphasised "how the Toyota Production System was considerably more than a production system, but a Lean complete management system" and therefore, Comm and Mathaisel (2000) insist that "Leanness is [a] relative measure" as cited by (Bhasin, 2015). Lean culture needs the commitment from all the different levels within the Lean organisation. Bhasin (2015) maintains that "for a successful Lean implementation, organisations need to separate the Lean philosophy from the techniques and tools used to support the philosophy. It is a composition of techniques embraced from a structure that has been derived from a philosophy. Lean must always be observed as a philosophy with the tools".

Bhasin (2015) describes Lean as challenging the way in which things are being done and opening our eyes to that waste and inefficiency. Liker (1996) viewed Lean as "a philosophy that

when implemented reduces the time from customer order to delivery by eliminating sources of waste in the production flow". Bhasin (2015) stresses that "Lean philosophy may need to be modified to be relevant in different business, social or cultural backgrounds; this is the aspect which besides making it difficult is also a fascinating concept". Most Lean organisations need to acknowledge that "they are either on the journey or they are not; you actually never reach a destination". According to Campbell (2006) as cited by (Bhasin, 2015) that the minute you think you've reached a destination, you're actually done. You're off the journey. Therefore, Lean implementation is a journey and never an end state.

Implementing a Lean philosophy is not an easy task and it has been recorded that most Lean failures have something to do with the organisational culture (Utley *et al.*, 1997) and (McNabb & Sepic, 1995). Therefore, it is very important of Lean organisation to ensure that the right culture exist amidst organisation's employees in order to allow the production processes to reach the full benefits of Lean (Henderson *et al.*, 1999). Lean can be regarded as a philosophy, the reason being that the more organisation's employees buy into the Lean culture belief the better for the organisational Lean transformation and this will facilitate the Lean implementation process in the organisation (Vasilash, 2000).

2.4 Reasons why Lean transformation fails

McMahon (2013) believes that "when Lean principles are properly understood and applied, the upside for productivity improvements is nearly infinite". According to McMahon (2013) recent research studies conducted on Lean transformation from various Lean thinking initiatives have recorded that "failure rates for Lean programs range between 50 percent and 95 percent". McMahon (2013) stresses further that the basic reason why the Lean implementation fails at most Lean organisations boils down to the culture that is prevalent in the organisation.

McMahon (2013) in his article *Reasons why Lean transformation fails* and coupled with his ten years' experience within Lean manufacturing industries, stated ten reasons why Lean implementation fails as listed below:

- **Lack of rightful Lean strategy** – Organisations need to set proper strategies. The strategy should anticipate problems and recovery scenarios. The organisations have to determine the vision and direction to follow earlier. Clear metrics and timelines have to be defined.
- **Lack of Leadership Involvement** – Success of any Lean culture requires top to bottom leadership. The leadership has to be a passionate part of the Lean team.

- **Relying on Lean Sensei/Champion -** Lean organisation needs a sufficient number of Lean expertise among Lean department staff for Lean to work at the initial stage before spreading across other departments. McMahon (2013) stresses that without a strong implementation team, Lean deployment or implementation can fail before it even starts.
- **Copying other Lean organisations** – Effective Lean implementation has to be closely related to the organisation's management philosophy. Imitating other organisations Lean successfully might not work for another organisation because different organisations apply different Lean tools which might not suit another organisation.
- **Thinking Lean is a tool –** As stated by McMahon (2013) "Lean implementation cannot be treated as a delegated 'project'. Lean manufacturing is not a project. It is a fundamental change in the value delivery system. Top management must be in front of Lean transformation".
- **Lack of customer focus** – One major focus of Lean is to provide customer with value. Therefore, Lean management philosophy works hand in hand with customer focus.
- **No employee engagement** – To avoid Lean implementation failure, employees must participate in Lean project decision-making. Most times a lack of employee engagement usually affects employee productivity, innovation and their word satisfaction as well. McMahon (2013) maintains that "if workers participate in decision making, decisions will be made with better pools of information".
- **Lack of Lean training for employees** - Continuous Lean training is very essential. For effective Lean implementation, employees need to be educated.
- **Lack of understanding –** McMahon (2013) stresses the fact that "Most management teams don't understand Lean. When we don't understand something it is next to impossible to support it. This lack of understanding of Lean by management allows even the most subtle of things to derail Lean efforts".
- **Conflicting Metrics** - McMahon (2013) explains that "Lean requires metrics that focus on the processes of value creation and their associated costs. Lean accounting ties directly to financial measures but focuses on performance of the entire value delivery system".

In conclusion, McMahon (2013) explains that Lean implementation is not an easy task; however, the ten Lean implementation failures mentioned above can be avoided or overcome if Lean organisations can follow the proper implementation philosophy. He believes that "Lean lives up to its promises. Lean and its elements work". McMahon (2013) suggests that if an organisation

want to succeed in its Lean transformation, management has to become a student of Lean in order to be a successful sponsor, i.e. the organisation needs to apply Lean to their management process first and it will help them to apply it to other parts of the organisation process as well.

2.5 The Lean culture

Zarbo (2012) explains that "a successful Lean culture of continuous improvement is a work environment in which the leader can walk away and empowered employees can sustain themselves in pursuing higher quality targets by implementing continuous process improvements". Henry Ford (1926) said in his book 'Today and Tomorrow" that "Quality is doing it right when no one is looking".

According to Miller (2011) Lean culture is the inclusion and engagement of every employee in continuous improvement. Rubrich (2010) describes a Lean culture as one of the four components of a successful Lean implementation and explained that Lean implementation consist of four components, namely *Lean planning, Lean concepts, Lean tools and Lean culture*. Figure 2.2 shows the entire purpose of Lean implementation component at a glance (Rubrich, 2010).

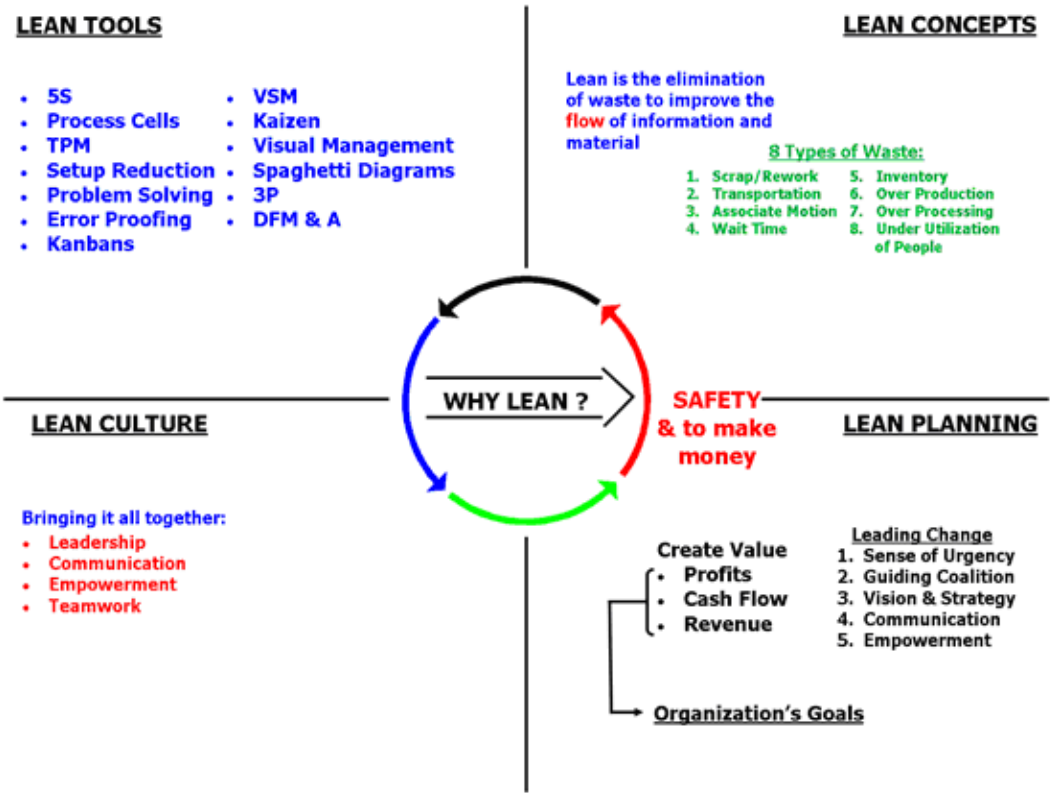


Figure 2.2 Four Lean Implementation Components Source: Rubrich (2010)

According to Rubrich (2010) the purpose of Lean planning is "to ensure that we are not using Lean as an add-on or attachment in manufacturing industries, but to be seen as the system to accomplish the organisation's goals". In a timely manner and for a successful Lean culture implementation, the four Lean components must be implemented to their fullest extent throughout the organisation. Manufacturing industries don't have to choose one element of the Lean component and implement it because Lean is a total system and it represents a complete and comprehensive culture change in an organisation (Rubrich, 2010).

A Lean culture will not develop unless the organisation's leadership team is willing to be an example or a model of the new culture and behaviours (Rubrich, 2010). According to McBride (2004) in an empowered Lean culture organisation, employees can be proactive, energized, and drive rapid continuous improvements, and bringing in dramatic bottom-line results.

McBride (2004) maintains that organisations or manufacturing industries that have successfully instilled a Lean culture within the organisation and workforce will consistently realize the following:

- More innovative, team-directed solutions;
- Lower employee turnover;
- Better success at sustaining improvements; and
- Greater numbers of improvement actions

According to McBride (2004) experts estimated that 80% of becoming a Lean organisation is culture related. An organisation's culture dictates how people work, their attitudes towards work and change, their relationships with each other and management, and the way change is introduced, embraced and tackled. Therefore, a good "culture is a driver of company health" McBride (2004).

2.6 Measuring Lean culture

According to van der Merwe (2014) many of the characteristics of an organisation are intangible and therefore very difficult to gauge. The scientific research project of Hofstede, Neuijen and Sanders (1990) has a link to "measurement of organisational culture' and their findings show that 'organisational culture can be measured quantitatively on the basis of answers completed by organisational members to written questions" as cited by (van der Merwe, 2014).

Mobley *et al.* (2005) maintain that 'measurement of organisational culture can be a strategically important addition to your tool kit as you continue to develop your competitive advantage'. Mobley *et al.* (2005) further illustrate that "measuring organisational culture can provide you with important information that will help guide your transformation and change processes".

Longo (2012) in his article *Can organisational culture be measured*? explains that "It can be indeed hardly contended that beliefs, values, norms, assumptions and practical behaviour can quantitatively be measured". Longo (2012) further illustrates that each organisation usually develops its own culture and in the same way each organisation different from each other, likewise each organisational culture is different. According to Longo (2012), over the years, several studies and investigations have been carried out to confirm the fact that 'culture can be measured'.

Longo (2012) describes all the tools and instruments developed over the years to "measure culture" aimed at empowering employers to discover within which category their corporate culture falls following certain distinctive characteristics. However, culture can be measured either qualitatively or quantitatively. Longo (2012) describes either qualitative or quantitative approaches of measuring culture as based "on information gathered by means of questionnaires submitted to employees whose feelings, sensations and opinions are actually formed on the basis of the concept and idea of organisational or psychological climate, rather than culture".

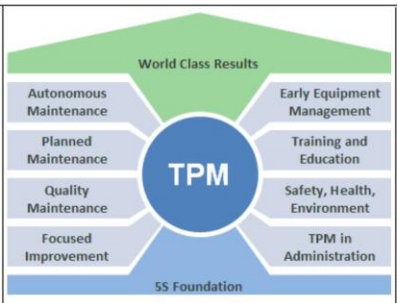
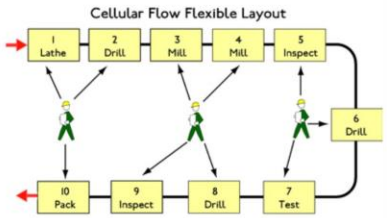
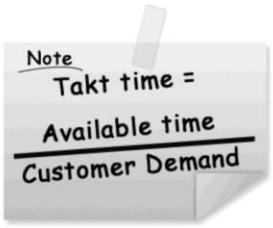
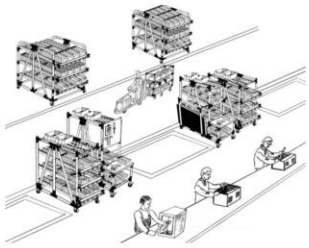
Noemi Imre *et al.* (2013) support the facts that an organisational culture can be measured and where two or more organisations can be compared. Noemi Imre *et al.* (2013) describe further that "analysis can be made in one or more points in time, for short or even for longer periods". Methods of investigation used for organisation culture research could be qualitative or quantitative (Noemi Imre *et al.*, 2013). More so, research findings from both Hofstede *et al.* (1990) and Noemi Imre *et al.* (2013) are of great relevance to this research because the main aim of this research is to measure the prevailing Lean culture using a quantitative research method.

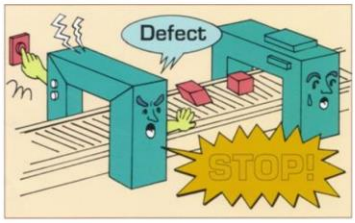
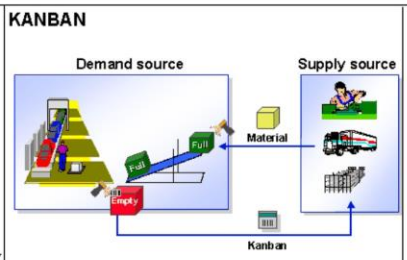
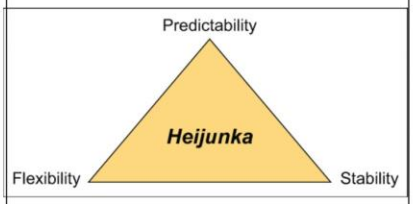
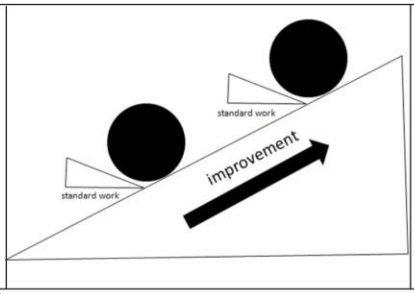
Conclusively, Scott *et al.* (2003) come up with another question "Do the Instruments Really Measure Culture?" and emphasize that "a rigorous multi-method approach may reveal different nuances to the public face, but qualitative methods are more suited to explore peoples' private beliefs, opinions and lived experiences. Quantitative and qualitative approaches can be used in a complementary way to help develop a more detailed understanding of all the layers of culture within an organisation" Scott *et al.* (2003).

2.7 The general Lean tools

Johnston (2007) makes a profound presentation on Lean culture which says "*implementing Lean tools is important, but it's the culture of change that unlocks the true potential of Lean; It's not the tools*". This implies that it is the Lean culture change that could facilitate the success of any Lean implementation, not the Lean tools *per se.* Therefore, Lean organisations or organisations willing to adopt Lean must identify the Lean tool which is most applicable to their organisation or processes. However, the organisation needs to educate their employees on the importance of the Lean tool applicable to their organisation and the do's and don'ts of the Lean tool chosen must be itemized or stated clearly (Johnston, 2007).

King (2009) supports Johnston's (2007) statement on Lean culture and Lean tools; and stresses that "the key strength of the Lean culture is not only the Lean philosophies behind it, but contains an array of effective work practices and tools that enable Lean philosophies to work and realize on the shop floor". Aitken (2010) also maintains that it is not "the number of tools used that is crucial to the success of Lean". However, it is the selective and appropriate deployment of such tools that is important. Each technique can be deployed at varying levels of complexity and at various stages of the analysis-to-solution implementation pathway (Aitken, 2010). Some literature has identified twenty to twenty-five Lean tools. In this section, only thirteen general Lean tools are described in figure 2.3 below:

Lean Tools	Sketch	Brief Descriptions
Lean Tool 1: **Total productive Maintenance (TPM)** **Sketch Source:** Lean Production.com		TPM is a set of practices aimed at improving manufacturing performance by improving the way that equipment is operated and maintained. Highly team-based and involving all levels of the operation, it drives toward autonomous maintenance, where the majority of maintenance tasks are done by those closest to the equipment, the operators (king, 2009) TPM places a strong emphasis on empowering operators to help maintain their equipment. In a right environment, this can be very effective in improving productivity.
Lean Tool 2: **Cellular Manufacturing** **Sketch Source:** PAC, 2012- Cellular Manufacturing		Cellular manufacturing is the practice of dividing the full product line up into families of products requiring similar processing steps and conditions, and then dedicating specific pieces of equipment to each family. This can often lead to shorter changeovers, higher quality, reduced variability, increased throughput, and better flow, (king, 2009). This is a manufacturing approach whereby the equipment are arranged to facilitate small lot and also for continuous flow of production and often times arranged in U-Shaped layout allowing quick feedback within operations and enable multiple tasks.
Lean Tool 3: **5S** **Sketch Source:** Bishop Wisecarver Corporation blog (2014)		The 5S is the name given to a five-step process for workplace organization, housekeeping, cleanliness, and standardized work to visual control and lean production (King, 2009) 5S maintain the conditions in which products are made better and more cheaply, quickly and safety and are designed for organization of any work place, including offices (Takeda, 2002) as describes by (Thorsten , 2006).
Lean Tool 4: **Takt Time** **Sketch Source:** kaizentrainer.co.uk		Takt is the time interval at which each item, each part, subassembly, or finished assembly must be produced to exactly meet customer demand. Takt creates pace, or rhythm, at which material must flow to meet customer needs, and Takt often expressed as a rate i.e. pounds per minute, (King, 2009).
Lean Tool 5: **Kaizen** **Sketch Source:** Kaizen System - Vision lean (2008)		Kaizen is the Japanese term for 'continuous improvement'. Kaizen is a work process wherein all employees are engaged in ongoing improvement of all processes. Kaizen is a way of thinking and behaving in an organization. Kaizen is a total philosophy that empowers the employees actually doing the work to remove waste and to design and implement more effective process i.e. kaizen is short, highly focused and well-defined improvement, (King, 2009)

Lean Tools	Sketch	Brief Descriptions
Lean Tool 6: **Jidoka** **Sketch Source:** ZeeshaN.SyeD (2014) -		*Jidoka,* or automation with a human touch, is one of the two pillars of the TPS house, and builds in quality at the source by providing equipment with intelligence to stop automatically when it senses it is producing off-quality material. This is a state of mind whereby specific technology is embedded in the equipment. It is a philosophy that everything must stop at the first sign of quality problems so that the problem can be corrected before production resumes and to limit the waste being
Lean Tool 7: **Kanban** **Sketch Source:** PP Kanban SAP Library		*Kanban* describes a mechanism for visually signalling what is needed, that is, what must be produced to replenish materials pulled by the customer, which may be final customer or the next step in the process (king, 2009). The term *Kanban* originates from the Japanese word for 'visible sign. It is a method that regulate the flow of goods both within the factory and with outside suppliers and customers based on automatic
Lean Tool 8: **Heijunka** **Sketch Source:** iSixSigma - Jamie R. Friddle		*Heijunka* is the practice of level the volume of material being produced over time. It is also called production levelling or production smoothing, heijunka increases operational stability and reduces variability in resources utilization and raw material requirements. It has specific tools called heijunka boxes and heijunka boards, (king, 2009). Heijunka has a relationship among predictability, flexibility and stability i.e. predictability by levelling demand, flexibility by decreasing changeover time and stability by averaging production volume and type over the long time, (Jamie R. Friddle)
Lean Tool 9: **Just-in-Time (pull)** **Sketch Source:** www.exactifab.com		Just-in-time, one of Ohno's two pillars, refers to the set of principles, tools, and techniques that enables a company to make what is needed only when it is needed and in exact quantity needed. JIT avoids overproduction, either producing more than will be needed or producing before it is needed, thereby reducing inventories to the minimum required for smooth flow. JIT is called Pull, based on the principle that "we will produce only what customers have pulled from the inventory shelf, commonly used in grocery supermarket, pull is the opposite of push production. (king, 2009)
Lean Tool 10: **Standard work** **Sketch Source:** www.shmula.com		Standard work sometimes defined as set of specific tasks to be rendered by an operator, including sequence of operations and timing. It is often referred to as standard operating procedures (SOPs), (King, 2009). Standard work is the best, safest and easiest way, to achieve and maintain a defined qualify level, (Kaizen Institute, 2013).

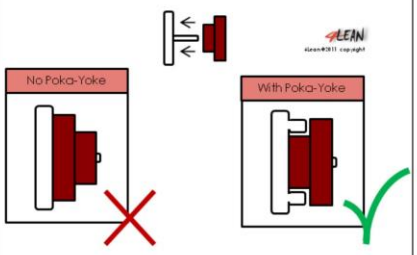
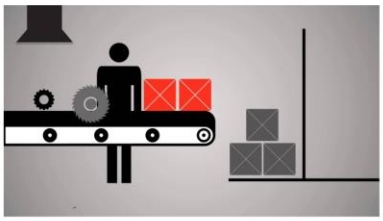
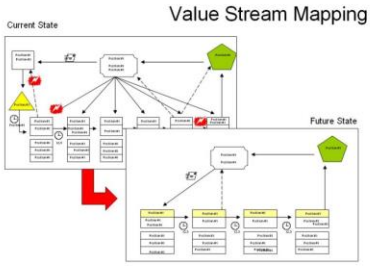
Lean Tools	Sketch	Brief Descriptions
Lean Tool 11: **Poka-Yoke** **Sketch Source:** http://www.4lean.net/		Poka-yoke is a set of techniques for mistake proofing, used both to prevent defective products from being produced and to prevent production equipment from being set incorrectly. Poka-yoke includes designing things so that they can be put together only one way, sensors to detect when things are not done correctly, and colour coding to reduce the likelihood of connecting things incorrectly. Poka-Yoke simply means 'Mistake proofing'. (King, 2009)
Lean Tool 12: **Single Minute Exchange of Dies (SMED)** **Sketch Source:** UttanaOnline		SMED is a process for systematically analysing all the tasks to be performed in a product changeover, in order that the changeover can be simplified and done in much less time. Shigeo Shingo developed the methodology. Shigeo Shingo is a consultant industrial engineer, who works with Toyota during the period of TPS development. SMED has been widely used in different Manufacturing environment, (King, 2009).
Lean Tool 13: **Value Stream Mapping (VSM)** **Sketch Source:** JC Gatlin (2010) Lean Homebuilding		VSM is a tool used to visually map the production flow. The VSM will show the current and future state of the processes in such a way that highlights the needs for continuous improvement. Therefore, Value Stream Mapping will exposes waste in the current production flow/processes and creates a roadmap for improvement in the future state. The key process steps are shown, along with data related to flow, quality, lead time, and throughput capability relative to Takt. VSMs are a key Lean tool for understanding where waste is created in the process and what might be improved to reduce or eliminate it. (King, 2009)

Figure 2.3 Thirteen general Lean tools
(Source: Researcher's own construction)

2.8 Organisational culture

Organisational culture is a system of shared assumptions, values, and beliefs, which governs how people behave in organisations (Orhan, 2014). These shared values have a strong influence on the way people behave in organisation and dictate how they dress, act, and perform their jobs. Every organisation develops and maintains a unique culture, which provides guidelines and boundaries for the behaviour of the members of the organisation (Orhan, 2014).

Pellet (2013) says that "organisational culture is created by what leaders allocate attention and resources to". Pellet (2013) further explains that "leaders determine where to spend their attention (time) and resources both (human and money) in their organisations. And the way they

do that communicates to the employees what the organisation values, which drives organisational culture". This is further explained in figure 2.4.

Figure 2.4 Explanation on how organisation culture can be created Source: Pellet (2013)

2.8.1 Three levels of organisational culture

According to Schein (1992) organisational learning, development, and planned change cannot be understood without considering culture as the primary source of resistance to change. Schein (2004:p23) describes that "the bottom line for leaders is that if they do not become conscious of the cultures in which they are embedded, those cultures will manage them. Cultural understanding is desirable for all of us, but it is essential to leaders if they are to lead".

Schein (1992) divides organisational culture into three levels (artifacts, espoused values and basic assumption and values) as shown in figure 2.5. Schein (1992) identifies three levels of organisational culture as inter-related and explains that there are often discrepancies among the three levels of organisational culture.

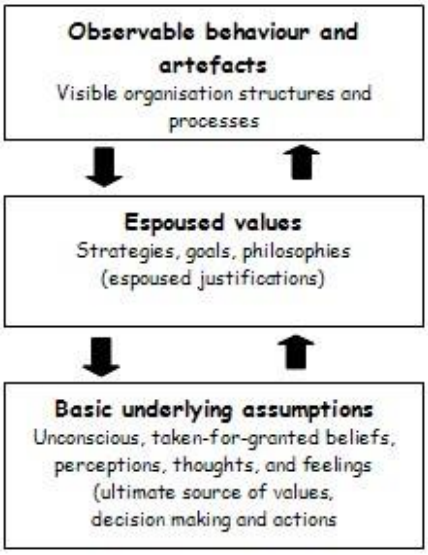


Figure 2.5 Three levels of organisational culture Source: Schein (1992)

2.8.1.1 Observable behaviour and artefacts

According to Greene and Stapledon (2007) these are the most obvious and visible aspects of the culture, for instance, the type of office you have (i.e. the building and office arrangement), types of products you produce, your publications, organisational website, and the organisational membership and the activity in industry. All these aspect of the organisational culture can be observed by others.

2.8.1.2 Espoused values

These are the statements the organisation makes to the public and its employees. These are statements of values, the mission statement, corporate slogans, etc. that tell people what the organisation stands for (Greene & Stapledon, 2007).

2.8.1.3 Assumptions and beliefs

Greene and Stapledon (2007) explain that "assumption and belief provides the deepest, least visible, and the most powerful aspects of the organisational culture. This includes key implicit and unconscious assumptions that guide behaviour in the organisation. They may be unspoken rules. Often, assumptions could include attitudes towards sustainability, new technology and opinions about the reliability of information from different sources".

However, since people may not be consciously aware of the organisational assumptions and beliefs, yet assumptions and beliefs are the most difficult to change. Schein (1992) acknowledges

that "even with rigorous study, we can only make statements about elements of culture, not culture in its entirety".

2.9 Creating and maintaining organisational culture

According to Carpenter *et al.* (2010) when the organisation's way of doing business provides a successful adaptation to environmental challenges and ensures success, those values are retained. These values and ways of doing business are taught to new members as the way to do business (Schein, 1992). Carpenter *et al.* (2010) say that "the factors that are most important in the creation of an organisation's culture include founders' values, preferences, and industry demands" as shown in figure 2.6.

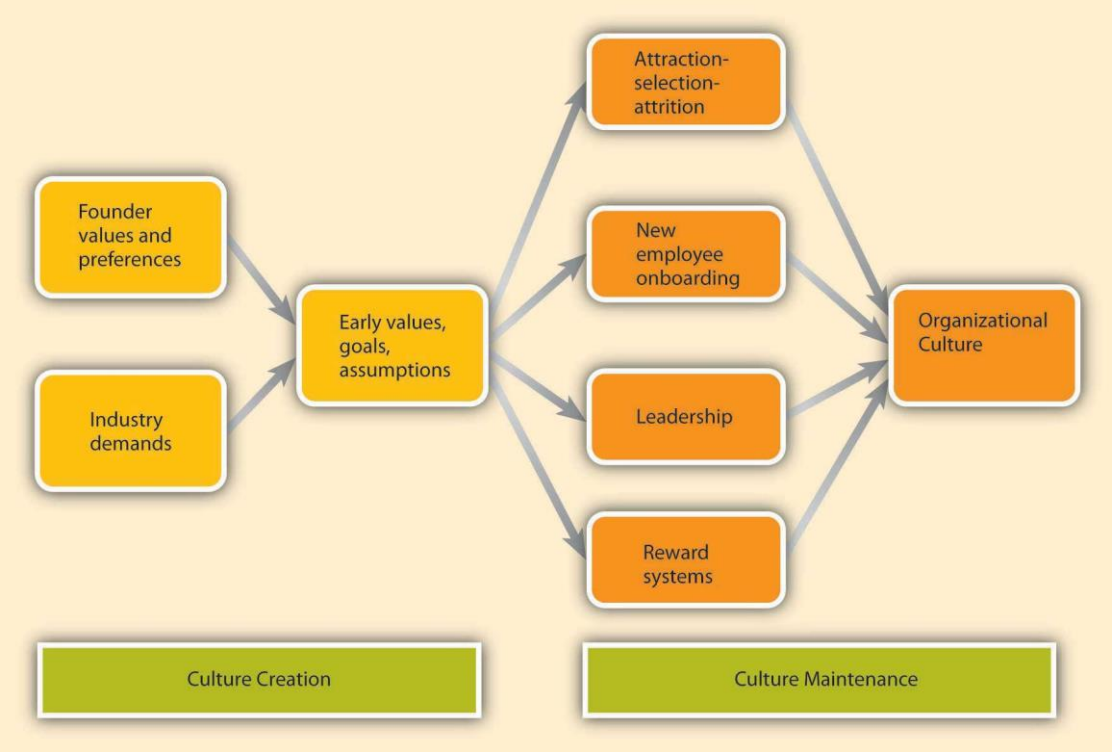


Figure 2.6 Models describing how cultures are created and maintained

Source: Carpenter *et al.* (2010)

Carpenter *et al.* (2010) maintain that when organisation matures and their cultural values are refined and strengthened. The early values of the organisation's culture will exert influence over the future values. Therefore, the organisational culture determines what type of employee is to be hired and what type of employee to be left out. When new employees are hired, the company assimilates new employees and teaches them the way things are done in the organisation and such process is been referred to as "attraction-selection-attrition and on-boarding processes", the

role of leaders and the reward system are also very important in maintaining and managing organisational culture (Carpenter *et al.*, 2010).

2.10 Learning organisation

Senge (1990) defines Learning organisation as a place:

"*where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together*".

2.10.1 Three elements of a learning organisation

Mohan (2012) describes three key elements to create a learning organisation as shown in figure 2.8.

Figure 2.7 Three elements of a learning organisation

Source: Mohan (2012)

The three elements of a learning organisation are described below:

- **Technology:** In a learning organisation, technology is simply the easiest component to set up and the organisation must ensure that the chosen technology solution is easy to use and flexible enough to change with the times. The technology should have one common platform across different departments and sections of the organisation (Mohan, 2012).

- **Framework:** The organisation will have a process framework that makes it easier to share ideas and learn new skills. Such a process framework could be a periodic forum where employees across different department can share what is happening in their area of

work; also a defined networking group could be another process framework that allows exchange of ideas (Mohan, 2012).

