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A CLOSER LOOK AT LEAN: THE CHANGES THAT OCCUR WITHIN AN ORGANISATION STRIVING FOR OPERATIONAL EXCELLENCE

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A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Science in Engineering.

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Abstract

A single case study of a major South African Maintenance, Repair and Overhaul facility was completed over a five week period from November 2012 to January 2013. The primary objective of the research was to track the changes that occur within an organisation which is striving for operational excellence in the context of lean production practices. A systems approach combined with the Baldridge Criteria for Performance Excellence was used to construct a theoretical framework for the study. Three main systems were identified within this theoretical framework, namely; social, technical and structural systems. Each of these systems encompassed individual change elements. Semi-structured interviews and participant observations were used as the principle means of gathering data.

Changes were observed within each of the systems, particularly within the department in which lean had been formally implemented. The technical system was found to be the most influenced. This was evidenced by management of resources, particularly of workforce input toward continuous improvement initiatives, and also of equipment and tooling. The quality system was found to be influenced through a continuous assessment of procedures and processes to remove waste within them. The structural system was found to embody many of the lean principles, however low correlation was found between the lean initiative and the respondents' existing knowledge.

The social system was found to be the least influenced, and in some cases its state was found to completely contradict the norms which lean theoretical underpinnings would suggest. A possible reason for this was that that the organisation was in the early stages of lean implementation.

The theoretical framework developed for the purpose of the study was considered to be applicable when analysing changes within organisations implementing lean. The framework could also be considered applicable in the analysis of other improvement initiatives. The framework's structure allows for distinctions to be made between changes brought about by the initiative itself and consequential changes of normal organisational development.

Acknowledgements

I would like to acknowledge my supervisor, Bernadette Sunjka for her unwavered support throughout this research. I would also like to thank all the respondents who committed their time to this research, without which it would not have been possible. Lastly, I would like to thank my family and friends who never gave up on me through my relentless journey.

Declaration

I declare that this research is my own unaided work. It is being submitted as due requirement to the University of the Witwatersrand, Johannesburg, in partial fulfilment for the degree of Master of Science in Engineering (Industrial) (50/50).

_____

Tyron Mansfield

This the _____ day of _____ 2013

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List of Abbreviations

AME	Aircraft Maintenance Engineer
AMO	Aircraft Maintenance Organisation
CAA	Civil Aviation Authority
CAGR	Compound Annual Growth Rate
DSA	Denel SAAB Aerostuctures
DTI	Department of Trade and Industry
FAA	Federal Aviation Authority
JIT	Just in Time
KPA	Key Performance Area
KPI	Key Performance Indicator
MOP	Manual of Procedures
MRO	Maintenance, Repair and Overhaul organisation
NNVA	Necessary Non Value-Adding
NVA	Non-Value Adding
OEM	Original Equipment Manufacturer
SACAA	South African Civial Aviation Authority
TOC	Theory of Constraints
TPM	Total Productive Maintenance
TPS	Toyota Production System
TQM	Total Quality Management
VA	Value Adding
VOC	Voice of the Customer
VSM	Value Stream Map
WIP	Work in process (inventory)

1. Introduction

South Africa in recent times, has seen many changes occurring within its Aerospace Industry, particularly in the field of manufacturing and maintenance (Locatory 2013; Campbell 2011; Campbell 2010). South Africa started developing its own aircraft specifically for the South African Air Force under Atlas Aircraft Corporation which, in 1992 merged into the Denel Group (Pty) Ltd, forming Denel Aviation. Atlas Aviation was initially responsible for the development and maintenance of various military aircraft such as the Impala Mk1, Oryx helicopter, Atlas Cheetah, Bosbok, Kudu and Rooivalk attack helicopter (GlobalSecurity.org 2012). Since 1994, South Africa has embarked on drastically reducing its SAAF compliment of aircraft, in some instances by 75% (GlobalSecurity.org 2012). This has forced local manufacturers such as Denel Aerostructures and Aerosud to compete in a highly industrialised international market, where their survival depends on their ability to maintain their standards and meet their customer needs within a niche market.

With South Africa having a relatively buoyant aircraft market within the private sector (Copens 2007), this requires that drastic measures be taken to ensure that South Africa sustains its competitive advantage in the fields of aircraft maintenance and manufacturing.

For manufacturing and maintenance companies (including their suppliers) to compete on a global scale in quality and throughput, the need may arise for them to adopt major changes within themselves (Haupt 2005). The current research attempts to bridge this gap in our understanding by analysing the organisational changes brought about as a result of implementing a lean strategy. This was accomplished by developing a unique theoretical framework around existing theory. A systems approach was adopted in developing the theoretical framework with which the various changes could be analysed. The Baldridge Criteria for Performance Excellence was used to inform the theoretical framework. Finally a case study analysis of one of South Africa's leading 'Lean' aircraft maintenance organisations was completed to test the application of the framework in the context of Lean. The following research report covers the development of the theoretical framework as well as the results from the single case study analysis through which the framework was tested.