- **Culture:** Culture is the most critical element of a learning organisation and may be the hardest to create or build. Mohan (2012) says the culture of sharing is where people share without fear and where the greatest reward for sharing is more sharing by others.

2.11 The management philosophy of the Toyota way

Toyota's management system is described by fourteen principles within the 4P level. According to Liker (2004) the "Toyota way" summarized the fourteen management principles of Toyota in a 4P model namely: philosophy, process, people and problem solving as shown in (Figure 2.8). The Toyota way is about culture, and the 4P model formed a pyramid. The fourteen management principles describe Toyota's culture. The Toyota way is described as a 'new way of thinking' which creates continuous improvements within an organisation. The 4P model of Toyota way is further illustrated below (Liker, 2004):

- **Philosophy –** It is about Toyota's purpose and why they exist.
- **Process –** what Toyota believes which leads to operational excellence and constantly eliminating waste.
- **People –** This is what drives Toyota Company forward and the culture is what teaches the people how to act, think and feel to work together toward a common goal.
- **Problem Solving –** The way Toyota people focus their efforts on continually improving.

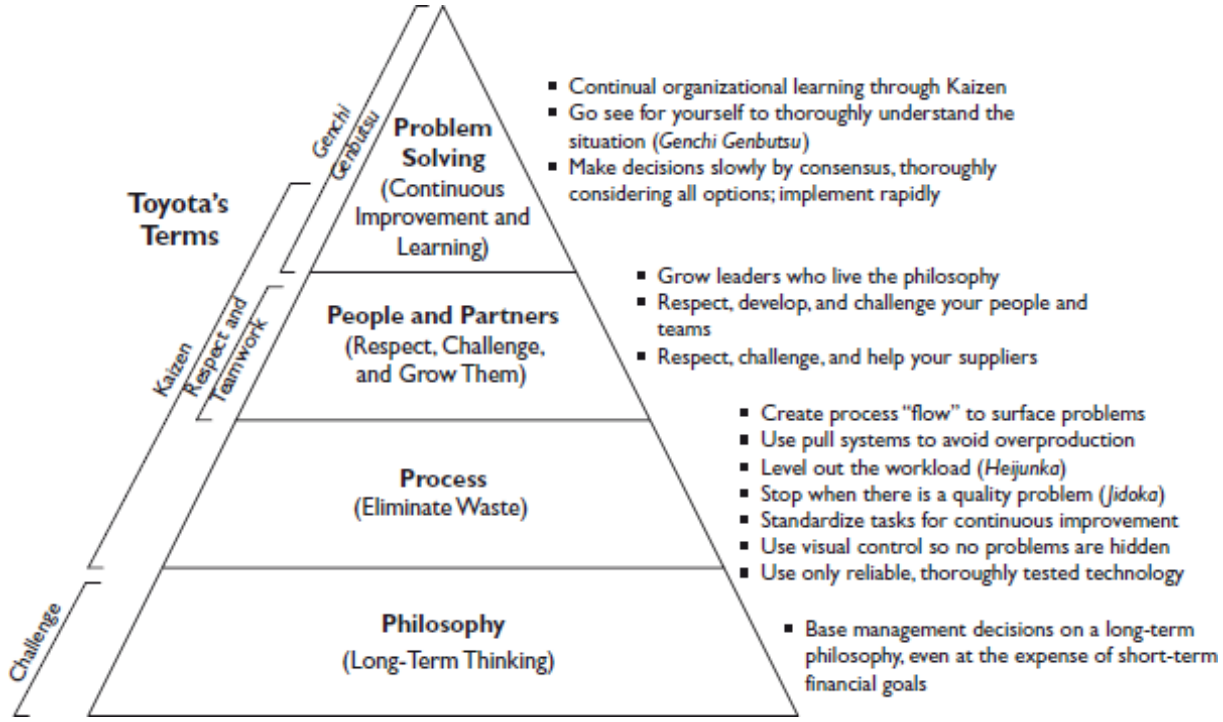


Figure 2.8 4P model of the Toyota way
Source: Jeffrey Liker, The Toyota Way, McGraw-Hill, 2004

2.11.1 The Toyota Production System

Toyota Production System (TPS) is regarded as the most visible product of Toyota in their pursuit for excellence and this shaped the Toyota manufacturing philosophy (Liker, 2004). TPS is the next major evolution in business processes after the mass production system which was invented by an American Industrialist known as Henry Ford. This was documented, analysed, and exported to many manufacturing industries and companies throughout the world, (Liker, 2004).

The TPS is Toyota's unique approach to manufacturing. It is the basis for much of the 'Lean Production' movement that has dominated manufacturing trends (along with Six Sigma) for the past 10years and thereabout (Liker, 2004).

Liker (2004) maintains that *"Despite the huge influence of Lean movement, most attempts to implement Lean have been fairly superficial. The reason is that most companies have focused too heavily on tools such as 5S and Just-in Time, without understanding Lean as an entire system that must permeate an organisation's culture. In most companies where Lean is implemented, senior management is not involved in the day-to-day operations and continuous improvement that are part of Lean because Toyota's approach is very different"*

According to Bhasin (2015) the Toyota philosophy shows that the culture must support the employees doing the work and rightful leadership and talent management are very important if any Lean organisation should want to succeed. Bhasin (2015) stresses further that "the Toyota Production System as practiced by Toyota may not be easily emulated by other organisations owing to the variation by which some processes are managed and the prevailing culture which acts as a pre-requisite". The Toyota way consists of certain vital principles of the Toyota culture which allows the Toyota Production System (TPS) to work effectively for the organisation.

2.11.2 Why companies often think they are Lean – but are not

According to Liker (2004) when he started learning about the Toyota Production System, he learned that all the supporting tools of Lean such as quick equipment change over, standardized work, pull systems, and error proofing, were all essential to creating flow, but as time goes by, experienced leaders working with the Toyota Company kept informing him that Lean tools and techniques were not the key to Toyota Production System (TPS) but rather the power behind Toyota Production System is "*a company's management commitment to continuously invest in its people and promote a culture of continuous improvement*".

Liker (2004) refuses to follow the Toyota Leaders advice but kept studying the kanban quantities and set up one-piece flow cells. After studying Toyota for almost 20 years and observing the struggles companies have had applying Lean manufacturing, he realized the truth in what some of the experienced leaders working with Toyota had said earlier - that the Toyota Way consists of far more than just a set of Lean tools like Just-in-time, 5S and etc. (Liker, 2004).

Liker (2004) says "I have visited hundreds of organisations that claim to be advanced practitioners of Lean methods; having studied Toyota for twenty (20) years it is clear to me that in comparison those hundreds of organisations visited were ranked amateurs. It took Toyota decades of creating a 'Lean culture' to get to where they are and they still believe they are just learning to understand 'Toyota way'. What percentage of companies outside of Toyota and their close-knit group of suppliers get an A or even a B+ on Lean? I cannot say precisely but it is far less than 1%".

Liker (2004) further says "the problem I noticed is that most companies have mistaken a particular set of Lean manufacturing tools for deep "Lean Thinking". Lean Thinking, which is based on 'the Toyota Way', involves a far deeper and more pervasive cultural transformation than most companies can begin to imagine". Liker (2004) suggests that the best approach to

'Lean Thinking' is to start with a project or two to generate some enthusiasms is the right thing to do. Therefore, Toyota way is based on culture and principles (Liker, 2004).

Figure 2.9 below, within the 4-P model of the Toyota Way, shows that most companies are dabbling at one level – "The Process" level without adopting the other 3Ps, as a result of this, the improvement they make will not have the heart and intelligence behind them to make a sustainable Lean organisation. Their performance will continue to lag behind those companies that adopt a true culture of continuous improvement, says Liker (2004).

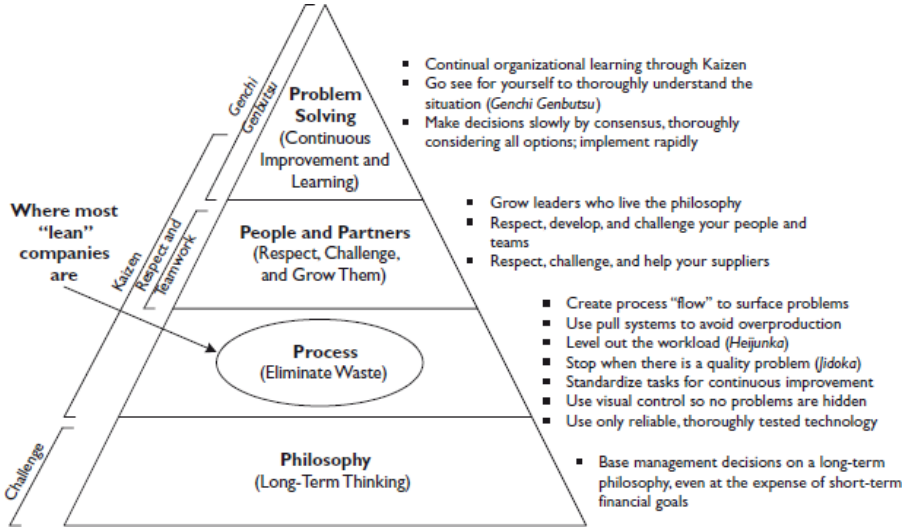


Figure 2.9 "4 P" Model and Where Most Companies Are

Source: Jeffrey Liker, *The Toyota Way*, McGraw-Hill (2004)

2.11.3 The secret of Toyota's success

The term "Lean Production" started with the Toyota Company and the company has recorded ever greater success as the Lean culture is concerned. Therefore in this section, Jeffrey Liker, Professor of Industrial and Operations Engineering, owner of Liker Lean Advisors, LLC, partner in the Toyota Way Academy, throws more light on the secret of Toyota's success based on his experience working with the Toyota Company for over twenty years,(Liker, 2004) .

Liker (2004) realizes that "Toyota challenges people to use their initiative and creativity to experiment and learn. Toyota will set up assembly lines, select only the best and brighter workers and challenges them to grow in their job by constantly solving problems. Toyota is a true learning organisation that has been evolving and learning for most a century". Liker (2004) stresses that 'the investment of Toyota is in its employees by given directive to improve their processes and find innovative ways to satisfy their customers". According to Liker (2004) the

Toyota way includes “profiles of a diverse group of organisations that have had great success in using Toyota's principles to improve quality, efficiency, and speed”.

In the 1990s it became clearly visible that there was something even more special about Toyota compared to other automakers in Japan (Womack *et al.,* 1991). It was simply the way Toyota engineered and manufactured the autos that led to unbelievable consistency in their processes and products says Liker (2004). Toyota’s success comes from its astounding quality reputation. Consumers know that they can count on their Toyota vehicle to work right the first time and keep on working, while most US and European automotive companies produce vehicles that may work when new but almost certainly will spend time in the shop in a year or so (Liker, 2004).

Liker’s (2004) research has shown that “Toyota’s continued success at implementing these tools stems from a deeper business philosophy based on its understanding of people and human motivation’. Toyota success is ultimately based on its ability to cultivate Leadership, Teams and Culture, to Devise Strategy, to Build Supplier Relationships, and to Maintain a Learning Organisation, (Liker, 2004).

2.12 The fourteen management principles of the Toyota way

According to Liker (2004) the Toyota way has been called "a system designed to provide the tools for people to continually improve their work". The fourteen management principles of Toyota way are Toyota’s unique approach to Lean management. The fourteen management principles are divided using 4P – model (philosophy, process, people & partners and problem solving) as shown in figure 2.8.

2.12.1 Section I: Long Term Philosophy

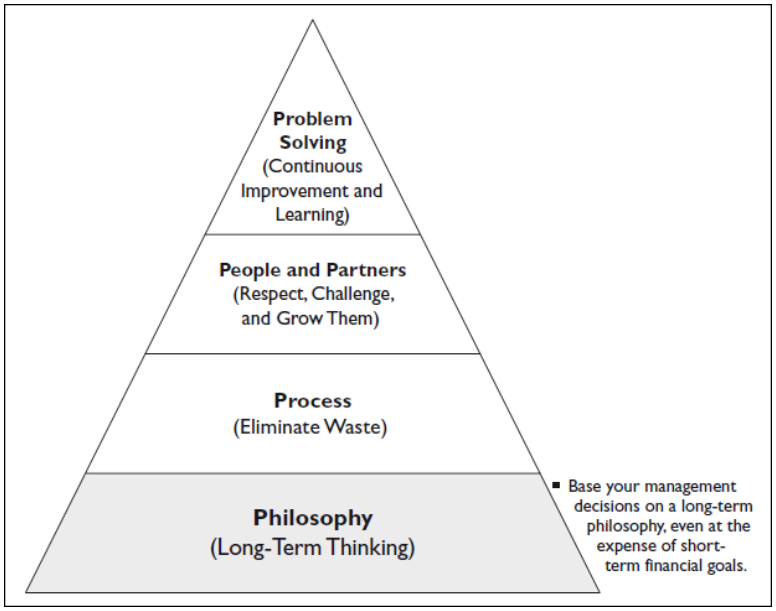


Figure 2.10 Section I: long-term philosophy. Source: Liker (2004)

Principle 1: Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.

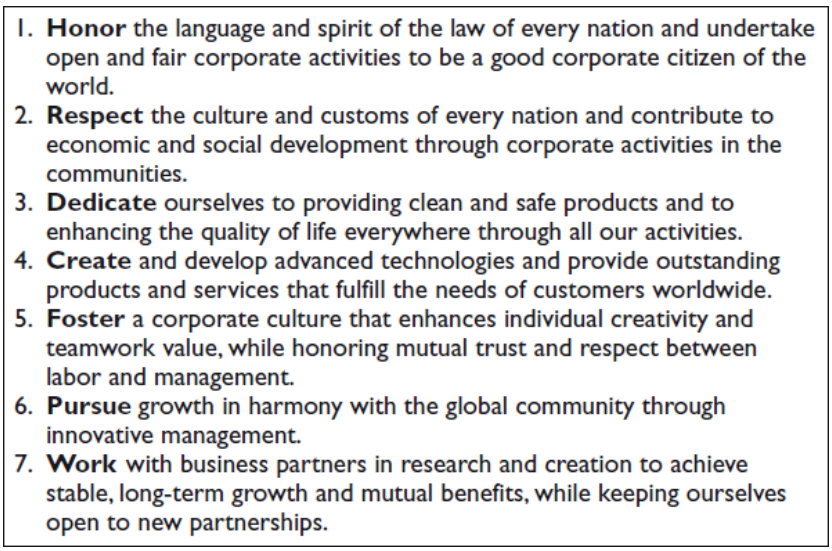
The first principle is the foundation of all other thirteen principles as shown in (Figure 2.10) and is incorporated in Toyota's mission "to do the right thing for the company, its employees, the customer, and society as a whole" (Liker, 2004). According to Walters (2012) the first principle is perhaps the hardest one to apply, as it will generally come with a giant culture and mind-set change. Most companies and organisations don't have a long-term philosophy because they are simply trying to survive in the current moment. Long-term plans may take years to implement to the fullest extent, but their purpose is to create a foundation for long-term growth and sustainment. Moreover, sometimes the organisation might be doing so at the sacrifice of short-term wins that did not fit with the plan (Walters, 2012).

Therefore, the organisational long-term philosophy should be 'doing the right thing for the customer'. Toyota's long-term philosophy is aligned around satisfying the customer needs (Liker, 2004). According to Liker (2004) the true Toyota mission statement has three parts as listed below:

- Contribute to the economic growth of the country in which it is located (external stakeholders).
- Contribute to the stability and well-being of team members (internal stakeholders).

- Contribute to the overall growth of Toyota.

According to Liker (2004), figure 2.11 is an internal document that shows Toyota's guiding principles; it was revised after Toyota's global expansion and to emphasize the company's responsibility as a global citizen.



1. **Honor** the language and spirit of the law of every nation and undertake open and fair corporate activities to be a good corporate citizen of the world.
2. **Respect** the culture and customs of every nation and contribute to economic and social development through corporate activities in the communities.
3. **Dedicate** ourselves to providing clean and safe products and to enhancing the quality of life everywhere through all our activities.
4. **Create** and develop advanced technologies and provide outstanding products and services that fulfill the needs of customers worldwide.
5. **Foster** a corporate culture that enhances individual creativity and teamwork value, while honoring mutual trust and respect between labor and management.
6. **Pursue** growth in harmony with the global community through innovative management.
7. **Work** with business partners in research and creation to achieve stable, long-term growth and mutual benefits, while keeping ourselves open to new partnerships.

Figure 2.11 Guiding principles at Toyota Motor Corporation. Source: Liker (2004).

2.12.2 Section II: The Right Process Will Produce the Right Results

According to Liker (2004) the Toyota leaders believe that "*The Right Process Will Produce the Right Results*". In section II, seven principles out of the fourteen management principles of the Toyota way will be discussed. Within these seven principles are most of the TPS tools for improving manufacturing processes as well as the more routine processes for product development and service organisations (Liker, 2004).

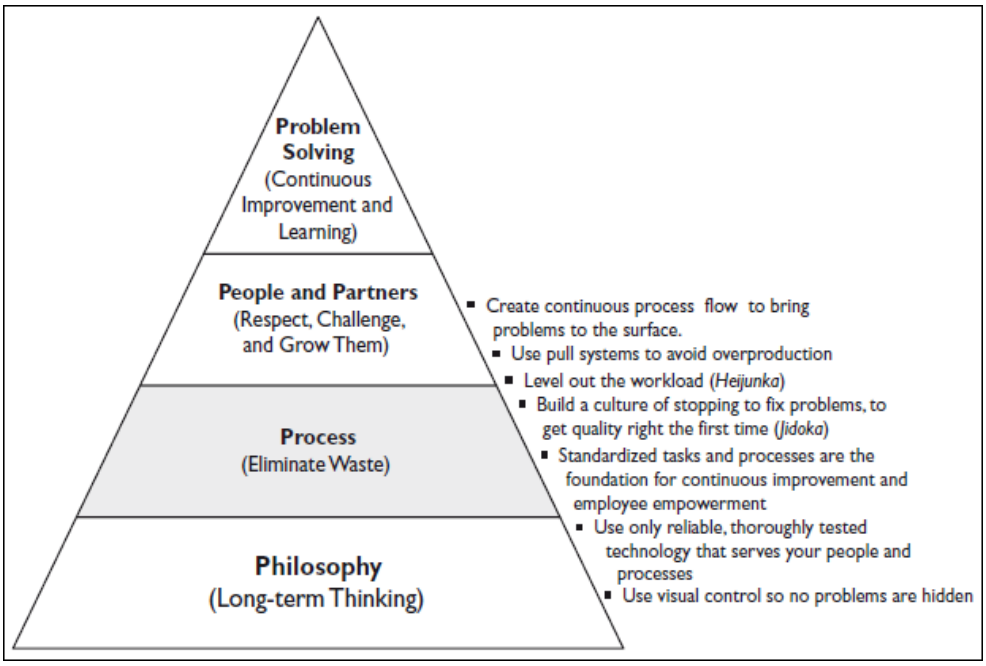


Figure 2.12 Section II: The Lean processes. Source: Liker (2004)

Principle 2: Create continuous process flow to bring problems to the surface

Liker (2004) explains that flow is a way in which all types of waste defined by Ohno (1988) are brought to the surface. Liker (2004) says "a good place for any company to begin the journey to Lean is to create continuous flow wherever applicable in its core manufacturing and service processes. Flow is at the heart of the Lean message that shortening the elapsed time from raw materials to finished goods (or services) will lead to the best quality, lowest cost, and shortest delivery time. Flow also tends to force the implementation of a lot of the other Lean tools and philosophies such as preventative maintenance and built-in quality (*jidoka*)".

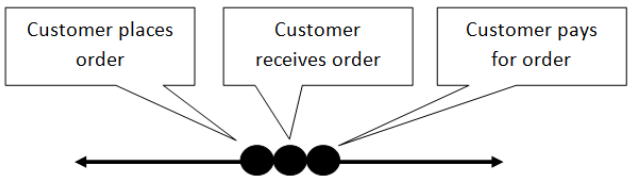


Figure 2.13 Process with minimal waste. Source: Walters (2012)

According to Walters (2012) figure 2.13 is a simplified example of continuous flow and depicts a process with minimal waste; meaning "the timeline shows an ideal state for any process, where there is zero time for the product or service or work-in-process (WIP) to be used between steps of a process, this implies there is zero waiting time between processes, and immediately one step is completed, the next step flows in without stopping".

Walters (2012) stresses that "the beauty of continuous flow is that, it features stability, continuity, balance, and doesn't waste-time (the non-renewable resource). No time wasted on waiting between steps/processes and means time is being maximized for its capabilities. However, the troubles with continuous flow are that it's very hard to achieve, process steps aren't generally balanced, and all process contains inherent waste activities". When an organisation starts continuous flow process, many process problems will be identified and come to surface and as a result of this, the optimal process features continuous flow, and problems that stand on the way to achieve continuous flow become visible and can be rectified" (Walters, 2012).

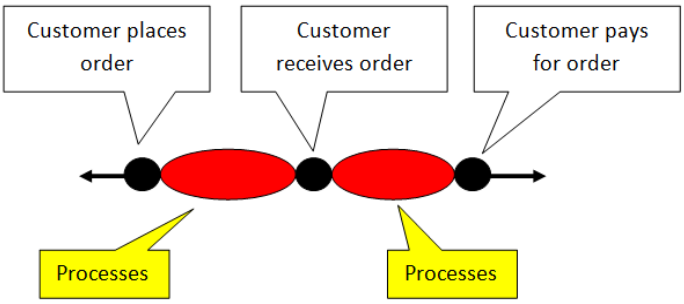


Figure 2.14 A continuous process flow to bring problems to the surface Source: Walters (2012)

Walters (2012) maintains that 'wastes causes delay in production or manufacturing processes, thereby wasting time and money. The problems need to be addressed rather than ignored. Wastes could be fixed if they were more visible'. Figure 2.14 shows a continuous flow process whereby all activities are organized with the intent of generating continuous flow, meaning "identifying problems and solving the problem and balancing the load and the lines, reducing wasteful activities during and between process steps" (Walters, 2012).

Principle 3: Use "Pull" systems to avoid over-production

According to Walters (2012) the purpose of the pull system also known as "kanban system" is to have a measured queue of materials such as raw materials, work-in-process (WIP), components, and etc. ready to be "pulled" by the next process step. After the materials are "pulled" a signal is sent to the preceding process step to replace what has been taken.

Walters (2012) describes the key concept of a pull system is "to maintain small quantities of items that you know are needed, and replenish what is taken only when it has been taken. This helps to avoid overproduction and over-ordering. You replenish only what has been used, and

reorder based on rate of consumption, delivery frequency, and minimum order quantities. Inventory management systems must be in place that calculates how many items have been purchased and signal to shelf-stockers how much peanut butter is to be brought out" (Walters, 2012).

Liker (2004) stresses that true one-piece-flow system would be a zero-inventory system where goods just appear when they are needed by the customers. The closest system Toyota has devised to achieve this is the one-piece flow cell that builds to order only at the precise time the product is needed. But when pure flow is not possible because processes are too far apart or the cycle times to perform the operations vary a great deal, the next best choice is often Toyota's *kanban* system (Liker, 2004).

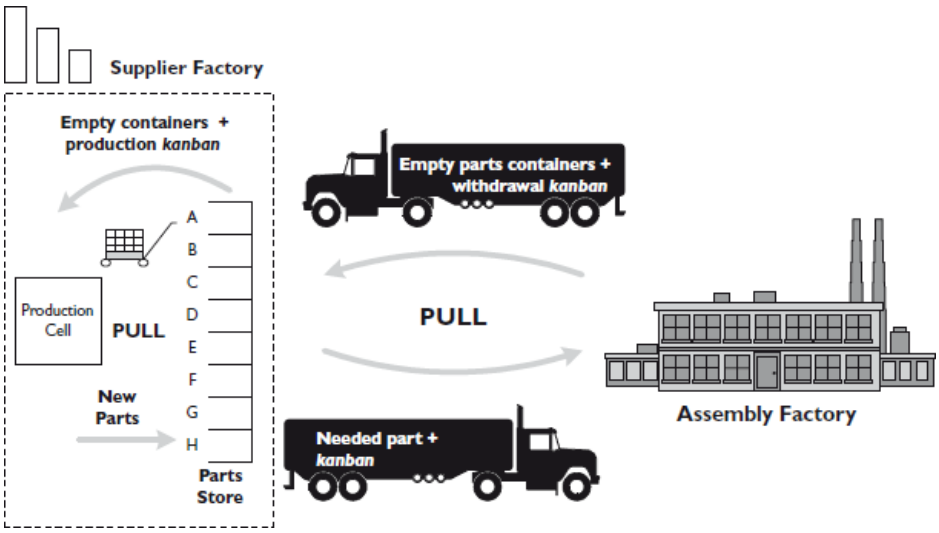


Figure 2.15 Internal and external pull system Source: (Liker, 2004)

Liker (2004) as seen from figure 2.15 is a pull system in a Toyota assembly plant. Orders accumulate from car dealerships. Production control creates a levelled schedule. For example, they make a white Camry, followed by a green Camry, followed by a Red Avalon, and so on. Liker (2004) uses figure 2.15 as an illustration to explain pull system "a system like this, where parts in the assembly plant are replenished from a supplier. The process starts at the assembly factory (on the right side of the figure 2.15) then "withdrawal *kanban*" and empty containers are sent by truck back to the supplier to be refilled.

Principle 4: Level out the workload (*Heijunka*)

According to Liker (2004) Toyota managers and employees use the Japanese term *muda* when they talk about waste. Most Lean manufacturing efforts are aimed at eliminating *muda*. The two

other Ms are just as important to making Lean principles work, and at the same time, all three Ms (Muda, Muri and Mura) fit together as a system. As a result of this, the eight Lean thinking wastes were identified as explained in the (Table 1.3) above.

Focusing exclusively only on the eight wastes of *muda* can actually hurt the productivity of people and the production system (Liker, 2004). Figure 2.16 refers to three Ms of the Toyota way known as "elimination of *Muda*, *Muri*, *Mura*".

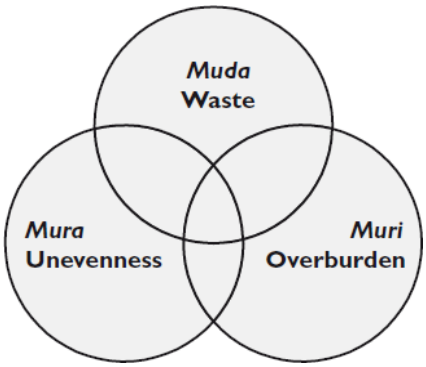


Figure 2.16 The three M's.

Source: Liker (2004)

1. *Muda:* Non-value-added activities that lengthen lead times, cause extra movement to get parts or tools, create excess inventory or different of wastes (Liker, 2004).

2. *Muri:* Refers to as an act of overburdening people or equipment. Muri is an act of pushing a machine or person beyond natural limits (Liker, 2004).

3. *Mura:* Unevenness results from an irregular production schedule or fluctuating production volumes due to internal problems, like downtime or missing parts or defects. *Muda* will be a result of *mura* (Liker, 2004).

Liker (2004) believes that "when it comes to scheduling, Toyota works to make lead times as short as possible". Liker (2004) illustrates further that "These days Toyota is increasingly using computer systems for scheduling. Toyota is moving to electronic *Kanban* rather than sorting and sending cards back. Toyota will often use a computer system for scheduling some operations, but then use manual cues like cards or white boards to visually control the process".

Principle 5: Build a culture of stopping to fix problems, to get quality right the first time

Principle 5 is simply referred to as 'the principle of stopping the process to build in quality (*Jidoka*). *Jidoka,* is the second pillar of the Toyota Production System. Sakichi Toyoda invented a device that can detect when a thread broke, and when this occurred, the loom would stop immediately. The loom will be reset and most importantly, the problem will be solved to avoid repeating the defect i.e. waste (Liker, 2004).

Liker (2004) describes the need for a method to identify or detect defects when they occur and automatically stop production so an employee can fix the problem before the defect continues downstream. Liker (2004) sees *Jidoka* as *autonomation, or* equipment endowed with human intelligence to stop itself when it has a problem. At Toyota the employee keeps things simple and uses very few complex statistical tools. The quality specialists and team members have just four key tools (Liker, 2004):

- Go and see.
- Analyse the situation.
- Use one-piece flow and *andon* to surface problems.
- Ask "Why?" five times.

Liker (2004) stresses that asking "why" five times whenever you uncover a problem will provide root cause analysis of the problem as well as countermeasures to solve it. According to Liker (2004) throughout the Toyota way, what matters when improving quality is to enable the process and the people involved. "The Toyota way is to build into the culture the philosophy of stopping or slowing down to get quality right the first time to enhance productivity in the long run. All aspects of the Toyota way; namely, philosophy, processes, partners, and problem solving; support its ability to '*build in quality'* and satisfy customers" (Liker, 2004).

Principle 6: Standardized tasks are the foundation for continuous improvement and employee empowerment

Liker (2004) emphasizes that "standardizing tasks became a '*science*' when mass production replaced the craft form of production. Much of modern manufacturing and standardization is based on the principles of industrial engineering first set forth by Frederick Taylor (the father of scientific management) says Liker (2004). Ford Motor Company was one of the early mass-production giants associated with inflexible standardization on the moving assembly line, and

Toyota's approach relating to standardized work was partially shaped by Henry Ford's view (Liker, 2004).

Liker (2004) explains that "standardization is the basis for continuous improvement and quality. Toyota's standards have a much wider role than making shop floor workers' tasks repeatable and efficient". The Toyota way results in standardized tasks throughout the company's white collar work process, such as engineering. All Toyota factories across the globe are using identical standard processes and Toyota also applies standards to design of product and Manufacturing equipment (Liker, 2004).

The critical task when implementing standardization is to find the balance between providing employees with rigid procedures to follow and providing the freedom to innovate and be creative to meet challenging targets consistently for cost, quality, and delivery (Liker, 2004).

Principle 7: Use visual control so no problems are hidden

According Liker (2004) visual control is the ability to see abnormalities at a glance. The principle is simply "clean it up, make it visual". Liker (2004) expresses that, in 1970s and 1980s, Americans were on pilgrimages to Japanese plants and the first reaction was invariably that 'the Japanese's factories were so clean and you could eat off of the floor'. In other word, the Japanese love their work and take pride in it and therefore ensure their factories were clean but in the real sense of it, their effort go beyond making the factory look clean and orderly.

The Japanese has "5S programmes" with series of activities for eliminating wastes that contribute to errors, defects, and injuries in the workplace. The 5Ss are (*seiri*, *seiton*, *seiso*, *seiketsu*, and *shitsuke*) translated into English as described in figure 2.17 by Liker (2004).

- **Sort** — Sort through items and keep only what is needed while disposing of what is not.
- **Straighten (orderliness) —** "A place for everything and everything in its place."
- **Shine (cleanliness) —** Cleaning process often acts as a form of inspection that exposes abnormal and pre-failure conditions that could hurt quality or cause machine failure.
- **Standardize (create rules) —** Develop systems and procedures to maintain and monitor the first three S's.
- **Sustain (self-discipline) —** Maintain a stabilized workplace is an on-going process of continuous improvement.

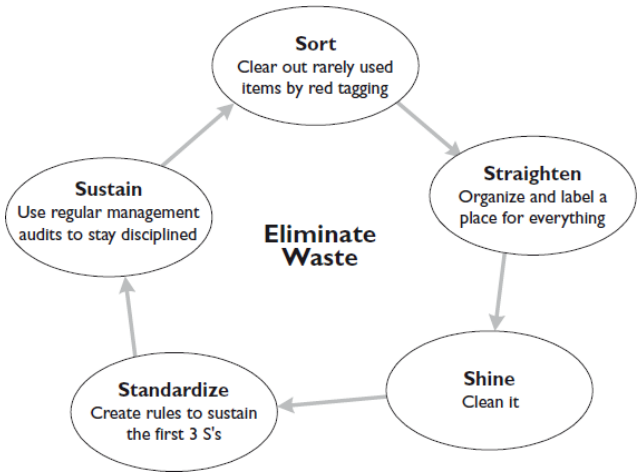


Figure 2.17 The 5 S's of Lean Manufacturing. Source: Liker (2004)

According to Liker (2004) Lean systems use 5Ss to support a smooth flow to take time. 5S is also a tool to help make problems visible and, if used in a sophisticated way, can be part of the process of visual control of a well-planned Lean system. Liker (2004) says "visual control systems are about improving value added flow. Visual control *is* any communication device used in the work environment that tells us at a glance how work should be done and whether it is deviating from the standard. It helps employees who want to do a good job see immediately how they are doing. It might show where items belong, how many items belong there, what the standard procedure is for doing something, the status of work in process, and many other types of information critical to the flow of work activities".

Visual control goes beyond capturing deviations from a target or goal on charts and graphs and posting them publicly. Visual controls at Toyota are integrated into the process of the value-added work (Liker, 2004). The *visual* aspect means "being able to look at the process, a piece of equipment, inventory, or information or at a worker performing a job and immediately see the standard being used to perform the task and if there is a deviation from the standard" (Liker, 2004).

The Toyota way recognizes that visual management complements human intelligence, because human beings are visually, tactilely, and audibly oriented (Liker, 2004). Well-developed visual control systems increase productivity, reduce defects and mistakes, help meet deadlines, facilitate communication, improve safety, lower costs, and generally give the workers more control over their environment (Liker, 2004).

Principle 8: Use only reliable, thoroughly tested technology that serves your people and processes.

Liker (2004) explains that "at Toyota, new technology is introduced only after it is proven out through direct experimentation with the involvement of a broad cross-section of people. This does not exclude new or cutting-edge technology". It means the technology has been thoroughly evaluated and tested to ensure it provides added value. Before Toyota can adopt a new technology, Toyota will go to great lengths to analyse the impact that the new technology will have on the existing technology or processes.

Toyota usually follows these steps listed below before implementing a new technology at any of their sites (Liker, 2004):

1. Toyota will go and see first-hand the nature of the value-added work being performed by the workers for the particular process. Toyota will try and look for new opportunities to eliminate waste and even out the flow.

2. Toyota will make use of a pilot area to improve the process with the existing equipment, technology and people.

3. When Toyota has accomplished as much improvement as possible with the new technology. Toyota will seek whether they can make additional improvement in order to know if the new technology can add value to the process;

4. The technology is then carefully analysed to see whether it conflicts with Toyota's philosophies and operating principles such as principles of valuing people over technology, using consensus decision-making and more so an operational focus on waste elimination.

5. If the technology violates these principles or if there is any chance it may adversely disrupt stability, reliability, and flexibility, Toyota will reject the technology or at least delay adopting it until the problems can be resolved.

If the new technology is acceptable, the guiding principle is to design and use it to support continuous flow in the production process and help employees perform better within the Toyota way standards (Liker, 2004). This means the technology should be highly visual and intuitive. The important principle is to find ways to support the actual work process while not distracting people from the value-added work. Throughout this analysis and planning, Toyota will broadly involve all key stakeholders in a consensus-building process. Once Toyota has thoroughly gone through this process, it will quickly implement the new technology. Because of this painstaking

process, Toyota will typically implement the new technology smoothly without employee resistance or process disruption and technology should be used to support, not to replace people, (Liker, 2004).

2.12.3 Section III: The People and Partners

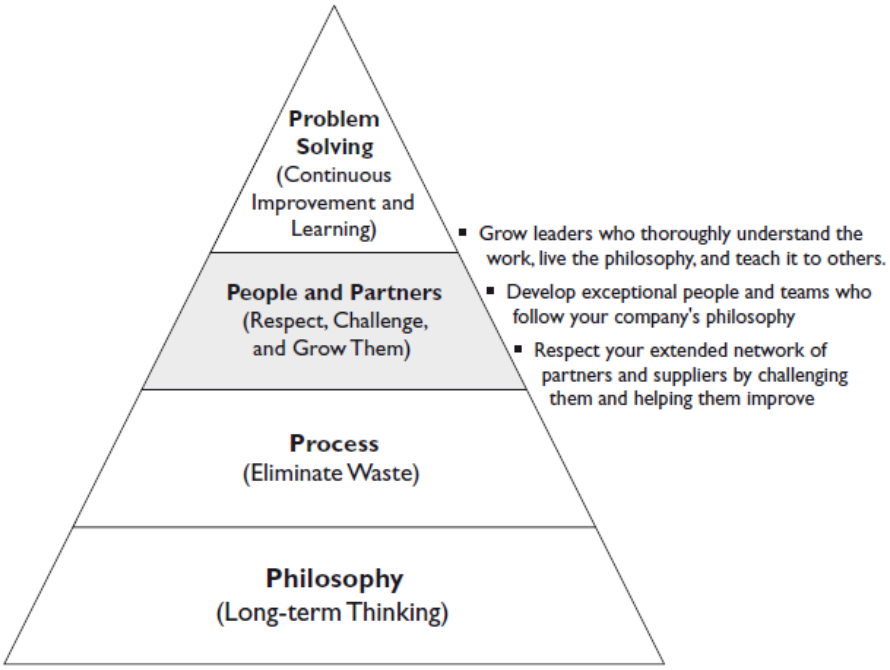


Figure 2.18 Section III: the people and partners. Source: Liker (2004)

Principle 9: Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others

According to Liker (2004) from Toyota's history, key leaders have been found within the company, at the right time, to shape the next step in Toyota's evolution. They have been there across the enterprise - in sales, product development, manufacturing, and design. Liker (2004) also stresses that "At Toyota, the new president or CEO does not need to come in and take charge to move the company in a radically new direction to put his imprint on the company".

Toyota does not go shopping for 'successful' CEOs and Presidents because their leaders must live and thoroughly understand the Toyota culture day by day (Liker, 2004). "Since a critical element of the Toyota's culture is *genchi genbutsu*, which means deeply observing the actual situation in detail; therefore leaders must demonstrate this ability and understand how work gets done at a shop floor level within Toyota. Toyota also expects its leaders to teach their subordinates the Toyota ay, which means they must understand and live the philosophy" (Liker, 2004).

The important leadership tenet of the Toyota way is the effort leaders make to support the culture year after year so it can create the environment for a learning organisation (Liker, 2004). “So changing the culture each time a new leader comes into office necessarily means jerking the company about superficially, without developing any real depth or loyalty from the employees” (Liker, 2004). The problem with an outsider leading radical shifts in the culture is that the organisation will never learn and the company loses the ability to build on achievements, mistakes, or enduring principles (Liker, 2004). This affects the ability of leaders to make effective changes. There is no doubt that Toyota's leadership culture was shaped by the personalities, values, and experiences of its founders in the Toyoda family (Liker, 2004).

Liker (2004) explains that “Gary Convis was the first American President of Toyota Motors and it took Toyota executives 15 years to develop Gary Convis into someone they could trust to carry the banner of the Toyota way but the result was a true Toyota leader”. Gary Convis talked about the philosophy of Toyota Production System (TPS) and the importance of culture and what he has learnt about TPS over the years working with Toyota NUMMI.

Liker (2004) quotes Garry Convis’ explanation as stated below and Garry Convis described his explanation diagrammatically in figure 2.19 as well:

> *Though the technical focus includes short lead times and is prominently featured in the definition, of equal prominence is "engaging people toward goals." Convis sees TPS as a three-pronged beast, where only one prong includes the technical tools often associated with lean production - JIT,* jidoka, heijunka, *etc. According to Convis, these are just technical tools and they can be effective only with* the ***right management and the right philosophy*** - the basic way of thinking. *At the centre of TPS are* ***people****.*

The executive or manager must go, see, and really understand the actual situation at the working level. Managers are not just managing technology or tasks; they are promoting the culture. The absolute core of the Toyota philosophy is that ‘*the culture must support the people doing the work’* (Liker, 2004). Management must demonstrate a commitment to quality every day, but ultimately quality comes from the workers. And you cannot tell people they are important and then risk their health and safety to make production goals that day - the two priorities are very clear, i.e. quality first, safety first, as explained by Gary Convis diagrammatically in figure 2.19 below (Liker, 2004).

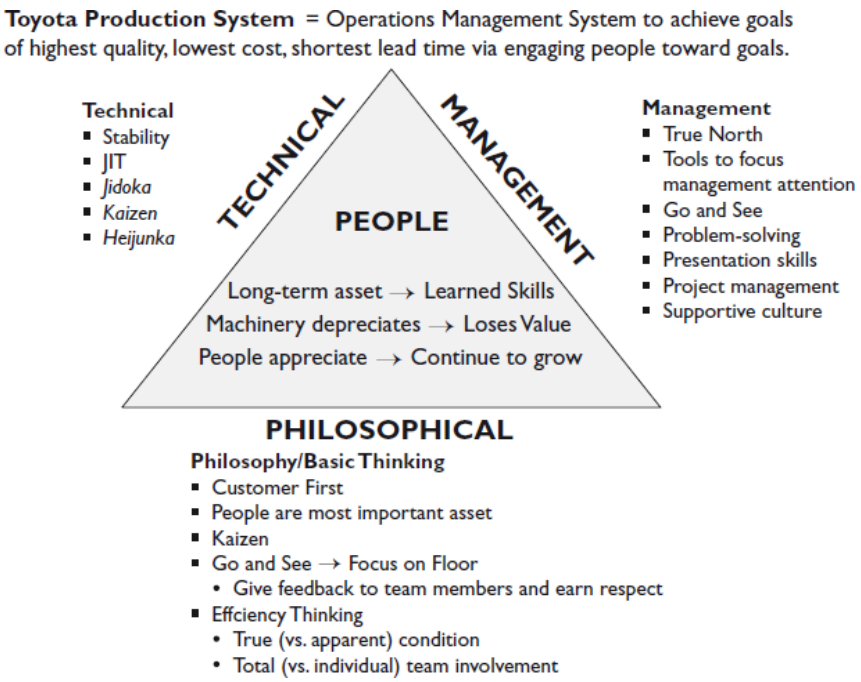


Figure 2.19 A Toyota Leader's View of the TPS

Source: Gary Convis designed figure 2.19 based on his experience at NUMMI (Liker, 2004)

Toyota has a common leadership theme, and Toyota leaders have a distinctive approach and philosophy that fits the Toyota way (Liker, 2004). The two-dimensional leadership matrix which describes leadership at Toyota is shown in figure 2.20, which means leaders can either rule by top-down directives or use a bottom-up involving style to develop people so they can think and make the right decisions on their own (Liker, 2004).

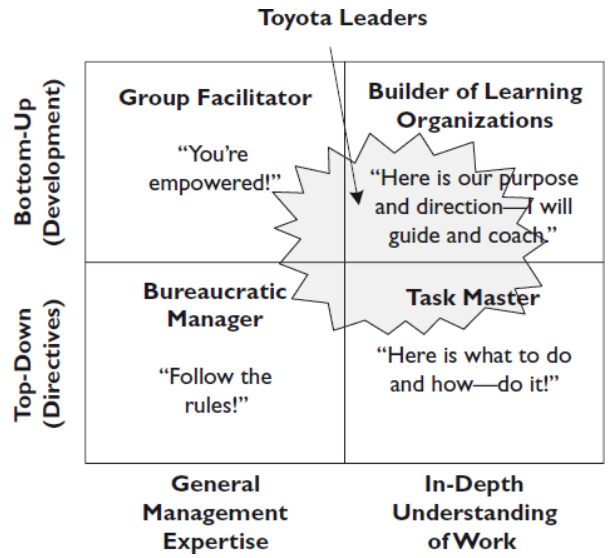


Figure 2.20 Toyota Leadership Model View of the TPS

Source: Liker (2004)

Figure 2.21 shows the Toyota leader partially in all four of the quadrants and each of these forms of leadership has a role at the appropriate time and place. The primary leadership role in Toyota is as builders of a learning organisation which serves as a distinctive strength of Toyota's culture. A common phrase from Toyota Company is that "*before we build cars, we build people*". The primary purpose of principle nine is to grow company leaders internally. It is paramount for organisation to grow and build their next generation of leaders internally (Liker, 2004).

Principle 10: Develop exceptional people and teams who follow your company's philosophy

According to Liker (2004) principle nine is all about developing excellent individual work while promoting effective team work. Based on the Toyota Production System, every employee at Toyota knows the important of teamwork because all the systems are in place to support teamwork. Liker (2004) stresses that "Teams at Toyota do not do value-added work but individual do". The teams coordinate the work, motivate, and learn from each other. Teams can suggest innovative ideas, and they might even control through peer pressure (Liker, 2004).

"Toyota has established an excellent balance between individual work and group work and between individual excellence and team effectiveness" (Liker, 2004). While teamwork is critical, having individuals work together in a group does not compensate for a lack of individual excellence or understanding of Toyota's system. Excellent individual performers are required to make up teams that excel (Liker, 2004). An assumption from Toyota is that "if any organisation makes teamwork the foundation of their company, individual performers will give their hearts and souls to make the company successful" meaning, it is all about challenging and respecting employees at the same time (Liker, 2004).

Liker (2004) expresses the view that "Toyota always puts a tremendous effort in finding and screening prospective employees because they wants to employ the right individuals to train and empower to work in teams". Liker (2004) stresses that "When Toyota selects one person out of hundreds of job applicants after searching for many months, it is sending a message that the capabilities and characteristics of individuals matter".

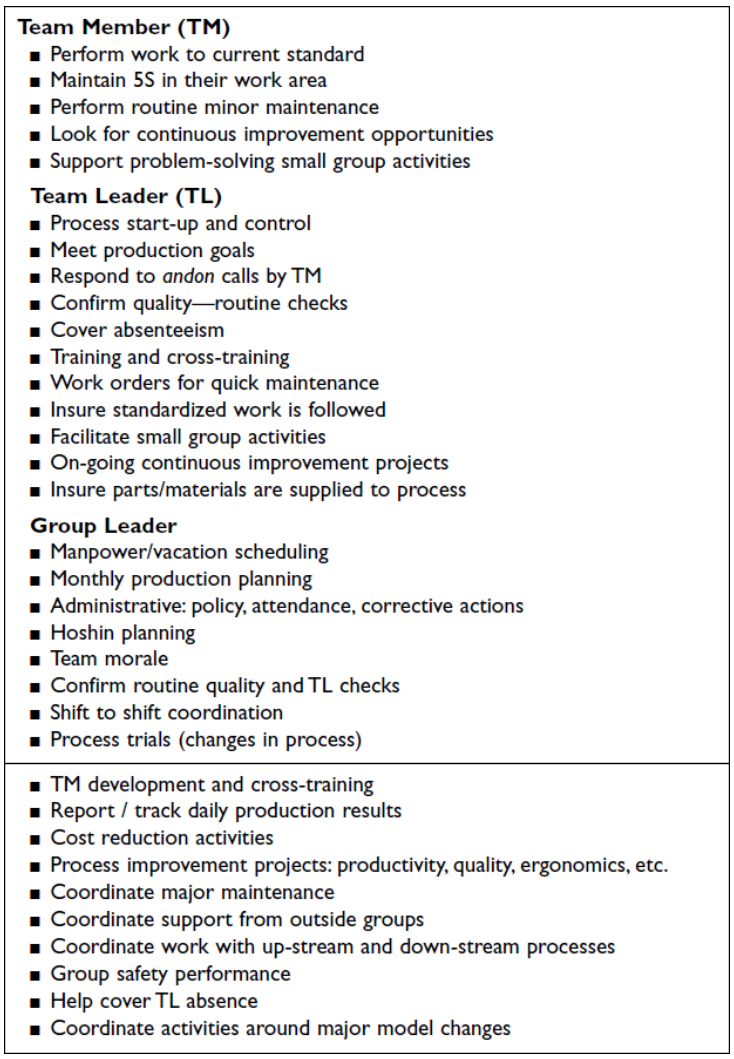


Figure 2.21 Toyota roles and responsibilities Source: Liker (2004)

According to Liker (2004) Bill Costantino compiled the roles and responsibilities for team members, team leaders, and group leaders for Toyota which are being summarized in figure 2.21 above. (Bill Costantino is one of the first group leaders at the Toyota plant in Georgetown, Kentucky.) Noteworthy is the progression of responsibilities from team members to group leaders and team members performing manual jobs to standard and being responsible for problem solving and continuous improvement (Liker, 2004).

Liker (2004) stresses that team leaders take on a number of the responsibilities traditionally done by "white-collar" managers, though they are not formally managers and do not have the authority to discipline other team members, and the primary role of team leader is to keep the line running smoothly and manufacturing quality parts, while group leaders do many things that otherwise would be handled by specialty support functions in human resources, engineering, and quality (Liker, 2004).

Liker (2004) says that Toyota's approach to the five most prominent motivation theories are summarized in figure 2.22. The five motivation theories are divided into two namely, internally motivated theory (intrinsic characteristics of the job itself motivate them to work hard and do quality work) and externally motivation theory (rewards, punishments, and measurement toward goals). Toyota uses all of these approaches to motivate employees as described in figure 2.22.

Liker (2004) stresses that "Toyota invests in people and in return it gets committed associates who show up to work every day and on time and are continually improving their operations". Training exceptional people and building individual work groups needs to be the backbone of any management approach, an approach that integrates your social systems with your technical system, (Liker, 2004). It is impossible to pull a ready-made culture out of a wizard's hat and building a culture takes years of applying a consistent approach with consistent principles, in this regard, the foundational elements of Maslow's theories as seen in figure 2.22 will be involved (Liker, 2004).

Internal Motivation Theories	**Concept**	**Toyota Approach**
Maslow's Need Hierarchy	Satisfy lower level needs and move employees up the hierarchy toward self actualization.	Job security, good pay, safe working conditions satisfy lower level needs. Culture of continuous improvement supports growth toward self actualization.
Herzberg's Job Enrichment Theory	Eliminate "dissatisfiers" (hygiene factors) and design work to create positive satisfiers (motivators).	5S, ergonomics programs, visual management, human resource policies address hygiene factors. Continuous improvement, job rotation, and built-in feedback support motivators.
External Motivation Theories		
Taylor's Scientific Management	Scientifically select, design standardized jobs, train, and reward with money performance relative to standards.	All scientific management principles followed but at the group level rather than individual level and based on employee involvement.
Behavior Modification	Reinforce behavior on the spot when the behavior naturally occurs.	Continuous flow and *andon* creates short-lead times for rapid feedback. Leaders constantly on the floor and providing reinforcement.
Goal Setting	Set specific, measur-able, achieveable challenging goals and measure progress.	Sets goals that meet these criteria through *hoshin kanri* (policy deployment). Continuous measurements relative to targets.

Figure 2.22 Classic motivation theories and the Toyota way. Source: Liker (2004)

Principle 11: Respect your extended network of partners and suppliers by challenging them and helping them improve

According to Liker (2004) automotive industry suppliers consistently report that "Toyota is their best customer and also their toughest. Toyota has very high standards of excellence and expects all their partners to rise to those standards and more importantly, Toyota always will help all their partners rise to those standards". Liker (2004) explains that "having respect for the extended network of supplier partners doesn't mean Toyota is being soft and an easy target, but as Toyota challenges its own people to improve, it needs to challenge its suppliers also". Supplier development includes a series of aggressive stretch targets and challenges to meet. Toyota believes that their suppliers want to work for them because they know they will get better and develop respect among their peers and other customers (Liker, 2004).

Liker (2004) explains that "Toyota is very careful when deciding what to outsource and what to do in house. Like other Japanese automakers, Toyota outsources a lot, about 70% of the components of the vehicle. But Toyota still wants to maintain internal competency even in components it outsources". The philosophical root of Toyota is the concept of self-reliance as seen from the Toyota Way document: "*We strive to decide our own fate. We act with self-reliance, trusting in our own abilities*". Therefore outsourcing the key capabilities to outside firms will contradict the Toyota's philosophy (Liker, 2004).

If Toyota outsourced 70% of the vehicle to suppliers that controlled technology for them and all its competitors, then the question is "how could Toyota excel or distinguish itself?" Therefore, Toyota wants to learn with suppliers, and never transfer all the core knowledge and responsibility in any key area to suppliers" (Liker, 2004). Toyota is working with Suppliers for Mutual Learning of Toyota Production System. Toyota has honed its skills as a result of applying TPS while working on project with the suppliers (liker, 2004).

"Toyota needs its suppliers to be as capable as its own plants at building and delivering high-quality components just in time" (Liker, 2004). However, Toyota doesn't cut costs unless their supplier does so, lest Toyota simply push cost reductions onto suppliers, which is not the Toyota Way. It is critical that it works with highly capable suppliers that are following TPS or an equivalent system and all the key suppliers of Toyota are also part of the Toyota Supplier association, (Liker, 2004).

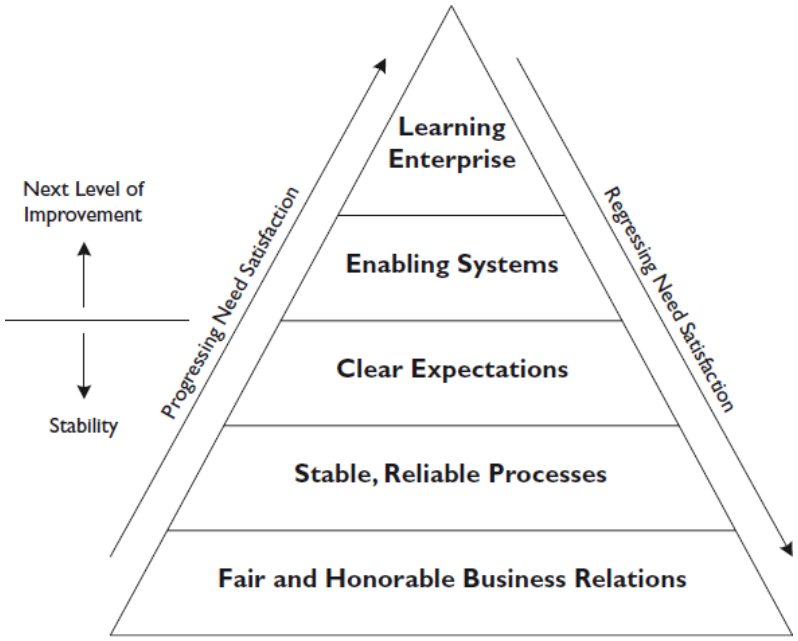


Figure 2.23 Supply chain need hierarchy (modelled after Maslow's need hierarchy) Source: Liker (2004)

Liker (2004) stresses that the supply chain need hierarchy and figure 2.23 suggests that "until the relationship has stabilized to the point where the business relationship is fair, processes are stable, and expectations are clear, it is impossible to get to the higher levels of enabling systems and truly learning together as an enterprise".

2.12.4 Section IV: Continuously solving root problems drives organisational learning

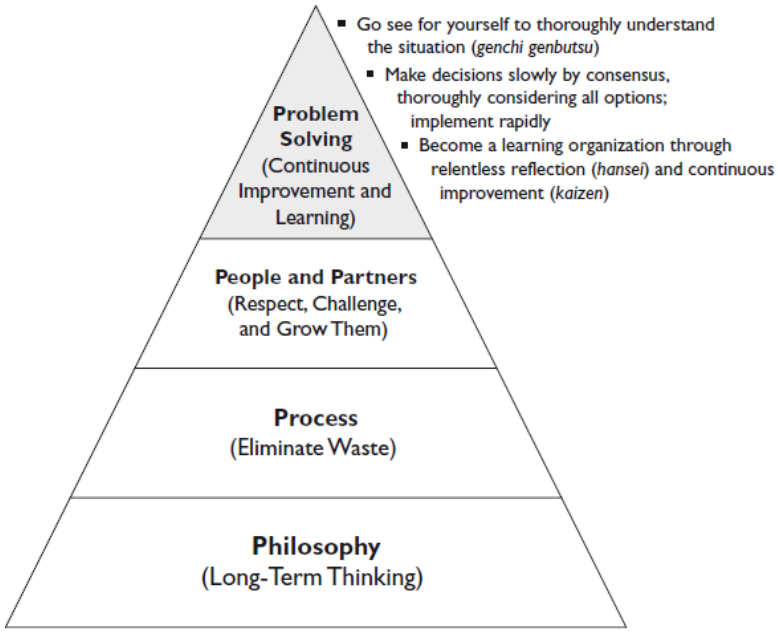


Figure 2.24 Section IV: The problem solving Source: Liker (2004)

Principle 12: Go and see for yourself to thoroughly understand the situation (*Genchi Genbutsu*)

According to Liker (2004) what distinguishes the Toyota way from other management approaches, the most common first response was *genchi genbutsu.* The only way someone could truly understand the state of Toyota Production System in the plant is for someone to go and see for himself. *Genchi* is translated as "the actual location" while *Genbutsu* is translated as "the actual materials or products. *Genchi Genbutsu* is being interpreted within Toyota as "*going to the place to see the actual situation for understanding*".

Liker (2004) maintains that "Toyota promotes and expects creative thinking, and innovation is a must, but it should be grounded in thoroughly understanding all every aspects of the actual situation". This is one of the behaviours that really distinguishes someone trained in the Toyota way; they take nothing for granted and know what they are talking about, because it comes from first-hand knowledge (Liker, 2004).

According to Liker (2004) any organisations attempting to learn from the Toyota way have to mandate all their engineers and managers to spend a half hour observing the floor to understand the situation and also to develop the skill to analyse and understand the current situation. There is a surface version of *genchi genbutsu* and a much deeper version, which takes many years for employees to master. Therefore, engineers and managers from different organisations trying to attempt the Toyota Way must know how to identify the root cause of any problems being observed and being able to communicate the problem effectively to others (Liker, 2004).

Principle 13: Make decisions slowly by consensus, thoroughly considering all options; implement rapidly

According to Liker (2004) at Toyota, thorough consideration in decision-making is paramount, new employees at Toyota face the challenge of learning the Toyota approach to problem-solving and decision-making. Toyota's process of consensus decision making is quite different and it a major re-education process. Decision-making processes at Toyota are very detailed, slow, cumbersome and time-consuming (Liker, 2004). At Toyota, "*how you arrive at the decision is just as important as the quality of the decision"*. Careful attention to every detail must be given to the entire underlying process of planning, problem solving, and decision making (Liker, 2004).

Liker (2004) emphasizes that a thorough consideration in decision-making includes five major elements or steps:

- **Step 1:** Finding out what is really going on, including *genchi genbutsu*.
- **Step 2:** Understanding underlying causes that explain surface appearances, i.e. asking "Why?" five times.
- **Step 3:** Broadly considering alternative solutions and developing a detailed rationale for the preferred solution.
- **Step 4:** Building consensus within the team, including Toyota employees and outside partners.
- **Step 5:** Using very efficient communication vehicles to do one through four, preferably one side of one sheet of paper.

Genchi genbutsu already being discussed in principle 12 while the "five - why analysis" will be discussed in principle 14 and principle 13 will focus on steps three through five.

Step 3: Broadly consider alternative solutions with a set-based approach

Liker (2004) says that

> "*as a young Toyota engineer, you attack a problem with relish. You carefully identify the cause of the problem, taking care to do a thorough five-why analysis. You then think and think and come up with a brilliant solution*".

Liker (2004) explains further that as a young Toyota engineer "you detail the solution and run in to share it with your mentor. Instead of evaluating the idea on its merits and congratulating you, he asks, "What other alternatives have you considered? How does this solution compare with those alternatives?" You are stopped dead in your tracks, as you were convinced that you had the best approach.

Liker (2004) has studied 'Toyota's product development system', and realized that Toyota senior engineers and managers were trained to think in sets of alternative solutions. As a result of this, Toyota is consistently faster in product development. Senior managers at Toyota say "*the hardest and most important lessons they teach young engineers is to delay decisions until they have considered a broad array of alternatives*". One of the advantages of getting many opinions

from many different people (through *nemawashi*, as discussed next in step 4) many alternatives are brought to light that can then be systematically evaluated (Liker, 2004).

Step 4: Getting on the same page through "*Nemawashi*"

Principle 13 includes the important process of *nemawashi*: that is "*make decisions slowly by consensus, thoroughly considering all options; implement rapidly*" (Liker, 2004). The process of *nemawashi* is often used to describe how junior people build consensus by developing a proposal and circulating it broadly for management approval. In the *nemawashi* process, many people are giving their input and this generates consensus. By the time the formal proposal comes up for a high-level approval, the decision is already made, agreements have been reached and the final meeting is a formality (Liker, 2004). Figure 2.25 shows that Toyota is using a group consensus approach. Management reserves the right to seek group input and then make a decision and announce it. This is done only if the group is struggling to reach consensus and management must step in or if there is an urgent need for a quick decision (Liker, 2004).