1.1. Background to the problem

The following section gives an overview of South Africa's aerospace industry. Section 1.1.1 covers the broad industry and where South African aerospace companies compete in relation to the global market. Section 1.1.2 focusses on aircraft maintenance and its current global status.

1.1.1. South African Aerospace Industry Overview

South Africa currently has over 200 companies which service its aerospace industry. This includes both manufacturing and maintenance organisations (Haupt 2005). Of these 200 companies, it is estimated that less than 5% are fully compliant with ISO9001 quality standards (a requisite for most companies who wish to conduct business within the aerospace sector), and less than 1% are compliant with AS/EN9100 standards (a preferred quality standard for international suppliers to the aerospace industry) (P. Haupt 2012, pers. comm., 11 June). To be a part of the global aerospace supply chain, it is necessary to be recognised as AS/EN9100 compliant. The global aerospace industry supply chain consists of 5 tiers or levels, with the majority of South Africa's aerospace industry operating within the 3rd tier (the supply of minor parts and sub-systems). Various South African companies who compete globally within this tier are Denel (Aerostuctures, Aviation, Kentron and Eloptro) and Aerosud (Haupt 2005).

1.1.2. Aircraft Maintenance

According to expert's beliefs, the current aircraft maintenance and repair sector in the African market will increase its value by 40% in the next decade (Locatory 2013). Although the coming years look positive for Africa's airline industries, their support structures are still lacking if they are to cope with any major increases in demand. The DTI identified lean as a means by which South African aerospace companies can optimise these support structures and thereby remain globally competitive (Haupt 2005). South Africa's aerospace supply chains form an integral part of the support structures previously mentioned, and according to the CCO of Locatory.com; *V.Vorobjovas;'In order to start cutting down on expenditure without compromising on quality and effectiveness African airlines must seek to supply spare parts supply innovations, outsourcing and new generation technologies. Currently the supply*

chain devours 60-90% of all costs but even the slightest 2% increase in the process effectiveness could result in 3000-5000% improvement in cost optimization as opposed to 2% increase in IT, human resources, finance and sales effectiveness.' (Locatory 2013). Therefore the application of lean principles within key aerospace companies will provide the perfect opportunity for South African aerospace organisations to increase their process effectiveness described above. If applied directly within South African aircraft MRO's this will assist in making South Africa a more economical solution for overseas airlines with regards to the maintenance, repair and overhaul of their fleet aircraft servicing the sub-Saharan African countries.

Presently, local companies such as Denel Aviation have contracts to serve sub-Saharan countries with both rotary and fixed wing maintenance, repair and overhaul (MRO) needs (Denel SOC Ltd 2012). By partnering with overseas companies, MRO's such as Denel Aviation are gaining strategic access into key markets (SADPE 2006), and are setting the example for competitors who wish to expand their operations into Africa.

Considering then the link that local MRO's have, and are yet to still attain with emerging markets, one needs to have a closer look at the current trends within international markets. Studies done into the international MRO markets by a leading consulting firm, *Frost and Sullivan* reveal the aggressive approach that will need to be taken by MRO's in the near future as OEM's begin to take control of MRO activities and integrated solutions (Lavigne 2010). Figure 1 reveals the expected growth of the global MRO Industry in the coming years. Note that between 2009 and 2019, the global MRO industry can expect growth of up to 4.5% whilst between 2009 and 2029 it can expect an average growth of 3.8%.

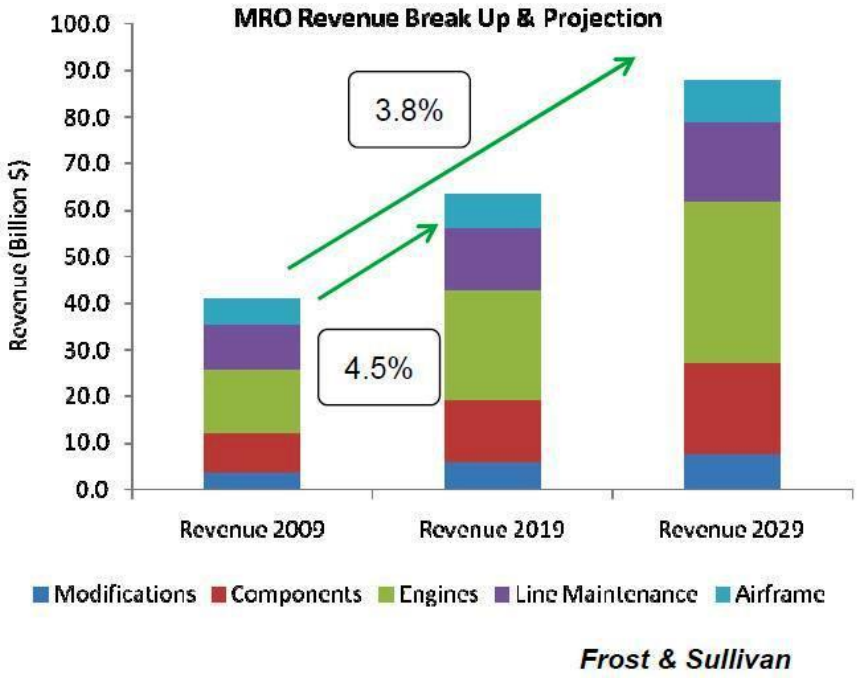


Figure 1: Projected growth of the global MRO industry (Lavigne 2010)

With lower operating costs in India and China, it is expected that the compound annual growth rate (CAGR) within those countries is going to be a respective 8.9% and 8.2% against Africa's 0.6% (Smith 2009). However, with Africa maintaining a 2.8% revenue share within the global MRO market, there is still a large amount of potential revenue to be made considering the future growth previously outlined in Figure 1. Figure 2 below outlines the global MRO market, with Africa expecting a spending of $1.8billion dollars in 2013 (Smith 2009).