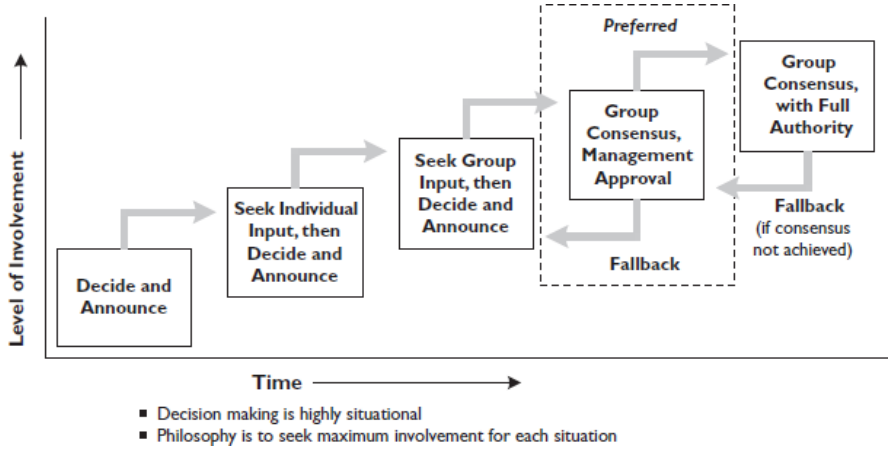


Figure 2.25 Alternative Toyota decision making methods Source: Liker (2004)

According to Liker (2004) one example of the *nemawashi* process is the way the broad circulation of ideas works in the early stages of product development. Liker (2004) explains that "one way new engineers learn about *nemawashi* at Toyota is through the freshman project. They are given a very challenging project, something they are unprepared for and could not possibly do on their own. The assignment will force fresh employees to learn *nemawashi* by doing it".

Step 5: Communicate visually on one piece of paper to arrive at decisions

Liker (2004) illustrates that "when communication going back and forth to build consensus, one might think that Toyota takes forever to get anything done" but yet "we know how efficient and

speedy Toyota is, so it should not be surprising that they have communication down to a science. The most time-consuming and difficult way to understand complex ideas is to have to decipher a lengthy report filled with technical descriptions, business terminology, and tables of data" (Liker, 2004). The visual approach is a more efficient way (i.e. a picture is worth a thousand words.). Acting on the fact that people are visually oriented, new employees at Toyota learn to communicate with as few words as possible and with visual aids (Liker, 2004).

Liker (2004) describes that an A3 sheet contains all the necessary information to make a complex decision and an A3 report contains problem, current situation, root cause, alternative solutions, recommended solutions [*plan, implementation process, and timeline*], and Cost-Benefit Analysis. This is the key part for the process of efficiency and getting consensus on complex decisions.

Liker (2004) says embedded in an A3 report is Toyota's problem-solving process, which is based on the Deming Cycle. Deming cycle says "*any good problem-solving process should include all of the elements of planning, doing, checking, and acting (PDCA)".* Figure 2.26 shows how the A3 proposal incorporates PDCA. Once you lay this groundwork, you are ready for the Deming Cycle steps—the plan, doing or implementing the plan, then checking and acting (Liker, 2004).

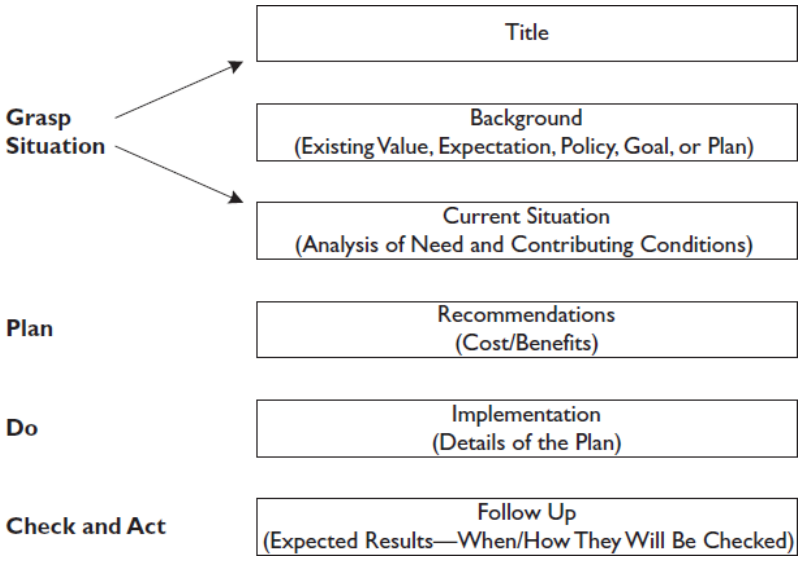


Figure 2.26 Plan-Do-Check-Act in the proposal process. Source: Liker (2004)

One of the benefits of the A3 communication format and a disciplined approach to problem-solving is that Toyota runs its meetings very efficiently (Liker, 2004). The discipline of the A3 process helps to accomplish effective meetings. According to Liker (2004) there are several prerequisites to an efficient meeting as listed below:

1. ***Clear objectives prior to the meeting:*** These are sometimes reflected in an agenda, but the agenda needs to be very focused on clear tasks and deliverables.
2. ***The right people at the meeting:*** People expected to show up need to show up.
3. ***Prepared participants:*** All participants know what they should prepare for the meeting and have done it.
4. ***Effective use of visual aids:*** The A3 format is extremely effective.
5. ***Separate information-sharing from problem-solving:*** Share information as much as possible prior to the meeting so that the focus of the meeting can be on problem-solving.
6. ***The meeting starts and ends on time*.**

According to Liker (2004) going through lengthy and thorough information gathering and analysis in decision-making processes assists Toyota Company to achieve the following:

1. It uncovers all the facts that, if not considered, could lead to a great deal of pain and backtracking further down the road. Execution tends to be flawless by most standards.

2. It gets all the parties on board and supporting the decision so any resistance is worked out before implementing anything. The cost of addressing this resistance when implementation begins is likely to be many times the cost of addressing it in the planning stage.

3. Toyota achieves a great deal of learning up front before anything is even planned or implemented.

Principle 14: Become a learning organisation through relentless reflection (Hansei) and continuous improvement (Kaizen)

According to Senge (1990) the primary goal of true learning organisations is to develop and grow over time, as it helps its members adapt to a continually changing competitive environment. Senge (1990) focuses on "new patterns of thinking" and learning to learn. Liker (2004) describes Toyota as the best learning organisation, and the reason is that it sees standardization and innovation as two sides of the same coin, melding them in a way that creates great continuity.

Toyota has judiciously used stability and standardization to transfer individual and team innovation into organisation-wide learning. TPS itself is designed to push team members to think

and learn and grow (Liker, 2004). The Toyota way involves the company and making sure that on a continuous basis it will be:

1. Learning from its mistakes
2. Determining the root cause of problems
3. Providing effective countermeasures
4. Empowering people to implement those measures; and
5. Having a process for transferring the new knowledge to the right people to make it part of the company's repertoire of understanding and behaviour.

Liker (2004) explains that continuous improvement will occur when a process is stable and standardized. Once waste and inefficiencies are publicly visible, then the organisation can learn continually from improvements. To be a learning organisation, it is necessary to have:

- Stability of personnel;
- Slow promotion, and
- Very careful succession systems to protect the organisational knowledge base.

Liker (2004) in figure 2.28 provides a hypothetical example of five-why analysis that "Toyota uses in internal problem-solving training; the problem is oil on the shop floor. In this example, each why brings us further upstream in the process and deeper into the organisation and the countermeasures on the other side are completely different depending on how deeply we dig" (Liker, 2004), and to keep asking why until the root cause(s) are determined. Take counter-measures at the deepest level of cause that is feasible and at the level that will prevent recurrence of the problem (Liker, 2004).

5 Whys is a method to pursue the deeper, systematic causes of a problem to find correspondingly deeper countermeasures.

Level of Problem	Corresponding Level of Countermeasure
There is a puddle of oil on the shop floor	Clean up the oil
Because the machine is leaking oil	Fix the machine
Because the gasket has deteriorated	Replace the gasket
Because we bought gaskets made of inferior material	Change gasket specifications
Because we got a good deal (price) on those gaskets	Change purchasing policies
Because the purchasing agent gets evaluated on short-term cost savings	Change the evaluation policy for purchasing agents

Figure 2.27 "5 - Why" investigation questions Source: Liker (2004)

Liker (2004) describes seven steps to a 'practical problem solving' as seen from Figure 2.28. At Toyota, a five-why analysis is often used as part of the seven-step process known as "practical problem solving" and before analysing the five-why questions, the 'practical problem solving' is required to clarify the problem, or in Toyota terminology "grasp the situation". Grasping the situation starts with observing the situation with an open mind and comparing the actual situation to the standard (Liker, 2004).

To clarify the problem, you must start by going to where the problem is (*genchi genbutsu*). This may include prioritizing a number of different problems in a Pareto analysis. The *Pareto diagram* uses bar graphs to sort problems according to severity, frequency, nature, or source and displaying them in order of size to show which problems are the most important. It is probably the most often used statistical analysis tool within Toyota - simple, but powerful (Liker, 2004).

Liker (2004) maintains that to set targets for improvement, the organisation must make the first attempt at identifying the point of cause (POC). The ultimate purpose of the exercise is to generate and implement a countermeasure and evaluate the results. The seventh step-standardizing the new process-is very important at Toyota. According to Liker (2004) standardization and learning go hand in hand and form the basis for continuous improvement. Tools, techniques, and metrics aside, Toyota's greatest emphasis is on thinking through problems and solutions. At Toyota, it is said that problem-solving is 20% tools and 80% thinking.

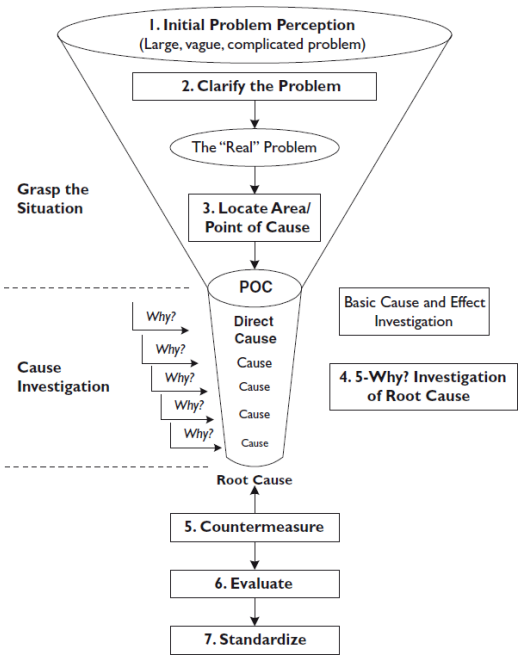


Figure 2.28 Toyota's practical problem-solving process Source: Liker (2004)

Liker (2004) explains that teamwork never overshadows individual accountability at Toyota. Individual accountability is not about blame and punishment, but about learning and growing (Liker, 2004). A key to learning and growing, not only within Toyota but in Japanese culture, is *hansei*, which roughly means "reflection." *Hansei* is a bit of Japanese culture and Toyota emulates it. It is one of the most difficult things they have ever had to teach, but it is an integral ingredient in Toyota's organisational learning (Liker, 2004).

Liker (2004) stresses that there are three types of measures used by Toyota:

1. ***Global performance measures:*** *how is the company doing?* At this level, Toyota uses financial, quality, and safety measures very similar to those used by other companies.
2. ***Operational performance measures:*** *how is the plant or department doing*? Toyota's measurements seem to be timelier and better maintained. The metrics tend to be specific to a process.
3. ***Stretch improvement metrics:*** *how is the business unit or work group doing?* Toyota sets stretch goals for the corporation, which are translated into stretch goals for every business unit and ultimately every work group.

Liker (2004) describes how *Hoshin Kanri is* directing and motivating organisational learning and the adage that "'"you get what you measure" is in a sense true at Toyota as well." Toyota long ago realized that the key to organisational learning is to align objectives of all of its employees

toward common goals (Liker, 2004). The underlying value system of Toyota's culture does that to a great degree. The important insight here is that simply setting specific, measurable, challenging goals and then measuring progress is highly motivating.

The basis for *Hoshin Kanri*, sometimes called "policy deployment", is Toyota's process of cascading objectives from the top of the company down to the work group level. Aggressive goals start at the executive level and then each level in turn develops measurable objectives for the year, designed to support the executive-level goals (Liker, 2004). Figure 2.29 shows how the process cascades down throughout the organisation and follows the PDCA process.

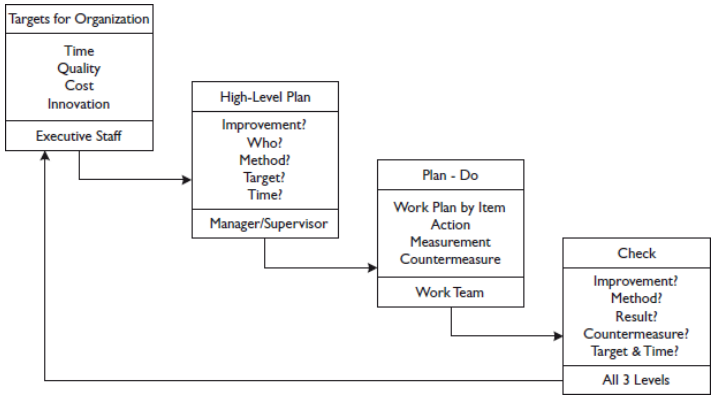


Figure 2.29 Policy deployment process (*hoshin kanri*). Source: Liker (2004)

2.13 The purpose for an in-depth review of the fourteen management principles of the Toyota way

The fourteen management principles of the Toyota way have very significant relevance to this research study because it highlights the reason why Toyota Company succeed using Lean philosophy. It provides the fundamental principles for a successful Lean implementation and any organisation planning to attempt Lean manufacturing principles can easily adopt the management principles as described by Liker (2004). Most importantly, what the fourteen management principles of the Toyota way do specifically is to assist Lean organisations to shape their understanding of Lean culture especially new organisations trying to adopt the Lean philosophy.

For an effective Lean implementation in any organisation, management members have significant roles to play. The fourteen management principles of Toyota way identify the key responsibilities of both management and employee in order to avoid Lean implementation failure. Therefore, every Lean organisation should ensure that they put into practice all the

fundamental principles that were outlined by Liker (2004). Moreover, any organisation willing to adopt Lean philosophy needs to explore and understand the fourteen management principles of the Toyota way; the purpose is not to emulate Toyota Company but to get the concept of Lean philosophy right from the very beginning of their Lean implementation journey.

2.14 Chapter summary

This chapter contains a comprehensive literature survey on 'Lean culture' as relating to the Toyota culture and Lean philosophy. Different dissertations, articles, journals, publications, online resources were sourced and reviewed. This chapter centred much on the Toyota Company because Toyota is the originator of Lean manufacturing through the development of the Toyota Production System (TPS). This chapter provides answers to the research questions stated in chapter 1 as listed below.

- What is Lean and more specifically what is a Lean philosophy? Why do lean implementations fail? What role does organisational culture play in this regard?
- What is organisational culture? Could the fourteen management principles of Toyota way help shape the Lean culture transformation? Are the fourteen management principles so important in Lean culture management?
- Can culture be measured qualitatively and quantitatively?

In the next chapter, the empirical investigation for the study is explained and the research methodology employed outlined.

Chapter 3

3. Empirical investigation

This chapter presents the empirical investigation of the study. The empirical investigation addresses the theory behind empirical investigation, scientific method, descriptive research and questionnaire survey. The different phases involved in the research methodology are explained.

3.1 An overview of the term "Empirical Investigation"

According to Bradford (2015) empirical investigation can be referred to as an act of conducting research and conclusions are reached through the means of observation, experimentation, measurement and documentation. Therefore, data is recorded and analysed by a scientist or a researcher and it forms a central process part of the scientific method.

Empirical investigation expresses both the structure of the research problem and the plan of investigation used to obtain empirical evidence on the problem statement (Stanley, 2014).

3.1.1 The scientific method

According to Bradford (2015) the scientific method begins with scientists formulating questions, or hypotheses, and then acquiring the knowledge to either support or disprove a specific theory, and as a result of this, collection of empirical data comes into play. Bradford (2015) further illustrates that "empirical research is the process of finding empirical evidence and therefore, empirical data is the information that comes from empirical research".

The scientific method often involves laboratory experiments that are repeated over and over, and these experiments result in quantitative data in the form of numbers and statistics (Bradford, 2015).

3.1.2 Descriptive research design

According to Penwarden (2014) descriptive research is conclusive in nature. Descriptive research is used to gather quantifiable information that can be used for statistical inference on a target audience through data analysis. Descriptive research design can be used to assist an organisation to better define and measure the significance of something about a group of respondents and the population they represent (Penwarden, 2014). Descriptive research is most commonly used when it comes to online and face-to-face surveying.

According to Penwarden (2014) most times organisations make use of the descriptive research method to reveal and measure the strength of a target group's opinions, attitudes or behaviour in line with a given subject or research area. Descriptive research can also be used when it comes to research which involves surveying demographic traits in a certain group (age, income, marital status, gender, etc.).

Penwarden (2014) explains that "the information gathered from the research surveying can be studied at face value, for measuring trends over time, and can also be used for more advanced data analysis like drawing correlations, segmentation, benchmarking and other statistical techniques". Therefore, this research study can be described as descriptive research because it possesses descriptive research attributes.

3.2 Types of empirical investigation

Bradford (2015) describes two research approaches commonly used by researchers and scientists to gather empirical measurements and data which are known as qualitative and quantitative research approach.

3.2.1 Qualitative research approach

According to Olds *et al.* (2005) as cited by (Borrego. *et al.* 2009) qualitative research is characterized by collection of data and analysis of textual data such as surveys, interviews, focus groups, conversational analysis, observation, ethnographies and by its emphasis on the context within which the study occurs.

3.2.2 Quantitative research approach

According to Borrego *et al.* 2009 quantitative methods are a good deductive approach to research in which a theory or hypothesis justifies the variables, the purpose statement, and the direction of the narrowly defined research questions. The quantitative research method allows the researcher to project his or her findings on a larger sample population by means of an objective process. The relevance of quantitative research approach to this research study is further illustrated in the research methodology under sub-section 3.1.

3.3 Measuring instrument

A measurement instrument can simply be defined as "a tool for collecting information about a particular issue of interest. A Questionnaire is made up of a list of questions, which must include clear instructions and space for answers or administrative details" (Kirklees Council, 2013:1). A

questionnaire must have a definite purpose that is related to the aim and objectives of the research study. More so, the respondents need to be made aware of the purpose of the research study wherever possible, and should be told how and when they will receive feedback on the findings (Kirklees Council, 2013:1).

Structured questionnaires are usually associated with quantitative research, i.e. research that is concerned with numbers, such as How many? How often? How satisfied? (Kirklees Council, 2013:1). More so, in quantitative research context, questionnaires survey can be seen from two perspectives (Kirklees Council, 2013:1):

- Postal and electronic questionnaires
- Face-to-face (F2F) and telephone questionnaires

3.3.1 The basic usefulness of a questionnaire

According to Kirklees Council (2013:3) questionnaires are most widely used to:

- Collect factual information in order to classify people and their circumstances
- Collect straightforward information that has to do with people's behaviour
- Look at the basic attitudes/opinions of a group of people relating to a particular issue
- Measure the satisfaction of customers with a product or service
- Gather 'baseline' information which can later be tracked over time to examine changes

3.3.2 Pilot survey for the research study

According to Stewart (as cited by Zailinawati, 2006) a pilot study can be defined as a 'small study to test research protocols, data collection instruments, sample recruitment strategies, and other research techniques in preparation for a larger study'.

This study used an existing questionnaire and no further pilot survey was conducted because a pilot survey had been conducted by the author and the questionnaires had been utilised in an automobile component manufacturer's environment in South Africa in 2011.

3.3.3 Research participants for the questionnaire survey

The aim of this research study is to measure the prevailing Lean culture at a South African aviation organisation and the same aviation company serves as the case study for the research. Therefore, employees at maintenance repair and overhaul operations (MRO OPS) and Depot Level working environment were the main target for the survey. They were duly informed and

the purpose of the survey was explained to them and they were requested to complete the questionnaire. The questionnaire were distributed manual by hand and the sample were 31. The sampling method used was probability sampling method i.e. each population element has a known (non-zero) chance of being chosen for the sample

3.4 Research methodology

In order to meet the aim and objectives of this study, the research methodology is further divided into two main phases, namely the pre-study and the main study. Figure 3.1 describes the research methodology diagrammatically. Each phase of the research methodology is explained in detail below.

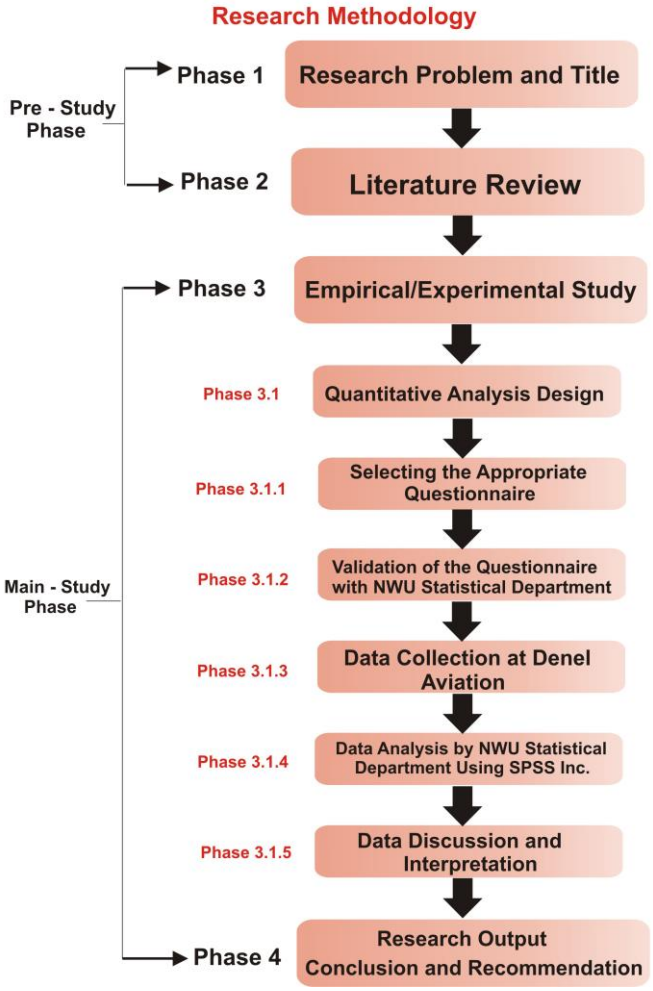


Figure 3.1 Research Design

Source: Researcher's own construction

3.4.1 Pre-study phase of the research methodology

The pre-study phase provides the preliminary insight into the research study. A pre-study precedes the actual main study of the research. During the pre-study phase, the research problem

is identified, the research title formulated and a comprehensive literature review conducted. Each pre-study phase was further elaborated below as shown in figure 3.1

- **Phase 1: Research problem and title**

The research problem was clearly identified after a comprehensive literature review of various publications, journals, articles and books on Lean culture. However, the research problem was identified as stated below.

The problem is that *in most Lean organization, the management and employees are not always aware of the impact that their influences have on Lean transformation and these actions are standing as strong barrier or obstacles to their Lean journey in the organization and the reason is that such actions are not being measured either qualitatively or quantitatively.*

- **Phase2: Literature review**

A comprehensive literature review was conducted on Lean philosophy. Several publications, articles, journals, books and internet resources were sourced from different research repositories.

3.4.2 Main study phase of the research methodology

The main study phase of the research is the pre-eminent aspect of the study. The main study entails choosing the appropriate empirical method for the research study. A quantitative research method was considered the suitable empirical method for the current study. The main study phase presents the research output and provides conclusion and recommendation for future research.

- **Phase 3: Empirical study/investigation**

Some literature sources were sought on the empirical study and vital insights acquired. This enabled the researcher to select suitable empirical method for the research study. This research study used quantitative empirical method which involves an application of a structure questionnaire to carry out a data survey at maintenance repair and overhaul operations (MRO OPS) and Depot Level workshop environment at a South African aviation company.

- **Phase 3.1: Quantitative research method**

The research study used a quantitative research method based on its advantage which allows the use of questionnaires, interviews and observations, etc. Moreover, a quantitative research

approach is suitable for statistical data analysis through the use of numerical data. The purpose and the objectives of the research study can be accomplished through the application of quantitative research method. As shown in figure 3.1 the quantitative research methodology was further divided into five sub-sections (3.1.1 to 3.1.5) as illustrated below.

- **<u>Phase 3.1.1</u>: Criteria for selecting appropriate questionnaire**

Selecting a suitable questionnaire for this research study was a great challenge. During the literature review phase, some existing measuring instruments (questionnaires) were found from open literature and scientific databases which were directly applicable to Lean culture and organisational culture. From figures 3.2 below, nine existing questionnaires were identified on Lean culture/implementation and one questionnaire on organisational culture.

To select a suitable questionnaire for the study, certain criteria were considered. Such criteria are as follows:

- Applicability of the questionnaire to the research study
- The questionnaire must be on Lean culture
- Applicability of the questionnaire to a South African aviation company
- Ease to complete and understand
- Useful for academic purpose

S/N	The Authors/Sources of the Research Papers/Publications	Title of the Research Paper /Publication that has the Questionnaire	The Purpose of the Questionnaire	Applicability to the research study	Lean Culture Questionnaire	Applicable to Denel Aviation	Ease to complete and understand	Useful for Academic Purposes
1.	Lawrence M. Miller (2011)	Lean Culture and Leadership Factors: A survey of Lean implementers' perception of execution and importance	To measure the perceptions of Lean implementers' based on Lean culture and Leadership factors.	X	X	X	X	X
2.	Gerald Davies (2008)	Assessing Readiness: Estimating the Challenge [Lean Enterprise Process Management]	To access process improvement readiness	X			X	
3.	Karl Robert van der Merwe (2011), PhD - Thesis	The Development of a Lean Culture Framework to Support the Effective Implementation of Lean in Automotive Component Manufacturers in South Africa	To develop a tool that can be used to diagnose organizational culture in the context of the Lean philosophy.	X	X	X	X	X
4.	Niklas Göthberg and Anastacia Simonchik (2013).	ATTITUDE TOWARDS LEAN: Change drivers impact on employees' attitude in the early stage of lean implementation:Case study	Explore the chosen change drivers' effect on employees' attitudes towards lean initiative during the early stage of lean implementation process	X	X		X	X
5.	Thorsten Ahrens (2006)	Lean Production: Successful Implementation of Organizational Change in Operations Instead of Short Term Cost Reduction Efforts	To analyse the critical success factors for successful Lean implementation.	X	X		X	
6.	Noemi Imre, Istvan Jenei and Davis Losonci [Corvinus University of Budapest, Hungary]	What is Lean Culture - and How to Measure it?	To measure the 'leanness' of existing culture	X	X	X	X	X
7.	Bingwen Yan and Keith Jacobs (2009)	Evaluating Employee Response to the Lean Enterprise System at a Manufacturing Company in Cape Town, South Africa	To analyze the reactions of employees when (LE) system is being Implemented	X			X	X
8.	Transformance Advisors Web-Page	Lean Cultural Transformation Assessment	To assist Lean organization to transformation into a full sustainable lean organization	X	X		X	
9.	Pentti Seppala and Soili Klemola (2004)	How Do Employee Perceive Their Organization and Job When Companies Adopt Principles of Lean Production?	To examine the perception of employees when adopting Lean production	X	X	X	X	X
10.	Provincial Government Western Cape (PGWC) 2009.	PGWC Organizational Culture Survey Questionnaire	To describe and assess the organizational culture of the PGWC.				X	

Figure 3.2 Criteria table used to select an appropriate questionnaire for the research study

Source: Researcher's own construction

A matrix table was used to select the appropriate questionnaire for the research study as shown in figure 3.2. The Karl van der Merwe questionnaire (based on a PhD-Thesis) was chosen; the questionnaire fulfilled all the criteria.

- **Phase 3.1.2: Validation of the questionnaire**

A copy of the questionnaire was designed and submitted to the NWU Statistical Consultation service for thorough evaluation and further validation. As stated earlier in chapter 1 and 3, Dr Karl van der Merwe (2011) is the original author of the measuring instrument used for this study. He conducted a pilot survey in order to validate the questionnaire. The questionnaire was sent to ten individual expert in the Lean research field. The questionnaire received positive response as to the validity of the questionnaire. Also the questionnaire has been utilized after at an automobile company in the Eastern Cape province of South Africa.

- **<u>Phase 3.1.3</u>: Data-collection process**

The data collection processes took the researcher two months of planning and preparation. Employees at the maintenance repair and overhaul operation (MRO OPS) and Depot Level workshop environment at a South African aviation company and were asked to complete the questionnaire. The data collection was conducted in a controlled manner. Fifty structured questionnaires were handed over to the human resources business partner at the chosen South African aviation company and thirty-one completed questionnaires were returned.

- **<u>Phase 3.1.4</u>: Statistical data analysis**

According to Tania (2014) statistical data analysis is the process of assigning meaning to the information collected during data survey and to determining the conclusions, significance, and implications of the findings.

According to Tania (2014), in statistical applications, there are varieties of data-analysis techniques. However, data analysis is divided into descriptive statistics, exploratory data analysis (EDA), and confirmatory data analysis (CDA). Exploratory data analysis focuses on discovering new features in the data. Confirmatory data analysis focuses on confirming or falsifying existing hypotheses (Tania, 2014).

From an article written by Koestler Parapsychology Unit Study Registry, i.e. KPUSR (2015). It was explained that a well-designed confirmatory analysis should be capable of providing evidence that an experimental hypothesis is false as well as true. One of the objective of the research is to apply an existing tool (a questionnaire) to measure and analyse the prevailing Lean culture at a South African Aviation Company and the hypotheses were stated.

A well-designed confirmatory data analysis has certain characteristics to follow and these characteristics were followed to arrive at the variables and these independent and dependent variables were carefully selected in line with Lean philosophy. Sample size is set to usefully test the hypothesis based on the power analysis with a power of at least 0.80 or higher 0.90. (KPUSR, 2015).

All analysis decisions that could affect the results are made before data collection starts. These includes: (a) the specific statistical test, (b) whether the test is one-sided or two - sided, (c) the criterion (e.g., p-value) for acceptable evidence, (d) any transformations or adjustments to the data, (e) any criteria for excluding or deleting data, and (f) any corrections for multiple analyses.

Given the established research methodology and adequate power, a nonsignificant result would be evidence that the experimental hypothesis is false for the effect size used in the power analysis as later discuss in chapter 5 when interpreting the hypothesis result based on stated null and alternative hypothesis. All the null hypothesis were confirmed true because they all have power analysis of at least $p > 0.08$.

The North-West University Statistical Consultation Services analysed the data collected with the aid of SPSS version 22 (Statistical Package for the Social Science). The most commonly accepted statistical measures were employed such as mean, standard deviation, frequency distribution and so on.

- **Phase 3.1.5: Interpretation of data**

The North-West University Statistical Consultation Services returned the data analysed within two weeks (i.e. August, 2015). The data was studied, discussed and interpreted based on the sample size of the data and the result was reported in chapter 5 as well. The interpretation of the data is to further support an effective Lean culture implementation at a South African aviation company.

- **Phase 4: Research output, conclusion and recommendation**

The interpretation of the empirical results and findings was done with distinct reference to the chosen South African aviation company. This phase presents the conclusions and recommendations and brings the entire research study to logical conclusion and suggests possible future research study in this area.

3.5 Chapter summary

In this chapter, a clear description of the empirical investigation was presented. The research methodology and criterion for selecting a suitable questionnaire for the research study was explained.

The next chapter will contain the empirical results and findings as relating to the research study. The chapter will further explain the process of categorization involved in structuring the questionnaire by the author. The chapter also presents the analysis of the biographical information in section A of the questionnaire.

Chapter 4

4. EMPIRICAL AND FINDINGS

This chapter presents the empirical results and findings. The measuring instrument was explained which contained the dependent and independent variables. This chapter described some useful statistical terminologies such as (effect size, p-value, significance testing, Confidence interval, and Cronbach's alpha coefficient) which are relevant to the discussion and interpretation of data in chapter 5.

4.1 An overview of empirical findings

Empirical findings are collective information, data or knowledge gained by means of observation or experimentation rather a theory based information. Empirical research is research which is based on experimentation or observation, (UNCC, 2015).

4.2 Independent, dependent and extraneous variables

According to McLeod (2008) a variable is anything that can vary, that is, changed or be changed. Variable are given a special names that only apply to experimental investigations. (McLeod, 2008) mentioned two types of variable namely (dependent variable and independent variable). During an experiment, a researcher is searching for possible effect on the dependent variable that might be caused by changing the independent variable.

According to McLeod's (2008), independent, dependent, operationalising and extraneous variables are explained below:

- **Independent variable (IV)**

The researcher manipulates these types of variables (i.e. they make changes). The researcher assumed that the variables would have a direct effect on the dependent variable. And the independent variables used are: awareness, consistency, engagement and accountability. This are further explained in detail in chapter 4 section 4.3

- **Dependent variable (DV)**

The variable the researcher measures after making changes to the independent variable that are assumed to affect the dependent variable.

- **Operational variables**

It is very essential to clearly define what the researcher means when specifying independent and dependent variable in research. An operational variable describes the techniques or how the researcher defines the variable used and how the researcher measure a specific variable as it is used in the research study.

- **Extraneous variables**

Extraneous variables are those variables which are not the independent variable but could affect the results (for instance, dependent variable) of the experiment. (McLeod, 2008) explains that "When we conduct experiments there are other variables that can affect our results, if we do not control them. The researcher wants to make sure that it is the manipulation of the independent variable that has changed the changes in the dependent variable". The variables that could affect dependent variable results are called extraneous or confounding variables. Extraneous variables need to be controlled where it is possible.

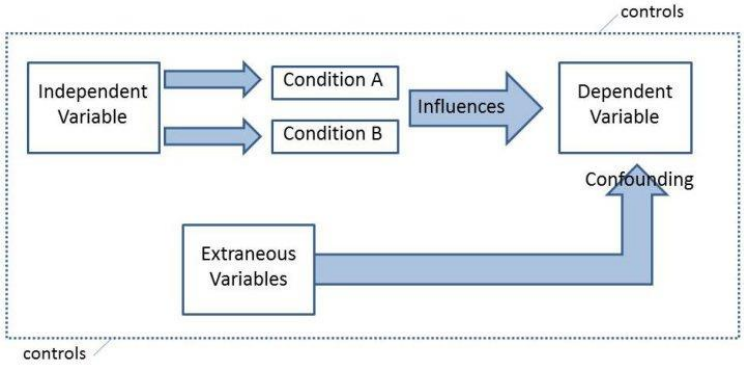


Figure 4.1 Possible way to controlling extraneous variable effects

Source: McLeod (2008).

4.2.1 Four types of extraneous variables

According to McLeod (2008) there are four types of extraneous variable which can be controlled as explained below.

1 **Situational variables**: These are features of the environment that might affect the participant's behaviour such as temperature, noise, lighting conditions etc. Standardized procedures can be used to control situational variables by ensuring that the conditions are the same for every participant during the research through the use of standardized instructions.

2 **Participant or person variable**s: The participant variables could be referred to the ways in which each participant varies from the other, and how this could affect the results such as mood, intelligence, anxiety, nerves, concentration etc. (McLeod, 2008). The experimental design chosen by the researcher can have an effect on participant variables as well. Participant variables can be controlled using random allocation to conditions of the independent variable (McLeod, 2008).

3 **Experimenter or investigator effects**: The researcher unconsciously conveys to participants how they should behave and this is referred to as experimenter bias. The researcher needs to give unintentional clues to the participants as regarding what the entire experiment is all about and how they were expected to behave. Personal attributes of the experiment such as (age, accent, manner, gender and etc.) can affect the participant's behaviour. Often, the researcher is completely unaware of the influence which he is exerting on the participant behaviours in regardless of the subtle of clues given, nevertheless such clues have an influence on the result.

4 **Demand characteristics**: These are the clues in an experiment which convey to the participant the purpose of the research. The participants could be affected by their surroundings, the researcher's characteristics, the researcher's behaviour such as non-verbal communication, and their interpretation of what is going on in the situation. The researcher can minimise those demand characteristics mentioned by keeping the environment as natural as possible and also the standardised procedures should be carefully followed (McLeod, 2008).

4.3 Measuring instruments for the research study

A questionnaire serves as the measuring instrument for the surveys. As earlier stated in chapter 1 and 3, the survey was administered using an existing questionnaire (previously-tested) which was designed by Dr Karl van der Merwe. The researcher took into consideration all possible

extraneous variables that might affect or influence the survey result and ensured they were put under control as much as possible.

According to van der Merwe (2011) the questionnaire was selected from a group of questionnaires commonly used to measure the overt Lean characteristics of organisations and was developed from the findings of the literature study on Lean philosophy. The questionnaire for the study was administered to the respondents via personal delivery and was returned via personal collection at the aviation company . As stated in chapter 1, the questionnaire has been utilised in an automobile component manufacturer's environment in the Eastern Cape province of South Africa.

Van der Merwe (2011) explains that the questionnaire was designed based on one dependent variable (to examine the current level of Lean culture in the organisation) and four categories of independent variables, namely Situational awareness, Engagement, Consistency, and Accountability (further explained below):

- **Awareness:** The degree to which managers have successfully implemented Lean culture with an aim to create a shop floor environment that respond to situational awareness. Value streams are compulsory to create and support a Lean culture change and must be developed to create situational awareness. Awareness can be achieved partly when all team members who form a value stream are aware of the boundary, components, and importance of the value stream they manage.

- **Engagement:** The degree to determine to what extent management has actively engaged and challenged the employees within the Lean department. An awareness and engagement variable goes hand in hand because both have the tendency to accommodation the management activities that are special to Lean culture. Employee engagement serves as the key preference for most organisations that have successfully made their transition to a Lean culture organisation (van der Merwe, 2011).

- **Consistency:** The degree to determine the consistency of the management actions, if it guided and supported by the vision and mission of the organisation Lean culture. When certain amounts of standardised works are being created for managers, the primary aim is to ensure the managers and employees are strongly embedded in a Lean culture system. However, the main goal of such Lean organisation is to attain consistency through the adoption of standardised leadership work (van der Merwe, 2011).

- **Accountability:** This considered the two factors in the development of a Lean culture; namely exercising corrective actions and corresponding follow-up process. Van der Merwe *et al.* (2014) suggest that "the acceptance of accountability is a key factor in Lean culture development process. It is very evident from the works of many Lean authors with their support that accountability is regarded as a Lean culture activity".

4.3.1 The structure of measuring instrument

The measuring instrument (questionnaire) for this study was structured in two sections (A and B) as shown in figure 4.2. Section A contained the biographical information and section B contained variables that can be used to measure Lean management or leadership actions as regarding to Lean culture implementation.

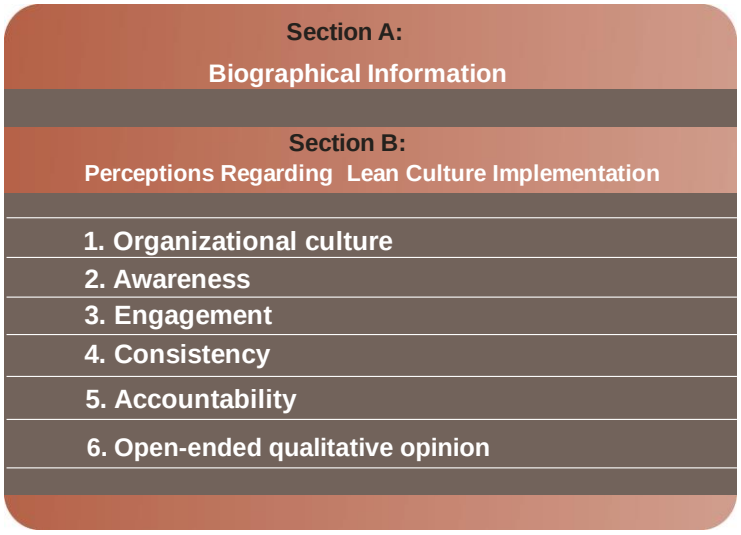


Figure 4.2 Questionnaire structure

Source: Researcher's own construction (adapted from van der Merwe, 2011)

4.3.1.1 Section A: Biographical information

The biographical information as shown in figure 4.3 contains five questions. The respondents were requested to indicate their age, gender, their current organisation, their level within the current organisation and years of service at the current organisation in the biographical information section.

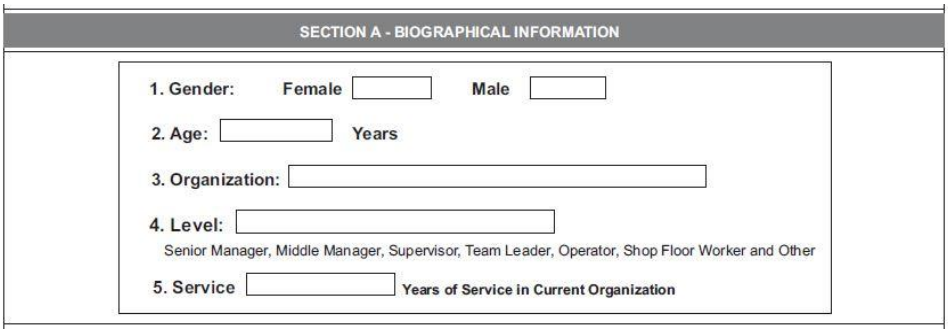


Figure 4.3 Section A - Biographical information

Source: Researcher's own construction

All the questions asked in section A as shown in figure 4.3 were considered relevant to the study. When the respondents indicated his/her age and gender in the questionnaire, this would assist the researcher in characterising the way each respondent perceived the management actions as relating to Lean culture activities based on gender and age (i.e. to know which gender perceive the relevance of Lean culture in their organisation and also assist to know if individual age has something to do with their perception) van der Merwe (2011).

Moreover, the years of service and the position of responsibility of individual employee most times have influence on the way each employee perceives their current organisation. Identifying respondents' organisational history is of great importance for an effective data survey (van der Merwe, 2011).

4.3.1.2 Section B: The main body of the questionnaire

Section B comprises the main body of the questionnaire as shown in figure 4.2, the section contained the variables that were used to measure prevailing Lean culture as relating to Lean culture implementation at South African Aviation Company. Section B was divided into six sub-sections, the first sub-section was a dependent variable which aimed to measure "the prevailing level of Lean culture within the organisation, as perceived by each respondent" (van der Merwe, 2011).

The questions in the first sub-section would be suitable to gauge the impact of the remaining five sub-sections, that is, testing the impact of the independent variables upon the dependent variables. The last question in the questionnaire is categorized as an open-ended question. According to van der Merwe (2011) the open-ended question "was expected to provide further insight into the four major independent variables and thereby possibly raising other actions considered important to the Lean culture development process".

The measuring instrument contained a total number of 45 questions. The first sub-section contained ten questions. The second, third and four sub-sections contained nine questions each. The fifth sub-sections on contained six questions and the sixth sub-section is an open-ended question. A copy of the questionnaire can be found as appendix A. Each sub-section of the questionnaire was clearly explained below:

Section B - Sub-Section 1 – Related questions on Lean culture

Figure 4.4 described the questions that relate to attitudes and behaviours which characterized a Lean organisational culture (van der Merwe, 2011).

1. This section relates to your organization's culture or, more simply "the way we do things around here". Please indicate to what extent you agree with each of the statements below by circling the		Disagree Strongly	Disagree	Agree	Agree Strongly
1.1	A problem is viewed as an opportunity to improve	1	2	3	4
1.2	Recurring problems disrupt flow	1	2	3	4
1.3	We consider the impact of decisions on the rest of the organization	1	2	3	4
1.4	We believe that reducing waste makes us more competitive	1	2	3	4
1.5	We are able to respond quickly to customers' changing demands	1	2	3	4
1.6	Identifying problem does **not** lead to blame	1	2	3	4
1.7	Solutions are implemented that prevent a problem from recurring	1	2	3	4
1.8	Decisions are taken for the "greater good" of the organization	1	2	3	4
1.9	Negative customer feedback (internal or external) leads to change	1	2	3	4
1.10	We believe that quick response to change is important	1	2	3	4

Figure 4.4 Related questions on Lean culture.

Source: Researcher's own construction (adapted from van der Merwe, 2011)

- **Questions 1.1 and 1.6** were used to examine the attitudes and behaviours as relating to problem-solving approach and to test the level of understanding of individual employees as relating to Lean philosophy.
- **Questions 1.2 and 1.7** were used to examine the attitudes and behaviours of each employee as relating to root-cause solutions.
- **Questions 1.3 and 1.8** were designed to examine the attitudes and behaviours that show the extent to which individual employees understand their responsibility within the organisation and more so the nature of the Lean system in the organisation.
- **Questions 1.4 and 1.9** were used to investigate the attitudes and behaviours that show an embedded culture of waste elimination. The question also examines respondents' knowledge of how customers defined the value or waste for the organisation.

- **Questions 1.5 and 1.10** examine the attitudes and behaviours that show the extent to which the employees can be flexible and give quick response to change.

<u>Section B - Sub-Section 2</u> – Related questions on situational awareness

In figure 4.5, the questions were used to investigate the extent to which the managers have successfully implemented Lean systems, thereby creating a shop floor environment that facilitates situational awareness.

2. This section relates to the levels of awareness on the shop floor. Please indicate to what extent you agree with each of the statements below by circling the appropriate number. **Note:** Value Stream: the processes of creating, producing, and delivering a good or service to the market		Disagree Strongly	Disagree	Agree	Agree Strongly
2.1	The concept of a value stream is widely understood	1	2	3	4
2.2	A visitor would be able to identify each shop floor value stream	1	2	3	4
2.3	We know what measures are important to each value stream	1	2	3	4
2.4	Visual systems provide information about the status of each value stream	1	2	3	4
2.5	We constantly refer to our visual systems	1	2	3	4
2.6	Employees know the location and extent of each value stream	1	2	3	4
2.7	Key processes have been identified in each value stream	1	2	3	4
2.8	Problems affecting output have been identified	1	2	3	4
2.9	Problems on the shop floor become obvious as soon as they occur	1	2	3	4

Figure 4.5 Related questions on situational awareness

Source: Researcher's own construction (adapted from van der Merwe, 2011)

- **Questions 2.1, 2.2 and 2.6** were used to investigate the degree to the management have followed actions that initiate awareness of Lean concept and the extent and the boundaries of each value stream.
- **Questions 2.3, 2.7 and 2.8** were designed to measure the ability of individual employee to identify factors that are critical to the success of every value stream and to investigate how far the employees are aware of those critical factors that lead to situation awareness.
- **Questions 2.4, 2.5 and 2.9** were designed to investigate the extent to which the visual system implemented has helped the entire working environment.

A positive response from the respondents to questions under sub-section 2 shows that Lean management in any Lean organisation has actively made decisions resulting in an operational environment where team members are constantly aware of the conditions prevailing throughout the length of their value stream (van der Merwe, 2011).

<u>Section B - Sub-Section 3</u> – Related questions on employee engagement

Questions from sub-section 3 were developed to investigate the degree to which Lean management have actively engaged and challenged the employees within the Lean organisation (van der Merwe, 2011).

3	This section aims to explore the degree to which employees are engaged and challenged by management. Please indicate to what extent you agree with each of the statements below by circling the appropriate number	Disagree Strongly	Disagree	Agree	Agree Strongly
3.1	Leaders participate in shop floor improvement efforts	1	2	3	4
3.2	Team members' feedback is valued by supervisors and managers	1	2	3	4
3.3	Team members' are challenged to provide the best solutions	1	2	3	4
3.4	A formal procedure exists for obtaining suggestions	1	2	3	4
3.5	Feedback is provided on all suggestions	1	2	3	4
3.6	Leaders discuss work problems and often offer guidance	1	2	3	4
3.7	Team members are asked for problem solutions	1	2	3	4
3.8	Experience and guidance has led to an improved problem-solving	1	2	3	4
3.9	Good suggestions are implemented	1	2	3	4

Figure 4.6 Related questions on employee engagement

Source: Researcher's own construction (adapted from van der Merwe, 2011)

- **Questions 3.1, 3.2 and 3.6** were used to measure the degree to which Lean management has actively engage team members and how the management value the team members input.
- **Questions 3.3, 3.7 and 3.8** were used to measure meaningful employee engagement, i.e. investigate whether the managers are challenging the team member or the team members are challenging each other in order to provide innovative solution to identify problems.
- **Questions 3.4, 3.5 and 3.9** were used to investigate the degree to which the organisation is able to receive feedback and suggestions from team members and also to know how effective the system in place for gathering feedback and suggestion working is (van der Merwe, 2011).

Section B - Sub-Section 4 – Related questions on consistency

The questions in sub-section 4 are directly related to the consistency of managerial actions on Lean culture implementation in the organisation. Such managerial actions are supported or guided by the vision and mission illustrated by means of consistent decisions guided by standardized meetings by the leadership group within the organisation (van der Merwe, 2011).

4	This section relates to the consistency of managerial actions. Please indicate to what extent you agree with each of the	Disagree Strongly	Disagree	Agree	Agree Strongly
4.1	A regular schedule of Lean feedback meetings exists for all leaders	1	2	3	4
4.2	Regular Lean feedback meetings ensure sustained focus	1	2	3	4
4.3	All levels of leadership are included in the plan	1	2	3	4
4.4	Leaders make decisions that support the vision and mission objectives	1	2	3	4
4.5	Daily decisions are made to support our vision and mission statements	1	2	3	4
4.6	Managers meet with supervisors regularly throughout a shift	1	2	3	4
4.7	The feedback meeting schedule is written into organizational procedures	1	2	3	4
4.8	Managers are often too busy to attend scheduled Value Stream Meetings	1	2	3	4
4.9	Managers have a common approach to problem solving	1	2	3	4

Figure 4.7 Related questions to consistency

Source: Researcher's own construction (adapted from van der Merwe, 2011)

- **Questions 4.1, 4.2 and 4.6** were used to examine the degree to which successful layered and standardised leadership plans have been developed (van der Merwe, 2011).
- **Questions 4.3, 4.7 and 4.8** were used to determine the extent of the standardised leadership plan, as well as the degree to which it has been institutionalised and accepted as standard practice or "the way we do things around here" (van der Merwe, 2011).
- **Questions 4.4, 4.5 and 4.9** examine the aspect of making decisions aligned with the stated Lean objectives and the consistency thereof within the management group (van der Merwe, 2011).

Section B - Sub-Section 5 – Related questions on accountability

Sub-section 5 questions were grouped under common title called "accountability" as shown in figure 4.8. Questions under sub-section 5 were designed to investigate two important factors when developing a Lean culture in an organisation; the two factors are "the assignment of corrective actions and the associated follow-up process" (van der Merwe, 2011).

5	This section aims to explore the prevailing levels of accountability and associated systems. Please indicate to what extent you agree with each of the statements below by circling	Disagree Strongly	Disagree	Agree	Agree Strongly
4.1	Corrective actions are assigned to individuals	1	2	3	4
4.2	Team members know what is expected of their team	1	2	3	4
4.3	Due dates are assigned to corrective actions at all levels	1	2	3	4
4.4	Procedures exist for assigning corrective actions to individuals within teams	1	2	3	4
4.5	Managers and supervisors follow up on corrective actions	1	2	3	4
4.6	Action is taken when deadlines are missed	1	2	3	4

Figure 4.8 Questions related to accountability

Source: Researcher's own construction (adapted from van der Merwe, 2011)

- **Questions 5.1, 5.2 and 5.4** were designed to measure the degree to which corrective actions are assigned to team members and the likelihood of these actions being sustainable. Sustainability is considered achievable if team members understand what is expected of them. Furthermore, the procedures for creating accountability must be written into standard operating procedures (van der Merwe, 2011).
- **Questions 5.3, 5.5 and 5.6** examine the issue of due date assignation and the consequences of missed deadlines (van der Merwe, 2011).

Section B - Sub-Section 6 – The open-ended question

The sub-section 6 contained one single open-ended question as shown in figure 4.9. The open-ended question was expected to provide more insight into the four major independent variables, the answer to this open-ended question might possibly raise some other actions considered important to the Lean culture development process in the organisation (van der Merwe, 2011).

6. What actions do you believe have influenced the Lean Culture of your Organization in either a positive or negative way?

Figure 4.9 Open-ended question

Source: Researcher's own construction (adapted from van der Merwe, 2011)

The respondents were expected to consider actions that may have negatively impacted on the initiation of a Lean culture. Such factors that might be raised in sub-section 6 could reasonably

be considered to be *barriers* to the development of a Lean organisational culture (van der Merwe, 2011).

4.4 Confidence interval in statistical analysis

According to Du Prel *et al.* (2009:336) confidence interval is a range of values calculated by statistical methods which includes the desired true parameter with a probability defined in advance (coverage probability, confidence probability, or confidence level). The confidence level of 95% is usually selected. This means that the confidence interval covers the true value in 95 of 100 studies performed (Du Prel *et al.*; 2009:336).

Du Prel *et al.* (2009:336) maintain that "the size of the confidence interval depends on the sample size and the standard deviation of the study groups. If the sample size is large, this leads to '*more confidence*' and a '*narrower confidence interval'*. If the confidence interval is wide, this may mean that the sample is small. If the dispersion is high, the conclusion is less certain and the confidence interval becomes wider". Moreover, the size of the confidence interval is influenced by the selected level of confidence. Du Prel *et al.* (2009:336) explain that "a 99% confidence interval is wider than a 95% confidence interval. In general, with a higher probability to cover the true value the confidence interval becomes wider".

4.5 Cronbach's alpha coefficient (α) in quantitative analysis

For the purpose of this study, the reliability of statistical analysis or test was examined using Cronbach's alpha coefficient (α). 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 (IDRE, 2015). From the technical point of view, Cronbach's alpha is not a statistical test but rather a coefficient of reliability or consistency (IDRE, 2015).

Cronbach's alpha can be written as a function of the number of test items and the average inter-correlation among the items (IDRE, 2015). For conceptual purposes, the standardized Cronbach's alpha formula can be checked below:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

From the Cronbach's alpha standardized formula, N can be described as the number of items, the c-bar as the average inter-item covariance among the items and lastly the v-bar equals the

average variance (IDRE, 2015). When the Cronbach's alpha is equal to (.80) and above, this suggests that the items have "relatively high internal consistency". In most quantitative research study, a relatively Cronbach's alpha coefficient of (.70) or higher is considered "*acceptable"* (IDRE, 2015).

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent (High-Stakes testing)
$0.7 \leq \alpha < 0.9$	Good (Low-Stakes testing)
$0.6 \leq \alpha < 0.7$	**Acceptable/Moderate reliability**
$0.5 \leq \alpha < 0.6$	**Poor/Low reliability**
$\alpha < 0.5$	**Unacceptable**

Figure 4.10 Description of Cronbach's alpha coefficient

Source: Vasudevan (2014)

4.6 Population and sample size for the research study

Zamboni (2015) stresses that "sample size is an important concept in statistics, and refers to the number of individual pieces of data collected in a survey. A survey or statistic's sample size is important in determining the accuracy and reliability of a survey's findings". In most cases, either qualitative or quantitative research study large sample sizes are required for a statistic to be accurate and reliable, particularly if its research findings are to be extended to a larger population or group of data (Zamboni, 2015).

The sample size for this research study was very small due to the limited number of employees at the Maintenance Repair & Overhaul (MRO OPS). The total sample frame (size of employees) at the MRO OPS and Depot level workshop was identified to be within 60 employees in different functions and levels of operation. 50 questionnaires were handed out at the case study company. The final number of completed questionnaires returned was 31 (a 62% response rate) while one of the questionnaire was unusable because the respondent didn't complete his biographical information. 19 questionnaires were not returned (a 38% non-response rate) as shown in figure 4.12. Griffin and Hauser, (1993), explain that a sample size of 30 respondents would provide a

reasonable starting point for either qualitative or quantitative research. Therefore, the sample size of 31 questionnaires received for this research purpose was sufficient for statistical analysis and gives sufficient research result.

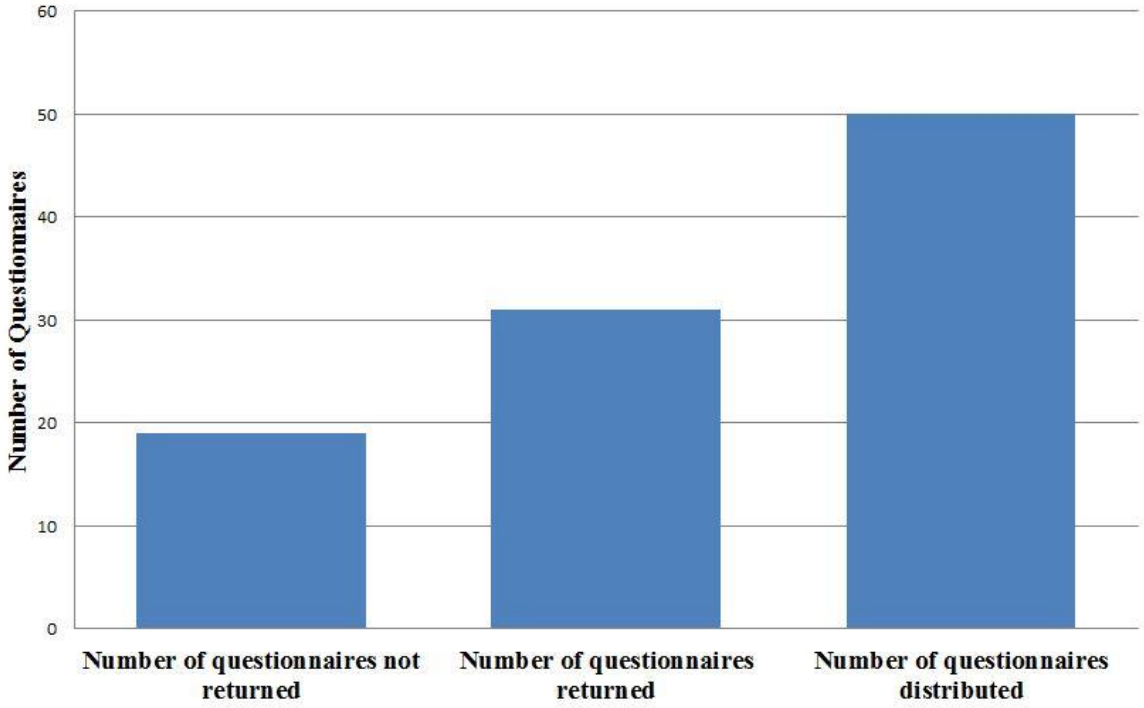


Figure 4.11 Sample size for the research study

Source: Researcher's own construction

Some of the reasons why 100% response rated was not recorded might be as a result of the following:

- Lack of understanding of the Lean concept
- Uncaring attitude from some of the employees toward the research survey
- Wrong assumption that Lean implementation implies shortage of staff or loss of their jobs
- Inability of the management to instil the Lean culture in the hearts of the employees
- Apathy problems, i.e. some employees not seeing any reason to participate in the questionnaire survey.

Future research on Lean culture at the case study company (Aviation Company) will address some of the wrong reasons mentioned above.

4.7 Analysis of the respondents' biographical information

This section presents the biographical information of the respondents. The biographical information contained respondents' gender, age, organisation, level and length of service as

shown in figure 4.3. The respondents' biographical information can be used for further analysis in the next sub-sections.

4.7.1 Gender of respondents

Table 1.5 below shows the respondents' gender (female and male). The biographical data indicated that 38.7% (n=12) of the respondents were female, while 58.1% (n=18) of the respondents were male. One respondents' biographical information 3.2% (n=1) could not be used because the biographical information session was not completed. The valid percentage recorded were 40% female and 60% male. The departments used for the data collection at the case study company (Aviation Company) officially have 20% of females and 60% of male employee on the average, that is, 12 females and 48 males. This implies that the entire female employees on the average completed the questionnaire while lower percentage of the male completed the questionnaire. However, the researcher was unable to identify the ethnicities of the gender respondents and their departments since these was not included in biographical session of the questionnaire.

Table 1.5 Gender of respondent

Gender	Number	Percentage	Valid Percentage
Female	12	38.7%	40%
Male	18	58.1%	60%
Total	30	96.8%	100%
Missing Value	1	3.2%	
Final Total with Missing Value	31	100.0%	

Figure 4.13 presents the graphical representation of the respondents' gender. The percentage of male responses was relatively high in relation to the female.

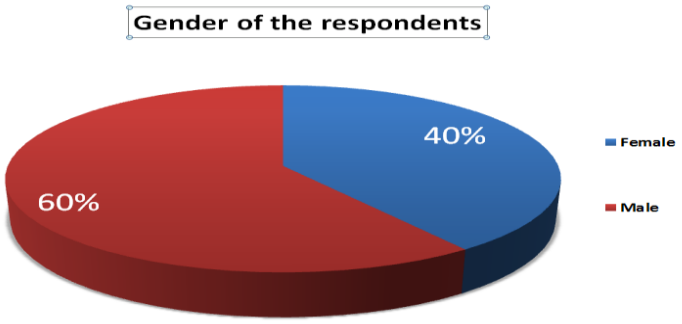


Figure 4.12 Gender of the respondents
Source: Researcher's own construction

4.7.2 Age of the respondents

The figure 4.14 below reveals the age brackets of the respondents. The highest age bracket of respondents that completed the survey were 25-29 i.e. 10.9% (n=9) and followed by age bracket 20-24 with 13.8% (n=4). Age bracket 30-34 with 10.2% (n=3), 40-44 with 10.2% (n=3), while 45-49 and 55-59 have 10.3% (n=3). In summary, the age bracket 20-24, 25-29 and 30-34 were the younger age in the survey with a total cumulative percentage of 54.9% (n=16). Table 1.6 shows the cumulative percentages of each respondent age group. The purpose of the "respondents' age" in the biographical information is to relate the respondent's age to Lean culture change acceptance, because of the school of thought that 'believes that younger people are more receptive to change'. In summary, a higher number employees that completed the survey fall within the younger age, but due to small sample size for this research survey, it is very difficult to make a conclusion that the younger employees who completed this survey are more receptive to accept Lean culture change.

Table 1.6 Age of respondents

Age	Number	Cumulative percentage
20-24	4	13.8%
25-29	9	30.9%
30-34	3	10.2%
35-39	1	3.4%
40-44	3	10.2%
45-49	3	10.3%
50-54	2	6.8%
55-59	3	10.3%
60-64	1	3.4%
Total	29	100%
Missing	2	

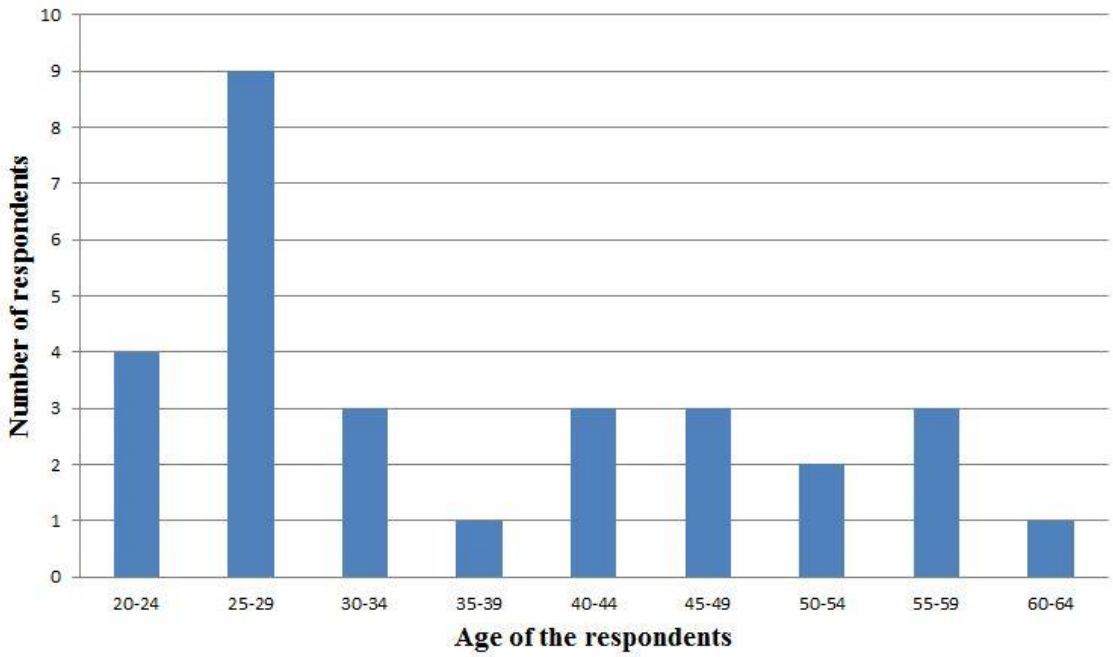


Figure 4.13 Age of the respondents

Source: Researcher's own construction

4.7.3 Respondents' levels within the organisation

The Table 1.6 below revealed the level of each respondent within the organisation. The respondents were asked to indicate their current level/position in the organisation.

Table 1.7 Level of respondent in the organisation

Level in the Organisation	Number	Valid percentage
Aircraft Technicians	2	6.5%
Apprentices	2	6.5%
Artisan	1	3.2%
Crew Chief	1	3.2%
Data Encoder	1	3.2%
Operator	2	6.5%
Other	8	25.8%
Senior Technician	1	3.2%
Shop Floor	9	29.0%
Team Leader	2	6.5%
Total	**29**	**93.6%**
Missing	2	6.5%

The respondents were requested to choose from the category listed in the questionnaire such as senior management, middle management, supervisor, team leader, operator, shop floor worker and other. The respondents used their 'job title' as reference for the 'level'. From the analysis of respondents' level below, the job level description "other" in this research context could be regarded also as "shop floor staff" and categorized as "inventory controller".

Results in figure 4.15 indicate that the majority of respondents were shop-floor employees with 29.0% (n = 9), the result also shows that support staff i.e. "other" comprised 25.8% (n = 8). Two respondents identified themselves as team leaders, falling within the lower level management with 6.5% (n = 2). The aircraft technicians comprised 6.5% (n=2), apprentices comprised 6.5% (n=2), operators comprised 6.5% (n=2). The result as shown for artisans is 3.2% (n=1), crew chief is 3.2% (n=1), data encoder is 3.2% (n=1) and senior technician is 3.2% (n=1). Two respondents 6.5% (n=2) did not indicate their level within the organisation and their data information was unusable.

From the result, the responses rate from the shop-floor staff and support staff was relatively high compared to other levels within the organisation as shown in figure 4.15.

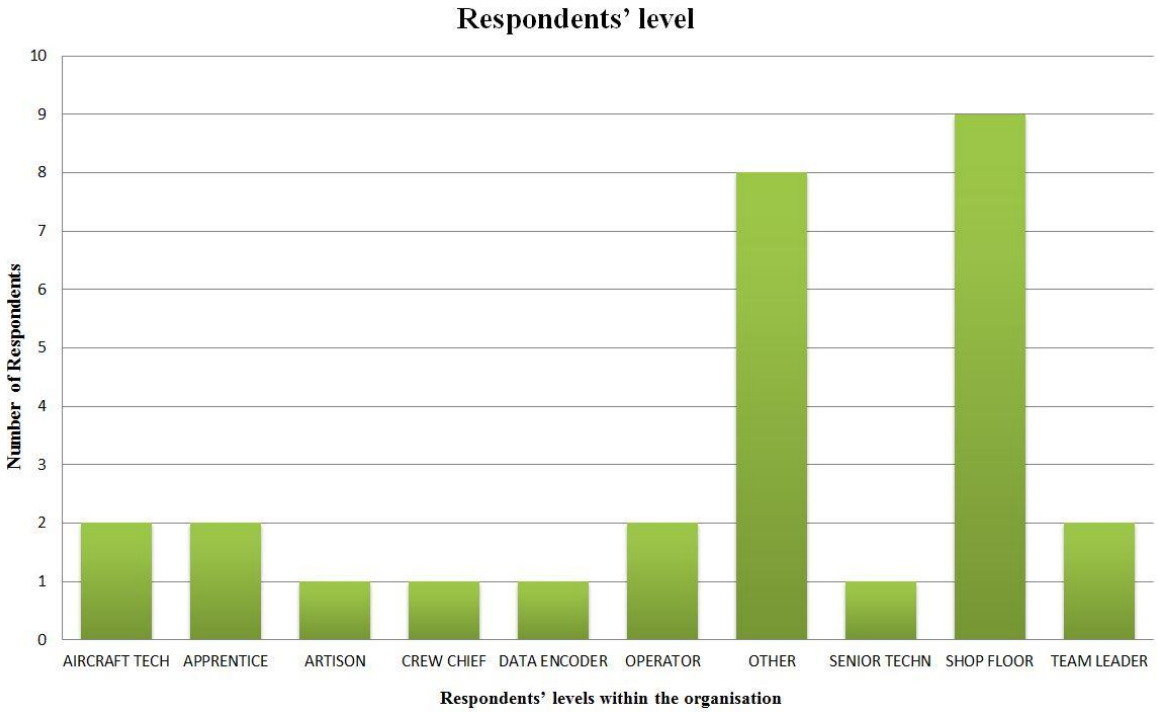


Figure 4.14 Respondents' level
Source: Researcher's own construction

4.7.4 Respondents' years of service

Individual respondents were requested to indicate the number of years of service at their current organisation. The results in figure 4.16 show that length of service between 0-5years received the highest percentage of 56.6% (n=17), and was followed by length of service between 26-30 years with 20% (n=6). Length of service between 11-15 years received 10% (n=3). Length of service between 6-10 years, 16-20 years, 31-35years and 36-40 years received the lowest percentage of 3.3% (n=1) each with total valid percentage of 13.2% (n=4). Length of service between 21-25 years recorded 0%.

The purpose of the 'years of service' in the biographical information was to explore the link between the length of service and Lean organisational culture as relating to 'resistance to change' among the employees, although respondents who fall within one year of service were relatively high in the respondent's biographical information with 56.6% (n=17).

In summary, due to the small sample size for this research survey, it was very difficult to link the relationship between long service years and resistance to change as relating to Lean culture.

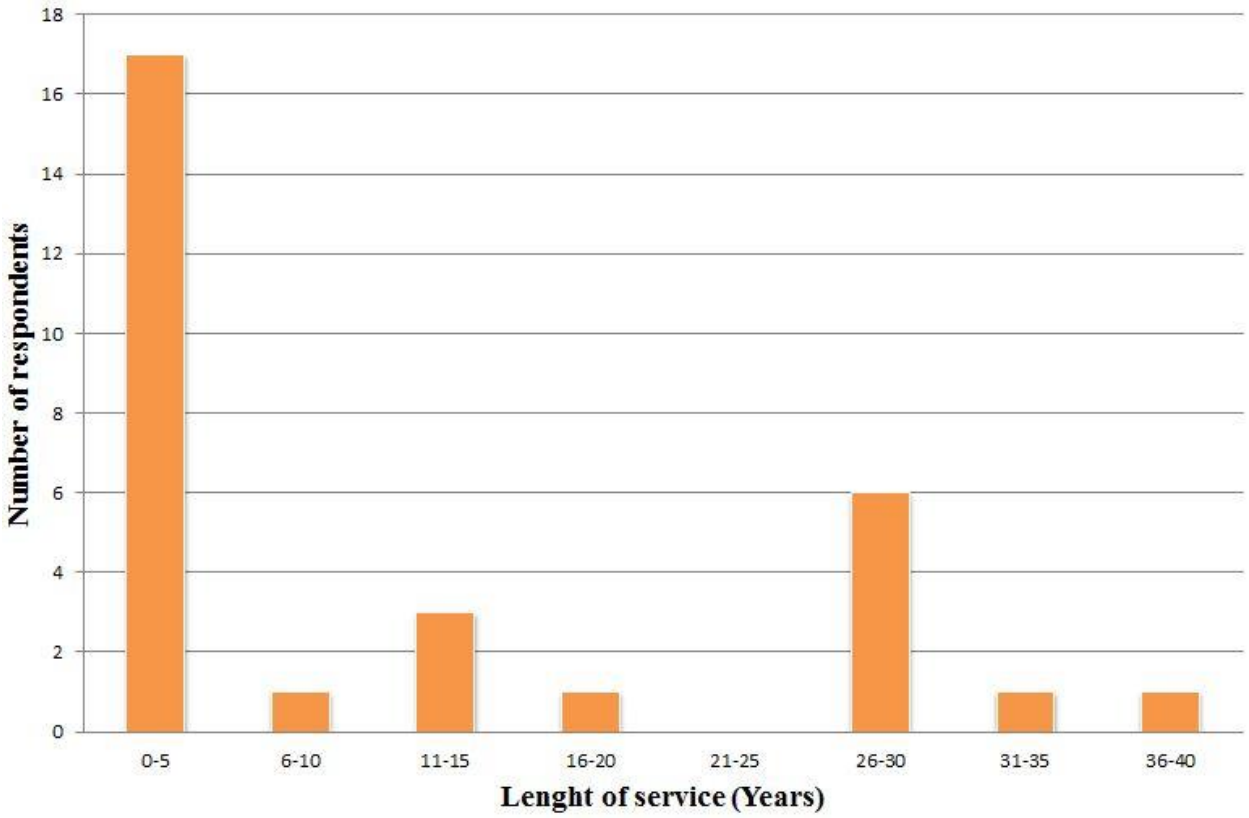


Figure 4.15 Respondents' years of service
Source: Researcher's own construction

4.8 Chapter summary

This chapter described the empirical results and findings for the study. The purpose and aim of each dependent and independent variables identified in the measuring instrument were clearly explained in detail. An analysis of the biographical information contained in Section A of the questionnaire was presented.

The next chapter presents the discussion and interpretation of the statistical analysis with distinct reference to a South African aviation company. The discussion and interpretation include the single dependent variable and four independent variables in section B of the measuring instrument and also the open-ended question.

Chapter 5

5. DISCUSSION AND INTERPRETATION

This chapter presents the discussion and interpretation of statistical analysis. The discussion and interpretation section contains the entire section B of the questionnaire which includes the prevailing Lean culture as the dependent variable, the four independent variables and the open-ended question. The hypothesis was stated and the right hypothesis was accepted. A conclusion was drawn based on the Cronbach's alpha and the effect size with a 95% confidence Interval. Verification and validation of the result are briefly discussed in this chapter.

5.1 Descriptive statistics for the data analysis

This section contains the descriptive statistics of section B of the questionnaire. Table 1.8 below shows the descriptive statistic of the entire section B of the questionnaire except the open-ended question. "Descriptive statistics implies a simple quantitative summary of a data set that has been collected. It helps us understand the experiment or data set in detail and tells us all about the required details that help put the data in perspective" (Explorable, 2010). Descriptive statistics will state what the data communicates and the result can be interpreted as well.

Descriptive statistics Table 1.8 was captured based on 31 completed questionnaire received from a South African aviation company. One out of 30 completed questionnaires was unusable because the respondent did not complete the section A (biographical information) and an unusable questionnaire in SPSS statistical analysis tool is referred to as "missing value". The table gives the complete description of section B, that is, the exact number of respondents that answered each question, shows both minimum and maximum options selected (1. Disagree strongly, 2. Disagree, 3. Agree, 4. Agree strongly) from each question.

The measure of central tendency used in Table 1.8 is the *mean* and the measure of spread used is *standard deviation* and both mean and standard deviation were calculated. The descriptive statistics recorded 23 valid N (listwise). In SPSS statistics tool, the term "Valid N (listwise)" is being referred to as the number of non-missing values, while N is used as the number of valid observations for the variable. More so, the total number of observations is the sum of N and the number of missing values (IDRE, 2015).

Table 1.8 Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	29	23	61	36.79	12.491
SERVICE	30	1	38	11.60	12.181
Q1N1	31	2	4	3.00	.577
Q1N2	31	2	4	3.52	.570
Q1N3	29	1	4	2.86	.693
Q1N4	31	2	4	3.39	.615
Q1N5	31	2	4	2.97	.752
Q1N6	31	1	4	2.71	.902
Q1N7	31	2	4	3.10	.651
Q1N8	31	2	4	3.03	.547
Q1N9	31	1	4	3.06	.629
Q1N10	31	2	4	3.16	.583
Q2N1	31	1	4	2.45	.768
Q2N2	31	1	4	2.55	.723
Q2N3	30	2	4	2.83	.592
Q2N4	31	1	4	2.77	.560
Q2N5	31	1	4	2.71	.739
Q2N6	31	1	4	2.68	.702
Q2N7	31	1	4	2.74	.575
Q2N8	31	1	4	2.71	.643
Q2N9	31	2	4	2.90	.539
Q3N1	30	2	4	3.03	.490
Q3N2	30	2	4	2.93	.521
Q3N3	31	2	4	2.84	.638
Q3N4	31	2	4	2.58	.564
Q3N5	30	1	3	2.37	.556
Q3N6	31	2	4	3.06	.512
Q3N7	30	2	4	2.90	.548
Q3N8	31	2	4	2.81	.543
Q3N9	30	2	4	2.73	.521
Q4N1	30	1	4	2.53	.681
Q4N2	30	1	4	2.73	.640
Q4N3	30	1	4	2.47	.681
Q4N4	31	1	4	2.94	.574
Q4N5	31	1	4	2.77	.617
Q4N6	30	2	3	2.70	.466
Q4N7	31	1	4	2.74	.631
Q4N8	30	2	4	2.53	.629
Q4N9	29	1	4	2.69	.660
Q5N1	30	1	4	2.60	.770
Q5N2	31	2	4	2.94	.442
Q5N3	31	2	4	2.81	.477
Q5N4	31	1	4	2.74	.631
Q5N5	31	2	4	2.97	.547
Q5N6	31	1	4	2.55	.850
Valid N (listwise)	23				

Table 1.9 Descriptive Statistics for Skewness and Kurtosis of the data

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
AGE	29	.564	.434	-1.203	.845
SERVICE	30	.825	.427	-.882	.833
Q1N1	31	.000	.421	.340	.821
Q1N2	31	-.644	.421	-.569	.821
Q1N3	29	-.502	.434	.880	.845
Q1N4	31	-.457	.421	-.563	.821
Q1N5	31	.054	.421	-1.164	.821
Q1N6	31	-.243	.421	-.574	.821
Q1N7	31	-.093	.421	-.475	.821
Q1N8	31	.029	.421	.743	.821
Q1N9	31	-.903	.421	3.263	.821
Q1N10	31	-.011	.421	.000	.821
Q2N1	31	-.536	.421	-.349	.821
Q2N2	31	-.180	.421	-.032	.821
Q2N3	30	.040	.427	-.082	.833
Q2N4	31	-1.268	.421	2.616	.821
Q2N5	31	.003	.421	-.250	.821
Q2N6	31	-.068	.421	-.036	.821
Q2N7	31	-1.080	.421	1.847	.821
Q2N8	31	-.464	.421	.617	.821
Q2N9	31	-.101	.421	.702	.821
Q3N1	30	.095	.427	1.744	.833
Q3N2	30	-.109	.427	1.089	.833
Q3N3	31	.142	.421	-.431	.821
Q3N4	31	.258	.421	-.855	.821
Q3N5	30	-.074	.427	-.796	.833
Q3N6	31	.124	.421	1.219	.821
Q3N7	30	-.081	.427	.589	.833
Q3N8	31	-.143	.421	.180	.821
Q3N9	30	-.298	.427	-.295	.833
Q4N1	30	-.478	.427	.072	.833
Q4N2	30	-.556	.427	.864	.833
Q4N3	30	.478	.427	.072	.833
Q4N4	31	-1.148	.421	4.267	.821
Q4N5	31	-.745	.421	1.451	.821
Q4N6	30	-.920	.427	-1.242	.833
Q4N7	31	-.600	.421	.979	.821
Q4N8	30	.758	.427	-.321	.833
Q4N9	29	-.369	.434	.432	.845
Q5N1	30	-1.087	.427	.427	.833
Q5N2	31	-.352	.421	2.664	.821
Q5N3	31	-.591	.421	.611	.821
Q5N4	31	-.600	.421	.979	.821
Q5N5	31	-.029	.421	.743	.821
Q5N6	31	-.683	.421	-.290	.821
Q1_Culture	31	-.447	.421	.174	.821
Q2_Awareness	31	-.455	.421	-.235	.821
Q3_Engaged	31	.116	.421	-.285	.821
Q4_Consistency	31	-.202	.421	2.476	.821
Q5_Accountability	31	-.407	.421	-.049	.821
Valid N (listwise)	23				

Skewness is asymmetry in a statistical distribution, in which the curve appears distorted or skewed either to the left or to the right. Skewness can be quantified to define the extent to which a distribution differs from a normal distribution, (Gibilisco, 2012). According to Bulmer (1979):

1. If skewness is positive, the data are positively skewed or skewed right, meaning that the right tail of the distribution is longer than the left.
2. If skewness is negative, the data are negatively skewed or skewed left, meaning that the left tail is longer.
3. If skewness = 0, the data are perfectly symmetrical.
   But a skewness of exactly zero is quite unlikely for real-world data.

Bulmer (1979) states three classic rules for interpretation of skewness of descriptive statistical data:

- If skewness is less than −1 or greater than +1, the distribution is **highly skewed**.
- If skewness is between −1 and –0.5or between +0.5 and +1, the distribution is **moderately skewed**.
- If skewness is between −0.5 and +0.5, the distribution is **approximately symmetric**.

In summary, from Table 1.9 above we have higher number of negative skewness of data than positive skewness of data and this implies that the data are negatively skewed or skewed left and meaning that the left tail is longer. The distribution of the skewness can be grouped between highly skewed and moderately skewed distribution because the skewness is (less than −1 or greater than +1) and (between −1 and –0.5or between +0.5 and +1).

Sam (2012) defines Kurtosis as a statistical number that tells us if a distribution is taller or shorter than a normal distribution. Westfall (2014) stresses that it is the tails that mostly account for Kurtosis, not the central peak. And the reference standard is normal distribution, which has a Kurtosis of 3. The excess Kurtosis is kurtosis -3.

As stated by Westfall (2014):

- A normal distribution has kurtosis exactly 3 (excess kurtosis exactly 0). Any distribution with kurtosis ≈3 (excess ≈0) is called **mesokurtic**.
- A distribution with kurtosis <3 (excess kurtosis <0) is called **platykurtic**. Compared to a normal distribution, its tails are shorter and thinner, and often its central peak is lower and broader.

- A distribution with kurtosis >3 (excess kurtosis >0) is called **leptokurtic**. Compared to a normal distribution, its tails are longer and fatter, and often its central peak is higher and sharper.

In summary, based on Westfall (2014), from Table 1.9 we have two kurtosis which were greater 3 (i.e. >3) and while the rest of the kurtosis were less than 3 (i.e. <3). Therefore, the kurtosis is not a normal distribution. According to Westfall (2014) it is called platykurtic distribution. This implies the tails are shorter and thinner, and the central peak is lower and broader.

5.2 Discussion and interpretation

This section presents the discussion and interpretation to respondents' responses to section B of the questionnaire. Section B is sub-divided into six sub-sections consisting of a single dependent variable and four independent variables. The questionnaire ended with a single open-ended question. The original intention of the first sub-section was to measure Lean culture and to provide support for the link between Lean culture and the four independent variables, i.e. to know whether the four independent variables were positively linked to the Lean culture development.

5.2.1 Sub-section 1 - Lean culture

The questions in sub-section 1 were directly related to Lean organisational culture. Sub-section 1 contained 10 questions. For the purpose of analysis, the 10 questions were further sub-divided into five constructs which enabled two questions to centre on a particular Lean culture philosophy as shown in Table 1.9. The respondents were requested to consider ten questions and to select an appropriate response as related to Lean culture at.

5.2.1.1 Discussion and interpretation for sub-section 1 questions

Table 1.9 shows the frequency percentages (%), the mean and the standard deviation of the respondents. Sub-section 1 is a dependent variable and exhibited an internal reliability of ***0.872 Cronbach alpha*** based on the analysis of 29 (93.5%) valid responses from 10 numbers of items (i.e. 10 questions). Cronbach alpha 0.872 is an acceptable reliability coefficient and therefore it suggests that the items have a relatively high internal consistency

From the fourth construct, the two questions (1.4 and 1.9) centred on *customer-defined waste elimination.* The responses from the employees on question1.4 have shown that 48.4 % selected *Agree* while 45.2% selected *Agree strongly* which implies that the employees understood that

waste reduction increases Lean organisation competitiveness and the employees have strongly waste reduction focus. Question 1.9 shows 71.0% *Agree* from respondents and 19.4% of the respondents selected *strongly agree* which means that the employees understood that negative customer feedback can lead to a change and help to eliminate waste.

The second construct centred on *root-cause problem solving*, Question 1.2 and 1.7 were used in this regard. From question (1.2) 54.8% respondents selected *Agree Strongly* while 41.95 selected *Agree.* Question 1.7 shows that 58.1% respondent selected *Agree* while 25.8% selected *Agree strongly.* Both Q1.2 and 1.7 show that the respondent knows that identifying the root cause of a problem can prevent a problem from recurring.

The questions (1.1 and 1.6) from the first construct focused on *problem-solving approaches,* question 1.1 received high positive response of 67.7% *Agree and* 16.1% of *Agree strongly* which means that the respondents are having sound problem-solving approach. On the other hand, question 1.6 received 41.9% *Agree* and 19.4% *Agree strongly.* Question 1.6 also has the highest negative responses of 29.0% of *Disagree*, this implies that there is a form of anomaly or irregularity and inconsistency in this area (i.e. identifying problems still leading to blame).

Table 1.10: Questions on Lean culture and respondents' responses (per construct)

LEAN CULTURE - Sub-section 1							
Construct: To measure the problem-solving approach		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
1.1	A problem is viewed as an opportunity to improve	0	16.1	67.7	16.1	3.03	0.566
1.6	Identifying problem does **not** lead to blame	9.7	29.0	41.9	19.4	2.66	0.897
Construct: To measure the root-caused solution		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
1.2	Recurring problems disrupt flow	0	3.2	41.9	54.8	3.52	0.574
1.7	Solutions are implemented that prevent a problem from recurring	0	16.1	58.1	25.8	3.07	0.651
Construct: To measure the systems nature of Lean		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
1.3	We consider the impact of decisions on the rest of the organization	3.4	20.7	62.1	13.8	2.86	0.693
1.8	Decisions are taken for the "greater good" of the organization	0	12.9	71.0	16.1	3.03	0.566
Construct: To measure customer-defined waste elimination		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
1.4	We believe that reducing waste makes us more competitive	0	6.5	48.4	45.2	3.38	0.622
1.9	Negative customer feedback (internal or external) leads to change	3.2	6.5	71.0	19.4	3.07	0.651
Construct: To measure the flexibilty		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
1.5	We are able to respond quickly to customers' changing demands	0	29.0	45.2	25.8	2.97	0.778
1.10	We believe that quick response to change is important	0	9.7	64.5	25.8	3.14	0.581
Rating Scale:	1 = Disagree Strongly	2 = Disagree		3 = Agree		4 = Agee Strongly	

RELIABILITY FOR LEAN CULTURE			
Internal reliability: Cronbach alpha	Valid N	Missing N	Total N
0.872	93.5% (n=29)	6.5% (n=2)	31

Source: Researcher's own construction

The two questions (1.5 and 1.10) from the fifth construct which centred on *measuring the flexibility*, question 1.5 has positive responses of 45.2% of *Agree* and 25.8% of *Agree strongly* and question 1.5 also received 29.0% of *Disagree* which is on the negative side. This implies that the organisation has attained some levels of flexibility responding to *customers' changing demands* while on the negative end there are some inconsistencies in the way the organisation responded to *customers' changing demands.* Question 1.10 received 64.5% *Agree* responses and 25.8% of *Agree strongly* which implies that the employees believe strongly in quick response to change and its importance in a Lean culture organisation.

The third construct from sub-section 1 centred on *systems nature of Lean* which contained two questions (1.3 and 1.8). Question 1.3 received 62.1% *Agree* and 13.8% of *Agree strongly* while 20.7% of *Disagree;* this implies that management's decision has great impact on the rest of organisation. Question 1.8 has the highest positive responses of 71.0% of *Agree* and 16.05 of

Agree strongly and this implies that the employees have clear perceptions that the management decisions are being taken for the "greater good" of the organisation.

Posner (2015) explains that "standard deviation could be considered a measure of the extent to which one's observers agree or disagree with each another. The smaller standard deviation suggests that people are in more agreement with one another than would be the case with a large standard deviation and looking at the standard deviation can help leaders make a quick determination of whether others see them in the same fashion or not".

As explained by Posner (2015) that a smaller standard deviation suggests that employees are in more agreement with one and another. Therefore, lowest standard deviation occurs at (Question1.0 and 1.8) with Std. 0.566, followed by (Question 1.2, 1.10, 1.4, 1.9, 1.7, and 1.3). The four highest *Strongly Agree* occurred with the questions with lower standard deviation. The highest standard deviation occurs at (Questions 1.6 and 1.5) with Std. 0.897 and 0.778 respectively. The two highest *Disagree* occurred with questions with highest standard deviation which implies that there is no relationship that linked with one another in this regard, from the earlier interpretation; there is an irregularity or inconsistency in the area.

The highest *Agree strongly* occurred with Questions 1.2 and 1.4, with 54.8% and 45.2% respectively. The highest *Agree* occurred with Questions 1.8 and 1.9 with 71.0% and followed by Questions 1.1 and 1.10 with 67.7 and 64.5% respectively.

5.2.1.2 Lean culture inter-item correlation matrix

The inter-item correlation matrices of the questions relating to Lean culture are shown in Table 1.10. (Piedmont, 2014:3304) explain that "Inter-item correlations are an essential element in conducting an item analysis of a set of test questions. Inter-item correlations examine the extent to which scores on one item are related to scores on all other items in a scale".

All the values in inter-item correlation should be positive and this implies that all the items are measuring exactly similar underlying characteristics. The presence of negative values could indicate that some of the items have not been correctly reverse-scored (Pallant, 2011:100). According to Miller *et al.* (2012) each inter-item correlation 'should be correlated with every other item measuring the same construct and should not be correlated with items measuring a different construct'. In practice, "inter-item correlation tends to be relatively small in size, often

in the .15 to .02 range, except for those items that are simple restatements of one another" (Miller *et al.*, 2012).

From Table 1.10, the inter-item correlation matrix for Lean organisational culture questions recorded eight negative values that is a negative correlation recorded; the presence of the negative values in the Table 1.10 implies that the numerical rating scale went in the opposite direction i.e. more negative responses of "*Disagree"* were returned on those items with negative values. The researcher didn't reverse score any of the question owing to the little sample size of the survey and also the researcher didn't envisage that some of the respondents will answer some of the questions on the other way round.

Table 1.11 Inter-Item Correlation Matrix for Lean organisational culture questions

	Q1N1	Q1N2	Q1N3	Q1N4	Q1N5	Q1N6	Q1N7	Q1N8	Q1N9	Q1N10
Q1N1	1.000	.273	.468	.570	.408	.446	.284	.554	.381	.637
Q1N2	.273	1.000	-.084	.231	-.118	.081	-.003	.273	-.003	.207
Q1N3	.468	-.084	1.000	.457	.587	.495	.418	.559	.655	.493
Q1N4	.570	.231	.457	1.000	.323	.435	.374	.469	.551	.542
Q1N5	.408	-.118	.587	.323	1.000	.596	.357	.570	.498	.327
Q1N6	.446	.081	.495	.435	.596	1.000	.592	.587	.470	.437
Q1N7	.284	-.003	.418	.374	.357	.592	1.000	.381	.663	.352
Q1N8	.554	.273	.559	.469	.570	.587	.381	1.000	.478	.637
Q1N9	.381	-.003	.655	.551	.498	.470	.663	.478	1.000	.541
Q1N10	.637	.207	.493	.542	.327	.437	.352	.637	.541	1.000

The questions with negative responses were Questions 1.3, 1.5, and 1.6 while Questions 1.1 and 1.7 had a moderate negative response of 16.1% of *Disagree.* The rest of the inter-item correlations in Table 1.10 had positive values and this implies that all the items (questions) do not measure the same underlying characteristics (Pallant, 2011). The inter-item correlations were statistically significant from level of 0.20 (Piedmont, 2014).

5.2.2 Sub-section 2 - Awareness

The questions in sub-section 2 were directly related to Lean awareness. Sub-section 2 comprised nine questions. For the purpose of analysis, the nine questions were further sub-divided into three constructs which enabled three questions to focus on a Lean awareness as shown in Table 1.11. The purpose of the nine questions was to measure the extent to which managers had successfully implemented and facilitated an enabling environment for situational awareness as relating to Lean culture (van der Merwe, 2011). The responses from the respondent show the emphasis management has placed on the awareness of Lean at their organisation.

5.2.2.1 Discussion and interpretation for Sub-section 2 questions

Table 1.11 shows the frequency percentages (%), the mean and the standard deviation of the respondents. Sub-section 2 is an independent variable and revealed an internal reliability of ***0.872 Cronbach's alpha*** based on the analysis of 30 (96.8%) of valid responses from 9 numbers of items (i.e. 9 questions). Cronbach's alpha 0.872 is an acceptable reliability coefficient and therefore, it suggests that the items have relatively high internal consistency

Table 1.12: Questions on Lean awareness and respondents' responses (per construct)

LEAN AWARENESS - Sub-section 2							
Construct: To measure the awareness of value streams		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
2.1	The concept of a value stream is widely understood	12.9	32.3	51.6	3.2	2.47	0.776
2.2	A visitor would be able to identify each shop floor value stream	6.5	38.7	48.4	6.5	2.53	0.730
2.6	Employees know the location and extent of each value stream	3.2	35.5	51.6	9.7	2.70	0.702
Construct: To measure the awareness of critical processes		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
2.3	We know what measures are important to each value stream	0	26.7	63.3	10.0	2.83	0.592
2.7	Key processes have been identified in each value stream	3.2	22.6	71.0	3.2	2.73	0.583
2.8	Problems affecting output have been identified	3.2	29.0	61.3	6.5	2.70	0.651
Construct: To measure visual systems		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
2.4	Visual systems provide information about the status of each value stream	3.2	19.4	74.2	3.2	2.77	0.568
2.5	We constantly refer to our visual systems	3.2	35.5	48.4	12.9	2.73	0.740
2.9	Problems on the shop floor become obvious as soon as they occur	0	19.4	71.0	9.7	2.90	0.548
Rating Scale: 1 = Disagree Strongly 2 = Disagree 3 = Agree 4 = Agee Strongly							

RELIABILITY FOR LEAN AWARENESS			
Internal reliability: Cronbach alpha	Valid N	Missing N	Total N
0.872	96.8% (n=30)	3.2% (n=1)	31

Source: Researcher's own construction

From the Lean awareness table above, Question (2.4, 2.7 and 2.9) received the highest *Agree* responses. Question 2.4 and 2.9 construct centred on *Visual system while* Question 2.7 centred on *Awareness of critical processes.* Question 2.4 recorded 74.2% of *Agree* and 3.2% of *Agree strongly* and on the negative side, recorded 19.4% *Disagree.* The response from Question 2.4 implies that the employees have clear perception of visual system as mean to provide information about value stream status. Question 2.7 received 71.0% of *Agree* and 22.6% of *Disagree.* Question 2.7 shows clear awareness of key processes relating to the value stream. Question 2.9 received 71.0% of *Agree* and 19.4% of *Disagree;* this implies employees on the shop floor are aware of the problems as they occur.

Question 2.3 recorded 63.3% of *Agree* and Question 2.8 recorded 61.3% of *Agree* as well. Both questions 2.3 and 2.8 were under second construct which centred on *awareness of critical processes* which shows that the employees are having clear awareness of the critical processes in the organisation. Questions 2.1, 2.2 and 2.6 centred on *awareness of value stream* and the three questions recorded moderate *Agree* and high *Disagree.* Question 2.1 recorded 51.6% of *Agree, 32.3% of Disagree* and 12.9% of *strongly disagree.* This implies that the concept of value stream is not yet universally understood. Question 2.2 recorded 48.4% of *Agree and 38.7% of Disagree.* Question 2.6 returned 51.6% of *Agree* and 35.5% of *Disagree.* The responses from the respondent as relating to Questions 2.1, 2.2 and 2.3 show that the employee awareness of value stream is yet to be attained.

Question 2.5 received 48.4% of *Agree* and 35.5% of *Disagree;* this implies that most employees don't constantly refer to the visual systems. As earlier stated, Questions 2.4, 2.7 and 2.9 had the highest percentage of *Agree* responses with 74.2%, 71.0% and 71.0% respectively, and these three questions also had the lowest standard deviation of 0.568, 0.583 and 0.548 respectively and were also followed by Question 2.3 with a standard deviation of 0.592. Questions 2.3, 2.4, 2.7 and 2.9 imply that employees are in more agreement to some extent with one as relating to situational awareness (Posner, 2015). The highest standard deviation occurred with Question 2.1 with Std. 0.776, Question 2.2 with Std. 0.730, Question 2.6 with Std. 0.702, Question 2.9 with Std. 0.740, and lastly Question 2.8 with Std. 0651. The highest level of standard deviations implies that the employees and managers placed little emphasis on some aspects of situational awareness in the organisation and situational awareness was not yet attained.

5.2.2.2 Lean Awareness inter-item correlation matrix

From Table 1.12, the inter-item correlation matrix for Lean awareness questions recorded no negative values. The entire inter-item correlation matrix returned positive values on the items. This implies that all the items measured the same underlying characteristics (Pallant, 2011). The inter-item correlations were statistically significant from the level of 0.02 (Piedmont, 2014).

Table 1.13 Inter-Item Correlation Matrix for Lean awareness questions

	Q2N1	Q2N2	Q2N3	Q2N4	Q2N5	Q2N6	Q2N7	Q2N8	Q2N9
Q2N1	1.000	.458	.625	.568	.465	.519	.513	.628	.357
Q2N2	.458	1.000	.532	.643	.655	.592	.588	.638	.397
Q2N3	.625	.532	1.000	.598	.682	.705	.566	.671	.159
Q2N4	.568	.643	.598	1.000	.585	.683	.534	.643	.255
Q2N5	.465	.655	.682	.585	1.000	.770	.709	.616	.102
Q2N6	.519	.592	.705	.683	.770	1.000	.556	.777	.099
Q2N7	.513	.588	.566	.534	.709	.556	1.000	.599	.022
Q2N8	.628	.638	.671	.643	.616	.777	.599	1.000	.203
Q2N9	.357	.397	.159	.255	.102	.099	.022	.203	1.000

5.2.3 Sub-section 3 - Engagement

The questions in sub-section 3 were directly related to Lean engagement. Sub-section 3 comprised nine questions. For the purpose of analysis, nine questions were further sub-divided into three constructs which enabled three questions to focus on a Lean engagement questions as shown in Table 1.13. The responses from the respondent show the emphasis management has placed on employees' engagement as relating to Lean culture.

5.2.3.1 Discussion and interpretation for Sub-section 3 questions

Table 1.13 shows the frequency percentages (%), the mean and the standard deviation of the respondents. Sub-section 3 is an independent variable and presented an internal reliability of ***0.889 Cronbach's alpha*** based on the analysis of 29 (93.5%) of valid responses from 9 numbers of items (i.e. 9 questions). Cronbach's alpha *0.889* is an acceptable reliability coefficient and therefore, it suggests that the items have relatively high internal consistency.

Table 1.14: Questions on Lean engagement and respondents' responses (per construct)

LEAN ENGAGEMENT - Sub-section 3							
Construct: To measure the active employee engagement		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
3.1	Leaders participate in shop floor improvement efforts	0	10.0	76.7	13.3	3.03	0.499
3.2	Team members' feedback is valued by supervisors and managers	0	16.7	73.3	10.0	2.93	0.530
3.6	Leaders discuss work problems and often offer guidance	0	9.7	74.2	16.1	3.03	0.499
Construct: To measure the meaningful employee engagement		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
3.3	Team members' are challenged to provide the best solutions	0	29.0	58.1	12.9	2.83	0.658
3.7	Team members are asked for problem solutions	0	20.0	70.0	10.0	2.86	0.516
3.8	Experience and guidance has led to an improved problem-solving	0	25.8	67.7	6.5	2.79	0.559
Construct: To measure suggestion harvesting		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
3.4	A formal procedure exists for obtaining suggestions	0	45.2	51.6	3.2	2.52	0.509
3.5	Feedback is provided on all suggestions	3.3	56.7	40.0	0	2.34	0.553
3.9	Good suggestions are implemented	0	30.0	66.7	3.3	2.72	0.528
Rating Scale:	1 = Disagree Strongly	2 = Disagree		3 = Agree		4 = Agee Strongly	

RELIABILITY FOR LEAN ENGAGEMENT			
Internal reliability: Cronbach alpha	Valid N	Missing N	Total N
0.889	93.5% (n=29)	6.5% (n=2)	31

Source: Researcher's own construction

The Lean engagement Table 1.13 above, Questions 3.1, 3.2 and 3.6 were within the same construct and the construct focused on *the active employee engagement.* These three questions recorded the highest positive responses of *Agree* of 76.7% Question 3.1, 73.3% Question 3.2 and 74.2% Question 3.6. The three questions also received lower negative of responses of *Disagree* of 10.0%, 16.7%, and 9.7% respectively.

The three questions have 0% of *Disagree strongly.* This implies that the employees have clear perceptions of active employee engagement which is an important aspect of an effective Lean culture implementation. The three questions returned lower standard deviation of 0.499% Question 3.1, 0.530 Question 3.2 and 0.499 Question 3.6. The lower standard deviation recorded with the same construct implies that there is good relationship between Leaders (managers and supervisors) and team member.

In summary, questions 3.1 and 3.6 show that the leaders participate at shop floor level for purposes of achieving an improvement effort.

Questions 3.3, 3.7 and 3.8 were within the same construct i.e., a construct on *meaningful employee engagement.* Questions 3.3, 3.7 and 3.8 returned 58.1%, 70.0% and 67.7% of *Agree* responses respectively. Questions 3.3, 3.7 and 3.8 received moderate negative responses of 29.0%, 20.0% and 25.8% of *Disagree* respectively and 0% responses of *Disagree strongly.* Question 3.3 have standard deviation of 0.658, question 3.7 have standard deviation of 0.516 and question 3.8 with standard deviation of 0.559. The result implies that the team members have meaning engagement to some degree and question 3.7 with lower standard deviation support the fact that team members are asked for problem solutions.

From Table 1.13, Question 3.4, 3.5 and 3.9 received the highest negative responses of *Disagree.* Question 3.4, 3.5 and 3.9 received 45.2%, 56.7%, 30.0% of *Disagree* responses respectively. The highest negative responses which indicate that there is a weak relationship link receiving suggestion and feedback from the team members and also show that not all good suggestions from team members are being considered. In summary, the responses from the second and third constructs show that the organisation is still in a "prescriptive" phase rather than a True Lean engagement phase.

5.2.3.2 Lean engagement inter-item correlation matrix

Table 1.14, the inter-item correlation matrix for Lean engagement questions recorded no negative values. The entire inter-item correlation matrix returned positive values on the items. This implies that all the items measured the same underlying characteristics (Pallant, 2011). The inter-item correlations were statistically significant from the level of 0.20 (Piedmont, 2014).

Table 1.15 Inter-Item Correlation Matrix for Lean engagement questions

	Q3N1	Q3N2	Q3N3	Q3N4	Q3N5	Q3N6	Q3N7	Q3N8	Q3N9
Q3N1	1.000	.415	.236	.209	.344	.426	.297	.283	.309
Q3N2	.415	1.000	.477	.402	.328	.550	.356	.673	.568
Q3N3	.236	.477	1.000	.383	.464	.345	.664	.579	.681
Q3N4	.209	.402	.383	1.000	.741	.490	.418	.515	.551
Q3N5	.344	.328	.464	.741	1.000	.474	.423	.586	.583
Q3N6	.426	.550	.345	.490	.474	1.000	.297	.667	.445
Q3N7	.297	.356	.664	.418	.423	.297	1.000	.517	.643
Q3N8	.283	.673	.579	.515	.586	.667	.517	1.000	.647
Q3N9	.309	.568	.681	.551	.583	.445	.643	.647	1.000

5.2.4 Sub-section 4 - Consistency

The respondents were given nine questions and the purpose of the questions was to examine the extent to which they perceived the organisation managerial actions as regarding Lean consistency. The nine questions were further sub-divided into three constructs which enabled three questions to focus on a Lean consistency questions as shown in Table 1.15. The responses from the respondent show the emphasis management has placed on Lean consistency.

Table 1.16: Questions on Lean consistency and respondents' responses (per construct)

LEAN CONSISTENCY - Sub-section 4							
Construct: To measure the layered Lean leadership		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
4.1	A regular schedule of Lean feedback meetings exists for all leaders	6.7	36.7	53.3	3.3	2.54	0.693
4.2	Regular Lean feedback meetings ensure sustained focus	3.3	26.7	63.3	6.7	2.75	0.645
4.6	Managers meet with supervisors regularly throughout a shift	0	30.0	70.0	0	2.71	0.460
Construct: To measure institutionalised leadership		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
4.3	All levels of leadership are included in the plan	3.3	53.3	36.7	6.7	2.50	0.694
4.7	The feedback meeting schedule is written into organizational procedures	3.2	25.8	64.5	6.5	2.75	0.645
4.8	Managers are often too busy to attend scheduled Value Stream Meetings	0	53.3	40.0	6.7	2.57	0.634
Construct: To measure consistent decision-making		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
4.4	Leaders make decisions that support the vision and mission objectives	3.2	9.7	77.4	9.7	2.93	0.604
4.5	Daily decisions are made to support our vision and mission statements	3.2	22.6	67.7	6.5	2.79	0.630
4.9	Managers have a common approach to problem solving	3.4	31.0	58.6	6.9	2.71	0.659
Rating Scale:	1 = Disagree Strongly	2 = Disagree		3 = Agree		4 = Agee Strongly	
RELIABILITY FOR LEAN CONSISTENCY							
Internal reliability: Cronbach alpha		Valid N		Missing N		Total N	
0.820		90.3% (n=28)		9.7% (n=3)		31	

Source: Researcher's own construction

5.2.4.1 Discussion and interpretation for sub-section 4 questions

From Table 1.15 above, Question 4.4, 4.5 and 4.9 centred on *consistent decision-making* and question 4.4 received the highest responses of 77.4% *Agree* with standard deviation of 0.604. Respondent's response to Question 4.4 implies that the management decision making support the vision and mission objective of the organisation. Within the same construct, questions 4.4 received 67.7% of *Agree* and 22.6% of *Disagree.* Question 4.9 received 58.6% of *Agree* and 31.0% of *Disagree*. The standard deviation of Question 4.5 is 0.630, Question 4.9 is 0.659 and

Question 4.4 is 0.604 and this shows almost the same standard deviation. From respondent's response to question 4.5 and 4.9, it shows that effective managerial approach to problem solving is not yet attained and daily decision making to support vision and mission is currently on the average.

The second construct in this section was designed to *measure institutional leadership*. The construct received the highest negative responses. Question 4.3 returned 53.3% of *Disagree* responses; Question 4.7 returned 25.8% of *Disagree* and Question 4.8 have 53.3% of *Disagree* as well. The two questions (4.3 and 4.8) in this construct have lower positive responses of 36.7% and 40.0% of *Agree* respectively while question 4.7 have the highest positive response of 64.5% of *Agree* within the same construct, this implies that effective institutional leadership has not yet been attained. With responses from Question 4.7, this suggests that the institutional leadership in the organisation is an on-going process. The standard deviation for the three questions within the second construct was very high and almost the same. Therefore, institutional leadership recorded a weak relationship.

The first construct was meant to measure *the layered Lean leadership.* From Question 4.1, 4.2 and 4.6, the highest positive responses were recorded from questions 4.6 with 70.0% of *Agree*, and with 30.0% of *Disagree.* Question 4.6 has the lowest standard deviation of 0.460 throughout sub-section 4 questions. This implies that good leadership communication styles exist between managers and supervisors in the organisation. Question 4.1 has 53.3% of *Agree* and 36.7% of *Disagree* responses. Question 4.2 has 63.3% of *Agree* and 26.7% *Disagree* responses. The respondent's responses to nine questions within sub-section 4 imply there is a weak Lean consistency.

In summary, there are significant "disagree" responses among sub-section 4 questions, because often times the leaders do not see themselves as part of Lean system and believes that Lean culture is for the employee on the shop-floor.

5.2.4.2 Lean consistency inter-item correlation matrix

The inter-item correlation matrix for Lean consistency questions recorded 14 negative values the presence of negative values in the Table 1.16. The questions within sub-section 4 received more negative responses of *Disagree* and this might lead to the high negative values recorded from inter-item correlations. Only question 4.4 recorded lower negative responses of 9.7% of

Disagree. The inter-item correlations in Table 1.16 have statistically significant from level of 0.10 (Piedmont, 2014).

Table 1.17 Inter-Item Correlation Matrix for Lean consistency questions

	Q4N1	Q4N2	Q4N3	Q4N4	Q4N5	Q4N6	Q4N7	Q4N8	Q4N9
Q4N1	1.000	.476	.655	.449	.527	.149	.642	-.217	.429
Q4N2	.476	1.000	.537	.427	.501	.249	.733	-.181	.523
Q4N3	.655	.537	1.000	.707	.593	.232	.620	0.000	.405
Q4N4	.449	.427	.707	1.000	.639	.324	.522	-.083	.505
Q4N5	.527	.501	.593	.639	1.000	.420	.592	-.238	.293
Q4N6	.149	.249	.232	.324	.420	1.000	.249	-.181	.087
Q4N7	.642	.733	.620	.522	.592	.249	1.000	-.271	.523
Q4N8	-.217	-.181	0.000	-.083	-.238	-.181	-.271	1.000	-.038
Q4N9	.429	.523	.405	.505	.293	.087	.523	-.038	1.000

5.2.5 Sub-section 5 - Accountability

The respondents were given six questions. The six questions were further sub-divided into two constructs which enabled three questions to focus on a Lean accountability questions as shown in Table 1.17. The responses from the respondent show the emphasis management and employees have placed on Lean accountability in their organisation.

Table 1.18: Questions on Lean accountability and respondents' responses (per construct)

LEAN ACCOUNTABILITY - Sub-section 5							
Construct: To measure the assigning actions		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
5.1	Corrective actions are assigned to individuals	13.3	16.7	66.7	3.3	2.60	0.770
5.2	Team members know what is expected of their team	0	12.9	80.6	6.5	2.93	0.450
5.4	Procedures exist for assigning corrective actions to individuals within teams	3.2	25.8	64.5	6.5	2.73	0.640
Construct: To measure the follow-up procedures		**1 %**	**2 %**	**3 %**	**4 %**	**Mean %**	**Standard Deviation %**
5.3	Due dates are assigned to corrective actions at all levels	0	22.6	74.2	3.2	2.80	0.484
5.5	Managers and supervisors follow up on corrective actions	0	16.1	71.0	12.9	2.97	0.556
5.6	Action is taken when deadlines are missed	16.1	19.4	58.1	6.5	2.53	0.860
Rating Scale:		1 = Disagree Strongly		2 = Disagree		3 = Agree	4 = Agee Strongly
RELIABILITY FOR LEAN ACCOUNTABILITY							
Internal reliability: Cronbach alpha		Valid N			Missing N		Total N
0.778		96.8% (n=30)			3.2% (n=3)		31

Source: Researcher's own construction

5.2.5.1 Discussion and interpretation for Sub-section 5 questions

The first construct in sub-section 5 was designed to *measure the assigning actions*. Question 5.2 has the highest responses of 80.6% *Agree* and minimal responses of 12.9% *Disagree.* The question was expected to examine if the team members know what is expected of their team. Other two questions (5.1 and 5.4) within the first construct received 66.7% and 64.5% of *Agree* respectively. Question 5.4 returned 25.8% of *Disagree* responses. Question 5.2 has the lowest standard deviation in the first construct and this implies that a strong relationship exists among team member. However, questions 5.1, 5.2 and 5.4 show that assigning responsibilities/actions within the team members and team leaders measured significant performance.

The second construct was designed to measure *the follow-up processes* existing among the managers, supervisors and team members. Within the construct, Question 5.3 and 5.5 received high responses of 74.2% and 71.0% of *Agree* respectively. Within the second construct, Question 5.3 and 5.5 has the lower standard deviation of 0.484 and 0.556 respectively which indicates that there is more agreement with one another and shows more data reliability. Question 5.6 returned 58.1% of *Agree*, 19.4% of *Disagree* and 16.1% of *Disagree strongly* responses. Question 5.6 has a very high standard deviation of 0.860 and this shows that there is no agreement with one another as relating to managers and supervisors taking necessary action when the deadlines for a specific job are missed.

In summary, this section shows significant positive responses of "*Agree"* and *"Strongly Agree"* and of which many Lean organisations are lacking accountability. Question 5.6 in the sub-section 5 questions can be linked to question 1.2 of sub-section 1 questions, that is, when recurring problems disrupt flow then accountability for deadlines is taken away from the operators on the shop floor.

5.2.5.2 Lean accountability inter-item correlation matrix

Table 1.18, the inter-item correlation matrix for Lean accountability questions recorded no negative values. The entire inter-item correlation matrix returned positive values on the items. This implies that all the items measured the same underlying characteristics (Pallant, 2011). The inter-item correlations were statistically significant from the level of 0.30 (Piedmont, 2014).

Table 1.19 Inter-Item Correlation Matrix for Lean accountability questions

	Q5N1	Q5N2	Q5N3	Q5N4	Q5N5	Q5N6
Q5N1	1.000	.219	.518	.756	.048	.697
Q5N2	.219	1.000	.412	.056	.404	.184
Q5N3	.518	.412	1.000	.378	.102	.679
Q5N4	.756	.056	.378	1.000	.168	.706
Q5N5	.048	.404	.102	.168	1.000	.038
Q5N6	.697	.184	.679	.706	.038	1.000

5.2.5 Sub-section 6 – Open-ended response

The respondents were asked to answer the open-ended question stated below.

"What actions do you believe have influenced the lean culture of your organisation in either a positive or negative way?"

Out of the total number 31 respondents, only six respondents decided to answer the open-ended question. A total of five of these responses were able to be linked to the independent variables contained in section B of the closed-ended questionnaire and one respondent returned a vague (unclear) response that is, the respondent answered "negative ways" without a genuine explanation to support it. Table 1.19 illustrates the category of the responses.

The responses were expected to fall between positive and negative. In the accountability category, two respondents answered the open-ended question and their responses were negative, their interpretations were given in Table 1.19. In the consistency category, one respondent responded to the consistency category and the response was classified to be negative and positive. Finally, in the engagement category, two respondents responded in this category. One negative and one positive response were returned and the interpretations are presented in Table 1.19.

Table 1.20: Respondents' responses to Open-ended questions

OPEN-ENDED RESPONSES - Sub-section 6			
CATEGORY	**RESPONSES**		**FREQUENCY**
Accountability	Positive:	Nil	1
	Negative:	No consequences for individuals who make repeatedly mistakes, causing the company losses	
	Positive:	Nil	1
	Negative:	Negatively impact on Lean culture because of poor discipline and misuse of human rights	
Interpretation:	**This suggests that employees do not think that accountability has been attained**		
Consistency	Both Positive: and Negative:	Depending on responsible managers action how regular the intense they convey messages/actions	1
Interpretation:	**This suggests that different managers, when confronted with a similar situation, would make different decisions**		
Engagement	Negative:	Negatively Perceptions - Blame games and distrust between department	1
Interpretation:	**This suggests that blame and distrust exist and this can support inconsistency within team member**		
Engagement	Positive:	Daily meetings with the supervisors help keep the team focus, and informed about deadlines, delays and feedback on problems encountered by the team.	1
Interpretation:	**This suggests *meaningful engagement* is taking place**		
		Total	5

Source: Researcher's own construction

5.3 Summary of Cronbach's Alpha Coefficient (α) of all Variables

In section 4.5 of chapter 4, Cronbach's alpha coefficient (α) was explained as relating to quantitative analysis. Van der Merwe (2011) explains that "internal reliability is an indication of the ability of the research instrument to reliably measure the constructs or variables in question. Cronbach's alpha coefficient is used to measure internal reliability".

Table 1.20 below shows the summary of the Cronbach's alpha coefficients of the entire range of variables used in the questionnaire. When the Cronbach's alpha is equal to (.80) and above, this suggests that the items have "a relatively high internal consistency". In most quantitative research study, a relatively Cronbach's alpha coefficient of (.70) or higher is considered "*acceptable"* (IDRE, 2015). From Table 1.20, the entire Cronbach's alpha for each variable has a relatively high internal consistency and is considered acceptable.

Table 1.21: Summary of Cronbach's alpha

CRONBACH'S ALPHA COEFFICIENT (α)				
LEAN VARIABLE	INTERNAL RELIABILITY: CRONBACH ALPHA	Valid N	Missing N	Total N
Culture	0.872	93.5% (n=29)	6.5% (n=2)	31
Awareness	0.872	96.8% (n=30)	3.2% (n=1)	31
Engagement	0.889	93.5% (n=29)	6.5% (n=2)	31
Consistency	0.820	90.3% (n=28)	9.7% (n=3)	31
Accountability	0.778	96.8% (n=30)	3.2% (n=3)	31

Source: Researcher's own construction

Table 1.20 shows that the analysis of *Lean Accountability* recorded the lower internal reliability of Cronbach's alpha of 0.778. The analysis of *Lean culture* and *Lean Awareness* recorded the same internal reliability of Cronbach's alpha of 0.872. The analysis of *Lean Engagement* and *Lean Consistency* recorded an internal reliability Cronbach's alpha of 0.889 and 0.820 respectively.

5.4 Hypothesis testing

According to Zaiontz (2015) hypothesis testing is a central belief in statistical analysis. A hypothesis is solely based on two types of testing, namely Null and Alternative hypotheses. In order to test for hypothesis, certain statistical techniques will be considered such as confidence intervals, effect size, statistical significance (*P)* and sample size requirements. A null hypothesis is an estimate which is based on chance. That is the null hypothesis is true if the observed data (in the sample) do not differ from what would be expected on the basis of chance alone (Zaiontz, 2015).

An alternative hypothesis is called a complement of the null hypothesis. A null hypothesis is denoted by H_0 while alternative hypotheses are denoted by H_1 (i.e. H_0 is true if and only if H_1 is false). Often, in an experiment, researchers are actually testing the validity of the alternative hypothesis by testing whether to reject the null hypothesis (Zaiontz, 2015).

The hypothesis was based on a 'two tailed significance testing' as shown in Table 1.21. The accepted significance level for two tailed hypothesis is $\alpha = 0.05$. For two tailed hypotheses testing there are H_0: $P =$ alpha and H_1: $P \neq$ alpha. If P-value <= 0.05, null hypothesis

H_0 rejected and If P-value>0.05, null hypothesis H_0 not rejected. 95% confidence interval accepted.

Table 1.22: Summary of t-Test for gender

TESTING FOR EFFECTS (SUMMARY)						
LEAN VARIABLE	Gender	N	Mean	Std. Deviation	Significance (*P*) (2-Tailed)	Effect size
Culture	Female	12	3.0926	0.35402	0.796	0.09
	Male	18	3.1327	0.44725		
Awareness	Female	12	2.7465	0.37146	0.998	0.00
	Male	18	2.7469	0.49221		
Engagement	Female	12	2.8519	0.43509	0.815	0.08
	Male	18	2.8171	0.36518		
Consistency	Female	12	2.7326	0.45632	0.845	0.06
	Male	18	2.7068	0.26097		
Accountability	Female	12	2.8194	0.46849	0.836	0.07
	Male	18	2.7870	0.37836		
Note: Confidence Interval of the Difference was 95%.						

Source: Researcher's own construction

According to Martz (2013) regardless of the alpha level, any hypothesis test has two possible outcomes as stated below:

- **Reject null hypothesis** – The significance (p-value <= 0.05) and a conclusion can be drawn that the alternative hypothesis is true at the 95% confident level/interval.
- **Fail to reject the null hypothesis** – The significance (p-value > 0.05) and a conclusion can be drawn that not enough evidence is available to suggest the null is false at the 95% confidence level/interval.

5.4.1 Stating the null and alternative hypotheses

The null and alternative hypotheses for both dependent and independent variables are stated below using (H_0) as null hypothesis and (H_1) as alternative hypothesis:

- **Lean culture**

(H_0): The actions of the management and the employees are aimed at increasing and promoting the prevailing Lean culture

(H_1): The actions of the management and the employees do not aim at increasing and promoting the prevailing Lean culture

- **Lean awareness**

(H_0): The actions of employees are aimed at promoting situational awareness as relating to critical processes, promoting visual system and increasing value stream awareness.

(H_1): The actions of employees do not aim at promoting situational awareness in term of critical processes, promoting visual system and increasing value stream awareness.

- **Lean engagement**

(H_0): The actions of the managers, supervisors, and team leaders are aimed at improving active and meaningful employee engagement and promote the suggestion harvesting

(H_1): The actions of the managers, supervisors, and team leaders do not aim at improving active and meaningful employee engagement and promote the suggestion harvesting

- **Lean consistency**

(H_0): The management actions are aimed at creating an enabling environment for Leadership consistency and to promote consistent decision making

(H_1): The management actions do not aim at creating an enabling environment for Leadership consistency and to promote consistent decision making

- **Lean accountability**

(H_0): The activities of the managers, supervisors and employees are aimed at increasing personal accountability through follow-up procedures and assigning corrective actions

(H_1): The activities of the managers, supervisors and employees do not aim at increasing personal accountability through follow-up procedures and assigning corrective actions

Table 1.23: Outcomes of the hypotheses testing

Outcomes of the Hypotheses Testing				
LEAN VARIABLE	The significance (p)	Null Hypothesis (H_0)	Alternative Hypothesis (H_1)	Effect size
Culture	P (0.796) value > 0.05	Accepted	*Rejected*	0.09
Awareness	P (0.998) value > 0.05	Accepted	*Rejected*	0.00
Engagement	P (0.815) value > 0.05	Accepted	*Rejected*	0.08
Consistency	P (0.845) value > 0.05	Accepted	*Rejected*	0.06
Accountability	P (0.836) value > 0.05	Accepted	*Rejected*	0.07
Note: Confidence Interval of the Difference was 95%.				
For two tailed hypotheses testing H_0: P = alpha, H_1: $P \neq$ alpha. If P-value <= .05, reject H_0 and If P-value>.05, do not reject H_0.				

Source: Researcher's own construction

From the hypotheses test results, the significance P-value was used to determine whether the data supported the null hypothesis or not. From table 1.22, all the significant P-values were all greater than (α = 0.05). Therefore, the null hypotheses **(H_0)** were all accepted. The entire alternative hypotheses **(H_1)** were rejected.

5.4.2 Reporting the effect size

Tables 1.22 and 1.24 described the effect size based on frequency (*N),* mean (*M)* and Standard deviation (*Std.)* for the two groups – female and male, statistical value (*t or F),* the degree of freedom (*df),* significance test (*P)* and the confidence interval of 95%. Zaiontz (2015) explains that "the effect size is a standardized measure of the magnitude of an effect. Since it is standardized we can compare the effects across different studies with different variables and different scales". According to Zaiontz (2015) most common measures of effect size are Cohen's *d.* Effect size can be viewed in a standardized way as stated below:

Table 1.24: The Standardized effect size

S/N	Effect Size - Cohen's *d*	Standardized Effect Size	Percentage of variance
1	d = 0.20	small effect	1%
2	d = 0.50	medium effect	10%
3	d = 0.80	large effect	25%

The effect size for each Lean variable was described below using a significant result (t-test) of $p \geq 0.05$.

- **Effect size for Lean culture**

The total population for the group is (*N=30)*, there was no statistically significant difference between the male respondents (mean=3.1327, Std. = 0.44725) and Female respondents (mean=3.0926, Std. = 0.35402), statistical value t = 0.796 $p \geq 0.05$, confidence interval of -0.35551 and 0.27527. The effect size is 0.09 and Cohen's effect suggested that effect size 0.09 has a low practical significance (Zaiontz, 2015). The null hypothesis was accepted because there was no difference between the male and the female responses to Lean culture.

- **Effect size for Lean awareness**

The total population for the group is (*N=30)*, there was no statistically significant difference between the male respondents (mean= 2.7469, Std. = .49221) and female respondents (mean=2.7465, Std. = 0.37146), statistical value t = 0.998 $p \geq 0.05$, confidence interval of -0.34290 and 0.34212. The effect size is 0.00 and the effect size does not determine the significance value. Cohen's effect suggested that 0.00 has a very too low practical significance and referred to as null value (Zaiontz, 2015). The null hypothesis was accepted based on the significance value, because there was a significance difference between the male and the female responses to Lean awareness.

- **Effect size for Lean engagement**

The total population for the group is (*N=30)*, there was no statistically significant difference between the male respondents (mean= 2.8171, Std. = .36518) and female respondents (mean=2.8519, Std. = 0.43509), statistical value t = 0.815 $p \geq 0.05$, confidence interval of -0.26615 and 0.33560. The effect size is 0.08 and Cohen's effect suggested that effect size of 0.08 has a low practical significance (Zaiontz, 2015). The null hypothesis was accepted because there was no difference between the male and the female responses to Lean engagement.

- **Effect size for Lean consistency**

The total population for the group is (*N=30)*, there was no statistically significant difference between the male respondents (mean= 2.7068, Std. = 0.26097) and female respondents (mean= 2.7326, Std. = .45632), statistical value t = 0.845 $p \geq 0.05$, confidence interval of -0.24205 and 0.29375. The effect size is 0.06 and Cohen's effect suggested that effect size of 0.06 has a low practical significance (Zaiontz, 2015). The null hypothesis was accepted because there was no difference between the male and the female responses to Lean consistency.

- **Effect size for Lean accountability**

The total population for the group is (*N=30)*, there was no statistically significant difference between the male respondents (mean= 2.7870, Std. = 0.37836) and female respondents (mean= 2.8194, Std. = 0.46849), statistical value $t = 0.836$ $p \geq 0.05$, confidence interval of -0.28524 and 0.35006. The effect size is 0.07 and Cohen's effect suggested that effect size of 0.07 has a low practical significance (Zaiontz, 2015). The null hypothesis was accepted because there was no difference between the male and the female responses to Lean accountability.

Table 1.25: The entire Independent and Dependent Variable Samples Test

Dependent Variable		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Q1_Culture	Equal variances assumed	.699	.410	-.261	28	.796	-.04012	.15397	-.35551	.27527
	Equal variances not assumed			-.273	27.048	.787	-.04012	.14682	-.34135	.26111
Independent Variable										
Q2_Awareness	Equal variances assumed	2.120	.156	-.002	28	.998	-.00039	.16721	-.34290	.34212
	Equal variances not assumed			-.002	27.470	.998	-.00039	.15798	-.32428	.32351
Q3_Engaged	Equal variances assumed	.513	.480	.236	28	.815	.03472	.14688	-.26615	.33560
	Equal variances not assumed			.228	20.791	.822	.03472	.15226	-.28212	.35156
Q4_Consistency	Equal variances assumed	1.279	.268	.198	28	.845	.02585	.13078	-.24205	.29375
	Equal variances not assumed			.178	15.833	.861	.02585	.14538	-.28261	.33431
Q5_Accountability	Equal variances assumed	.486	.491	.209	28	.836	.03241	.15507	-.28524	.35006
	Equal variances not assumed			.200	20.177	.843	.03241	.16200	-.30533	.37014

The main essence of Table 1.24 is to test for equality of the variances using Levene's test, since the hypothesis was based on a 'two tailed significance testing'. Levene (1960) explains that Levene's test is used to test if variables samples have equal variances. Equal variances across samples is called homogeneity of variance. All the null hypothesis were accepted based on two-tailed significance testing i.e. Sig (2-tailed) and two conditions were considered here:

1. If the Sig (2-tailed) value is greater 0.50, it implies that there is no statistically significant between the variables
2. If the Sig (2-tailed) value is less than or equal to 0.50, it implies that there is a statistically difference between the two variables.

In this case, all the dependent and independent variables (Q1, Q2, Q3, Q4 and Q5) are greater than 0.50 i.e. > 0.50 and this implies there is no statistically significant difference between the dependent variable and independent variable. Therefore, it is concluded that the differences between the two variables means are likely due to chance and not likely due to the independent variable manipulation. Also the independent variable column i.e. Q2 has a statistically significance difference which is relatively the same mean.

Table 1.26: Summary of the results for the statistical hypotheses testing

Lean Variable	Statistical Measures Used	Hypotheses result (H_0) or (H_1)	Reasons for the acceptance
Lean culture	P (0.796) value > 0.05 and an effect size of 0.09	Null hypothesis (H_0) - Accepted	The actions of the management and the employees are aimed at increasing and promoting the prevailing Lean culture The effect size is 0.09 and Cohen's effect suggested that effect size 0.09 has a low practical significance, Zaiontz [43].
Lean awareness	P (0.998) value > 0.05 and an effect size of 0.00	Null hypothesis (H_0) - Accepted	The actions of employees are aimed at promoting situational awareness as relating to critical processes, promoting visual system and increasing value stream awareness. The effect size is 0.00 and the effect size does not determine the significance value. Cohen's effect suggested that 0.00 has a very too low practical significance and referred to as null value, Zaiontz [43].
Lean engagement	P (0.815) value > 0.05 and an effect size of 0.08	Null hypothesis (H_0) - Accepted	The actions of the managers, supervisors, and team leaders are aimed at improving active and meaningful employee engagement and promote the suggestion harvesting The effect size is 0.08 and Cohen's effect suggested that effect size of 0.08 has a low practical significance, Zaiontz [43].
Lean consistency	P (0.845) value > 0.05 and an effect size of 0.06	Null hypothesis (H_0) - Accepted	The management actions are aimed at creating an enabling environment for Leadership consistency and to promote consistent decision making The effect size is 0.06 and Cohen's effect suggested that effect size of 0.06 has a low practical significance, Zaiontz [43].
Lean accountability	P (0.836) value > 0.05 and an effect size of 0.07	Null hypothesis (H_0) - Accepted	The activities of the managers, supervisors and employees are aimed at increasing personal accountability through follow-up procedures and assigning corrective actions The effect size is 0.07 and Cohen's effect suggested that effect size of 0.07 has a low practical significance, Zaiontz [43].

5.5 Verification and validation of results

The aim of this research has been to measure the prevailing Lean culture at a South African aviation company. This entailed the development of a measuring instrument (a questionnaire) to collect data. The questionnaire used for this research was validated and declared reliable for data survey purposes as relating to Lean culture. It was evident in the data interpretation that the measuring instrument had fulfilled its aim and purpose. The literature review showed that the questionnaire is proving to solve real life challenges if the research conclusion can be taken into consideration.

Verification refers to meeting the specification of a product. Base on the aim and objectives of this research, the term *verification* in the context of this research study is to use a questionnaire to measure and analyse the prevailing Lean culture at a South African aviation company. The measuring instrument was used and data analysed as well, and this implies that the specification has been met.

Suhr (2016) describes a confirmatory factor analysis (CFA) as a statistical technique used to verify the factor structure of a set of observed variables. As earlier stated in chapter 4, that the measuring instrument for this study has been used in an automobile environment in the Eastern Cape Province in South Africa as part of Dr Karl van der Merwe PhD research. The observed variables used were carefully selected by the original authors of the questionnaire and those four factors/variables (Awareness, Consistency, Engagement and Accountability) are directed applied to the Lean philosophy.

The discussion and interpretation of the data has shown the validity and reliability of measuring instrument through some widely used statistical techniques such as Cronbach's alpha, effect size, mean, standard deviation, and frequency. The measuring instrument can still be used by at the South African aviation company in the future to measure and analyse their Lean culture journey and can as well be used to large sample size survey.

5.6 Chapter summary

This chapter presented the discussion and interpretation of the empirical results and finding. The descriptive statistics were interpreted, followed by a detailed discussion and interpretation of

results statistical analysis based on the single dependent and four independent variables of the measuring instrument used. The open-ended question was discussed and interpreted based on the three independent variables, namely engagement, consistency and accountability.

In this chapter, the researcher employed widely accepted statistical techniques in order to ascertain the reliability and validity of the data. Each sub-section was provided with descriptive analysis, the inter-item correlations of the data were presented as well. The hypothesis testing were included thereby providing the statistical significance of the data based on the stated null and alternative hypotheses. The summary of Cronbach's alpha for internal consistency was identified and the internal reliability was ascertained.

The next chapter presents the conclusions and recommendations to further enhance effective Lean culture implementation. The research aim, objectives and research questions will be reviewed to further ascertain whether the research aim and objectives have been met. Future research areas will be suggested.

Chapter 6

6 Conclusions and recommendations

This chapter provides the general conclusion to the research based on the empirical results and findings. The general conclusion was made with distinct inferences to both dependent and independent variables such as (Awareness, Engagement, Consistency and Accountability). The research aim, objectives and questions were further reviewed. This chapter also provides recommendations, limitations of the study and possible future avenues of research.

6.1 General conclusion

The main purpose of this study is to measure the prevailing Lean culture at a South African aviation company and thereby contributing to a more successful implementation of Lean manufacturing and continuous improvement philosophy within an aviation environment in South Africa. The research output has shown the influences of the management and employees' actions as relating to the prevailing Lean culture at a South African aviation company. This study will also enable the South African aviation company to clearly see what they have attained so far and what they are yet to attain as far as Lean transformation is concerned in their organisation. Therefore, the aim of the research study has been achieved.

The research findings have come at the moment when a South African aviation company are embarking on a new project, a modern point-to-point regional airliner on low-density routes that will seat 15 to 24 passenger. Therefore, the South African aviation company used as the case study for this research needs to establish an effective Lean culture transformation company. This will allow company to attain success on the future projects. The company needs to improve their organisational competitiveness and sustainability within the aviation industry in South Africa. Aviation industry is a very competitive (and capital-intensive) industry and an effective Lean culture implementation could improve organisation competitiveness and provide sustainability through waste eliminating and value creation.

As clearly identified in chapter one, the research problem is that *"*The problem is that *in most Lean organization, the management and employees are not always aware of the impact that their influences have on Lean transformation and these actions are standing as strong barrier or*

obstacles to their Lean journey in the organization and the reason is that such actions are not being measured either qualitatively or quantitatively."

This research output has been able to support the fact that, Lean organisations need to constantly measure the prevailing Lean culture in their organisation. Through this medium, the influences of the management and employees' actions will be unveiled and necessary measures will be exacted to improve the Lean culture transformation journey in their organisation. The study was able to achieve this at a South African aviation company using an existing a measuring instrument (a Lean culture questionnaire) and the result was analysed and interpreted as shown in the previous two chapters.

The literature survey revealed that an effective Lean transformation journey has to start with the top, middle and lower management. The fourteen management principles of the Toyota way also support the fact that management has to be fully involved in a Lean journey in their organisation. The success of a Lean transformation does not reside with the employees on the shop floor or the lower management (i.e. team leader, managers, and supervisor). Most of the participants who completed the questionnaire survey fell within the lower management and shop floor staff and they have provided their appropriate answers based on their understanding of the Lean concept and this enabled the researcher to draw conclusions based on the data collected. From the participants' side, the survey might contain some elements of bias because the perceptions of individual participants are very different.

The next sub-section provides the general conclusion based on the interpretation of the empirical results and findings.

6.1.1 The conclusion based on the interpretation of the empirical results and findings

This section provides a conclusion to both a dependent variable (Lean organisational culture) and four independent variables, namely Awareness, Engagement, Consistency and Accountability based on the interpretation from the data analysis as explained chapter 5.

Lean organisational culture

The original intention of the first sub-section was to measure Lean culture and to provide support for the link between Lean culture and the four independent variables either in a positive or in negative ways. From the data interpretation in chapter 5, there is a positive link between "Lean

organisation culture" questions in sub-section one and the four independent variables from other sub-sections. The company has made some progress towards the attainment of Lean culture transformation but there remains work to be done. The respondent responses were not completely negative and the null hypothesis (H_0) was accepted because "*the actions of the management and employees aimed at increasing and promoting the prevailing Lean culture*".

According to the data interpretation, the company has made significant progress on root cause problem-solving, 54.8% of respondents chose "*Agree Strongly"* and 41.9% respondents chose *"Agree"* while 3.2% respondents chose *"Diagree"* and this implies that company still needs improvement in finding problem root causes and providing appropriate solutions. There is a degree of inconsistency in the problem identification approach, and the systems nature of Lean has not yet been attained. From question 1.6 of the questionnaire, there appears to be a certain degree of blame for mistakes that persists at company because the score ratings for "*Agree*" and "*Disagree*" are relatively low. The result shows that the employees have a strong waste reduction focus and the decisions are taken for the good of the organisation. Lean is a long term philosophy and more than a technique or tool, it is a way of life (Straub, 2010). It takes a gradual process for a Lean culture to reach its maximum level of implementation in an organisation. Therefore, Lean culture at a South African aviation company can be seen as an on-going process and there should be room for Lean training that will facilitate more continuous improvement.

Lean awareness

The main aim of second sub-section was to measure the degree to which managers had successful implemented and facilitate an enabling environment for situational awareness as relating to Lean culture (van der Merwe, 2011). The respondents' responses show that the company has made minimal progress towards the attainment of Lean awareness and there is much work to be on values streams and critical processes. The null hypothesis (H_0) was accepted because *"the actions of employees aimed at promoting situational awareness as relating to critical processes, promoting visual system and increasing value stream awareness*".

In order to attain a significant Lean awareness journey, the management and employees need to be more Lean thinking than before, i.e. creating an enabling environment for learning organisation as briefly described in section 2.10 of chapter 2.

Conclusively, situational awareness is a vital element in any successful Lean organisation because it assists organisations in simplifying processes and improving manufacturing performance. The main component lacking in Lean awareness is value stream mapping (VSM) and VSM is a Lean management tool that could assist organisation to eliminate waste. The primary goal of VSM is to assist organisation to identify necessary improvements that will allow consistent waste elimination. To achieve a successful VSM, the three visual stream mapping tools can be put into practice as described by (Castellon, 2010):

- **Scope the value stream** – Determine the value stream to be improved
- **Current state drawing** – Understanding how things currently operate, because this is foundation for the future state.
- **Future state drawing** – Designing a Lean flow through the enterprise. Through this medium, a successful visual stream mapping, planning and implementation will be achieved.

Lean engagement

The third sub-section was designed to examine the degree to which the management has meaningfully and actively engaged the employees within Lean organisation. The results have shown that the company has made some progress towards the attainment of Lean engagement but there is a need for more improvement. The results returned more positive responses on both meaningful and active employee engagement. Therefore, the null hypothesis (H_0) was accepted based on the fact that "The *actions of the managers, supervisors, and team leaders aimed at improving active and meaningful employee engagement and promote the suggestion harvesting*".

For a Lean organisation to become successful the employees have to be meaningfully and actively engaged at all levels of production and manufacturing processes. To achieve optimum profit on investment true employee engagement is required and a good feedback system must be put in place.

Conclusively, data interpretation on Lean engagement in chapter 5 shows that leaders at company seem to be participating in shop floor improvement efforts and this indicates active employee engagement. On the other hand, meaningful employee engagement and suggestions regarding the harvesting of proof has been contrary. On the true Lean engagement scale, it suggests that the South African aviation company chosen for this research purpose is in a

"prescriptive" mode rather than a true Lean engagement mode. Therefore, the employees have to be coached on how to identify opportunities/problems and provide solutions to the problem. Successful Lean culture organisations have a distinct reference to effective employee engagement.

Lean consistency

Sub-section four was designed to measure the degree to which the employees perceived the organisational managerial actions as relating to Lean consistency. Lean consistency has not yet been attained at company. Highest responses of "*Disagree*" were recorded which implies that "there is a degree of inconsistency perceived to be present in leadership actions and behaviours". The null hypothesis (H_0) was accepted based on the fact that "*the management actions aimed at creating an enabling environment for Leadership consistency and to promote consistent decision making*".

Lean consistency has more to do with the organisation leadership styles. Most failures in Lean culture journeys in many organisations can be traced back to inappropriate levels of Lean consistency. Often, leaders at Lean organisation do not see themselves as part of the Lean system, which implies that "*Lean culture is for the Shop floor employees*" and believing that the team leaders, managers and possibly supervisors on the shop floor will make a Lean success happen on their own while leadership will continue with "*the business as usual*" i.e. implementing decisions.

The Toyota Company is a very good example in this regard; the fourteen management principles of the "Toyota way" reviewed in chapter 2 explained the Lean leadership commitment to consistency. In order to avoid the same leadership error toward Lean culture, the management needs to make decisions that are congruent with Lean thinking; in other words, they have to make decisions that apply Lean logic. Non-Lean decisions are normally made for short-term gains while Lean decisions are to be made for long-term gains.

Lean accountability

This sub-section was meant to examine the two vital factors of Lean accountability i.e. exercising corrective actions and providing corresponding follow-up process. Accountability is an important component of Lean culture. Mann (2014) in his book *Creating a Lean culture* explains that "accountability is an important component of a Lean management system". Good

Lean accountability practices will allow the team to work efficiently, finding faults and preventing recurring problems. The result shows that the case study aviation company has made good success on

Lean accountability but there is still more room for improvement in this area. The null hypothesis (H_0) was accepted based on the fact that "*The activities of the managers, supervisors and employees aimed at increasing personal accountability through follow-up procedures and assigning corrective actions*"

Corrective actions are often built into quality management systems such as ISO. In many cases, employees see these systems as being separated from Lean and this could be the reason why a very low score was recorded on questions related to corrective actions, i.e. NCRs (Non-conformance report). Leadership needs to assign corrective actions at all levels. The leaders need to start taking action when deadlines are missed i.e. an efficient follow-up procedure have to be initiated. Lean accountability will promote quick problem identification, quality communication within the team, increase problem tracking skills, allow leaders to assign corrective actions daily and prevent problems from recurring.

Conclusively, Mann (2014) suggests daily accountability processes for any Lean organisation. Mann (2014) believes that daily accountability exposes and solves problems quickly and he refers to it as "three tiers of daily meeting" and the three tiers of daily meeting was explained below:

- Tier one – Team leader and production crew meeting
- Tier two - Supervisor and team leader meeting
- Tier Three – Value stream leader with supervisor and support groups (possibly middle and top management) meeting.

The three tiers of daily meeting is the platform for creating Lean accountability. The three tiers meeting will create an "opportunity" for assessment and corrective actions.

6.2 Review of the research objectives and questions

The study was aimed at presenting a research output that would further assist company in their Lean transformation journey. The research output could break Lean culture barriers such as lack

of understanding of Lean concept, misconception among managers, lack of team work, wrong Lean leadership, Lack of clear communication, lack of top management support and etc. In order to achieve the aim of this study, three specific objectives were stated in chapter 1.
The three specific objectives were listed below:

- To conceptualise Lean management according to the literature study that could answer the research questions mentioned above.
- To apply an existing tool (a questionnaire) to measure and analyse the prevailing Lean culture at a South African aviation company.
- To provide conclusions and recommendations thereby contributing to more effective Lean culture implementation.

6.2.1 Objective one

The first objective was to conduct a literature review that could answer the following research questions:

Research question 1: *What is a Lean and more specifically what is a Lean philosophy? Why do Lean implementations fail? What role does organisational culture play in this regard?*

Section 2.4 and 2.11.2 of chapter two provides answers to the first research questions. These two sections provided an insight into TPS and Lean production and the reasons *why most companies failed in their Lean transformation journey*. Section 2.3, 2.1.1 to 2.13 and 2.2 of chapter two explains Lean production philosophy and Lean thinking.

Research question 2: *What is Lean culture? Could the fourteen management principles of Toyota ways help shape the Lean culture transformation? Are the fourteen management principles so important in Lean culture management?*

Section 2.11.1 and 2.12 of chapter two provides answer to the second research questions and it reveals the significance of Toyota Production System (TPS). The fourteen management principles of the Toyota way in chapter two could help the employees and management to shape their understanding of TPS management culture or behaviour and section 2.5 of chapter two provides an insight to "*what is Lean culture*"

Research questions 3: *What is culture? How can organisation culture be created? What are the three levels of organisational culture? Ways to create and maintain organisational culture should be found?*

Sections 2.8, 2.81 to 2.8.2 and 2.9 of chapter two provide answers to culture, organisational culture, and ways to create and maintain organisational culture.

Research questions 4: *Can employee perceptions regarding leadership behaviour and prevailing organisation Lean culture be measured, or can Lean culture be measured qualitatively and quantitatively?*

Section 2.6 of chapter 2 extensively answered the fourth research question, that is, "*can the prevailing organisation culture be measured"?* The following scientists (Hofstede, Neuijen & Sanders, 1990) explained that organisational culture can be measured quantitatively. Noemi Imre *et al.* (2013) also illustrates that organisational culture can be measured either qualitatively or quantitatively.

A comprehensive literature study was conducted and the research questions were answered accordingly. Therefore, the first objective has been attained.

6.2.2 Objective two

The second objective was to use a measuring instrument to measure and analyse the prevailing Lean culture at a South African aviation company. This study achieved the second objective. The research methodology and the data analysis were clearly explained and interpreted in chapter four and chapter five respectively.

6.2.3 Objective three

The third objective was to provide conclusions and recommendations thereby contributing to more effective Lean culture implementation within the aviation industry in South Africa. This chapter provides a conclusion and recommendations to the study and future research was suggested as well. Therefore, the third objective was achieved.

6.3 Limitations to the study

The study was limited to a South African aviation company which is case study for the study. The sample size of the survey was very small because the questionnaire was distributed within

the maintenance repair and overhaul - operations (MRO OPS) and Depot Level workshop environment only. The researcher was not able to make a generalized conclusion of the prevailing Lean culture in the organisation. In spite of the limitations, the aim of the study was achieved. The research output shows that the questionnaire is a valid and reliable measuring instrument which can be employed by Lean organisations to measure the prevailing Lean culture.

6.4 Expected contribution to knowledge

The study is expected to contribute to a more successful implementation of Lean manufacturing and continuous improvement philosophy within an aviation environment in South Africa. This study can help existing Lean organisations or any kind of organisation aiming to embark on a Lean transformation journey to see the need to measure the prevailing Lean culture in the organisation.

6.5 Recommendations for the study

The prevailing Lean culture has been measured and analysed. Therefore, the following recommendations were suggested:

- This type of research study should be conducted on a larger sample size and this will give room for more extensive study and generalization of research result. This can be done using both qualitative (individual interviews, focus groups, observation etc.) and quantitative research methods. Future research studies in this area could employ online survey (i.e. through e-mail or web-based questionnaires method) to disseminate the questionnaire instead of the hard copy method (i.e. hand-outs and face-to-face) that was used for this research study.

- This same research study can be extended to other arms of the company provided they are practising Lean culture. From the statistical perspective, the measuring instrument could serve as diagnostic tool for other organisations to measure their areas of weakness, strength, and more over areas for improvement of Lean culture transformation. This measuring tool can be used to monitor and evaluate the prevailing Lean culture transformation and to secure future growth

- This research study used only one case study which was one South African aviation company. A comparative study could be done which could involve other aviation organisations in South Africa provided those aviation organisations are using Lean manufacturing principles and similar prevailing Lean cultures can be measured in those aviation organisations, since a specific research study can be replicated in other organisations or other countries.

- To secure future growth and continuous improvement in Lean culture transformation in any organisation, adequate Lean training for the employee will play significant roles in this regard, and have to be done on a regular basis. As explained in section 2.10 of chapter two as relating to "Learning organisation". Lean culture is a journey that involves continuous learning, engagement, awareness, improvement, consistency and accountability. The company needs to employ more expertise on Lean management systems that will help restructure, re-orientate and re-training the employee including the top, middle, lower management on the subject of 'Lean culture'.

6.6 Future research study

Future research in this context should accommodate a larger sample size of the population. Some suggestions for future research within the Aviation industry in South Africa as relating to Lean culture transformation are stated below:

- A study to report the benefits of Lean culture in an aviation industry in South Africa
- A study to create an enabling environment to instil an effective Lean culture system in the hearts of individual employees.
- A research study to look into how Lean management systems can be used to sustain Lean culture transformation.
- A research study aimed at determining the correlation between problem solving activities and the growth of Lean culture

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Appendix Section

Questionnaire Survey: Lean Culture

SECTION A - BIOGRAPHICAL INFORMATION

1. Gender: **Female** ☐ **Male** ☐

2. Age: ☐ **Years**

3. Organization: ☐

4. Level: ☐

Senior Manager, Middle Manager, Supervisor, Team Leader, Operator, Shop Floor Worker and Other

5. Service ☐ **Years of Service in Current Organization**

SECTION B - PERCEPTIONS REGARDING LEAN CULTURE

Options to Select: 1- Disagree Strongly. 2- Disagree 3- Agree 4- Agree Strongly

1. This section relates to your organization's culture or, more simply "the way we do things around here". Please indicate to what extent you agree with each of the statements below by circling the appropriate		Disagree Strongly	Disagree	Agree	Agree Strongly
1.1	A problem is viewed as an opportunity to improve	1	2	3	4
1.2	Recurring problems disrupt flow	1	2	3	4
1.3	We consider the impact of decisions on the rest of the organization	1	2	3	4
1.4	We believe that reducing waste makes us more competitive	1	2	3	4
1.5	We are able to respond quickly to customers' changing demands	1	2	3	4
1.6	Identifying problem does **not** lead to blame	1	2	3	4
1.7	Solutions are implemented that prevent a problem from recurring	1	2	3	4
1.8	Decisions are taken for the "greater good" of the organization	1	2	3	4
1.9	Negative customer feedback (internal or external) leads to change	1	2	3	4
1.10	We believe that quick response to change is important	1	2	3	4
2. This section relates to the levels of awareness on the shop floor. Please indicate to what extent you agree with each of the statements below by circling the appropriate number. **Note:** Value Stream: the processes of creating, producing, and delivering a good or service to the market		Disagree Strongly	Disagree	Agree	Agree Strongly
2.1	The concept of a value stream is widely understood	1	2	3	4
2.2	A visitor would be able to identify each shop floor value stream	1	2	3	4
2.3	We know what measures are important to each value stream	1	2	3	4
2.4	Visual systems provide information about the status of each value stream	1	2	3	4
2.5	We constantly refer to our visual systems	1	2	3	4
2.6	Employees know the location and extent of each value stream	1	2	3	4
2.7	Key processes have been identified in each value stream	1	2	3	4
2.8	Problems affecting output have been identified	1	2	3	4
2.9	Problems on the shop floor become obvious as soon as they occur	1	2	3	4

3	This section aims to explore the degree to which employees are engaged and challenged by management. Please indicate to what extent you agree with each of the statements below by circling the appropriate number	Disagree Strongly	Disagree	Agree	Agree Strongly
3.1	Leaders participate in shop floor improvement efforts	1	2	3	4
3.2	Team members' feedback is valued by supervisors and managers	1	2	3	4
3.3	Team members' are challenged to provide the best solutions	1	2	3	4
3.4	A formal procedure exists for obtaining suggestions	1	2	3	4
3.5	Feedback is provided on all suggestions	1	2	3	4
3.6	Leaders discuss work problems and often offer guidance	1	2	3	4
3.7	Team members are asked for problem solutions	1	2	3	4
3.8	Experience and guidance has led to an improved problem-solving	1	2	3	4
3.9	Good suggestions are implemented	1	2	3	4
4	This section relates to the consistency of managerial actions. Please indicate to what extent you agree with each of the statements below by circling the appropriate number.	Disagree Strongly	Disagree	Agree	Agree Strongly
4.1	A regular schedule of Lean feedback meetings exists for all leaders	1	2	3	4
4.2	Regular Lean feedback meetings ensure sustained focus	1	2	3	4
4.3	All levels of leadership are included in the plan	1	2	3	4
4.4	Leaders make decisions that support the vision and mission objectives	1	2	3	4
4.5	Daily decisions are made to support our vision and mission statements	1	2	3	4
4.6	Managers meet with supervisors regularly throughout a shift	1	2	3	4
4.7	The feedback meeting schedule is written into organizational procedures	1	2	3	4
4.8	Managers are often too busy to attend scheduled Value Stream Meetings	1	2	3	4
4.9	Managers have a common approach to problem solving	1	2	3	4
5	This section aims to explore the prevailing levels of accountability and associated systems. Please indicate to what extent you agree with each of the statements below by circling the appropriate	Disagree Strongly	Disagree	Agree	Agree Strongly
5.1	Corrective actions are assigned to individuals	1	2	3	4
5.2	Team members know what is expected of their team	1	2	3	4
5.3	Due dates are assigned to corrective actions at all levels	1	2	3	4
5.4	Procedures exist for assigning corrective actions to individuals within teams	1	2	3	4
5.5	Managers and supervisors follow up on corrective actions	1	2	3	4
5.6	Action is taken when deadlines are missed	1	2	3	4

6. What actions do you believe have influenced the Lean Culture of your Organization in either a positive or negative way?

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

Language Editor Declaration

Declaration

This is to declare that I, Annette L Combrink, accredited language editor and translator of the South African Translators' Institute, have language-edited the dissertation by

MO Alabi (25756982)

with the title

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Prof Annette L Combrink
Accredited translator and language editor
South African Translators' Institute
Membership No. 1000356
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