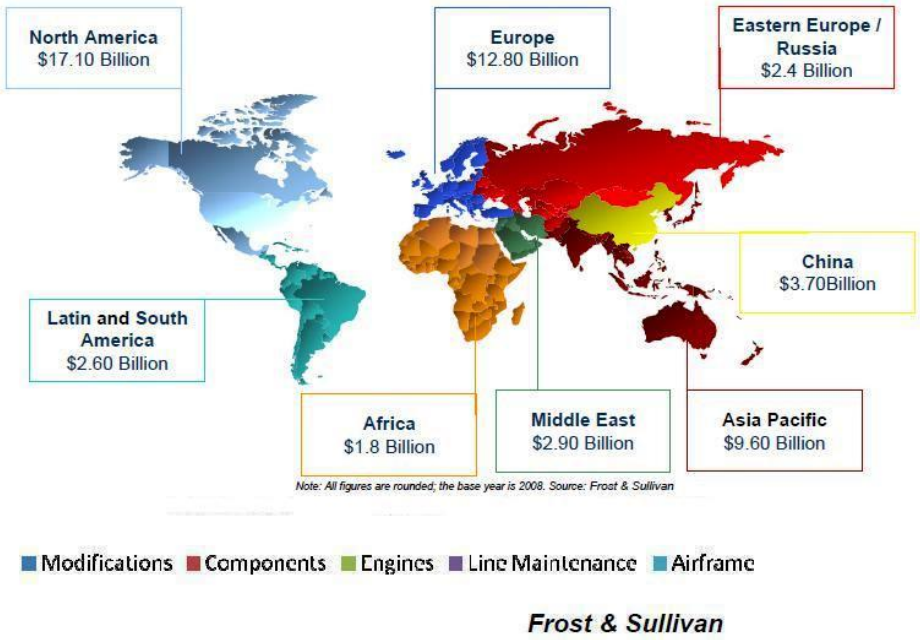


Figure 2: Expected MRO spending by region for the year 2013 (Smith 2009)

From the above figures, South African MRO's have much to gain by remaining competitive within only Africa. By implementing lean principles within local MRO's and their supply chains, South Africa could gain a larger revenue share of the $1.8 billion forecast to be spent in 2013.

However, there is little information on the application of lean within South African MRO's. One particular study found that the implementation of lean principles within South African aircraft maintenance organisations (AMO – a synonym of MRO) was not present, and further, that the implementation of other improvement methodologies such as Theory of Constraints and Six Sigma were also not present (Murphy 2011).

This highlights a gap in not only the understanding of lean principles within the South Africa's MRO industry, but in its direct application. As evidenced from previous research (Smith 2009), South African MRO's have much to gain from the application of lean principles. There is a prevalent gap in our understanding of lean implementation within South African MRO's. The current research attempts to bridge this gap by observing the changes brought about through its implementation in one particular aircraft MRO.

1.2. Motivation

As previously outlined, lean has been identified as a strategy for the local aerospace industry (including manufacturing and maintenance organisations) to remain competitive within global markets, however there are no established methods for implementing it. One reason could be that each organizations' social and technical make-up is different (Gryna et al. 2007). There are various authors (Narang 2008; Crute, Ward, Brown & a. Graves 2003; Ahrens 2006; Richardson & Inspection 2012) who propose different key aspects that require attention during the implementation of lean, but very few authors give direct guidelines on how to go about physically changing/adapting these aspects towards a lean organization. The transformation would entail changes in processes, material support, information systems, supplier relationships, organisational hierarchies and management and corporate mind-set (Mathaisel 2005). As previous research has been mainly focussed on the extent to which organisations have implemented various lean tools and principles (Crute, Ward, Brown & a. Graves 2003), the current research attempts to track the enculturation of them, with the purpose that this research may become a reference point for any South African aircraft maintenance organisation wanting to implement lean.

1.3. Problem Statement

Two known South African MRO's claim to have implemented lean, of which one would ultimately become the case study of this research. Based on the subjective nature of lean audits, this exposes their results to a certain amount of biasness (Taggart 2009). With this problem in mind, it was not the author's intention to first determine the level of lean implementation, but to identify the changes that occurred within various areas of the company. Therefore, from the outset, three themes were identified which encompass the required transformational changes as identified above in Section1.2, namely:

1. **Structural changes:** Supplier and customer relations, corporate hierarchy
2. **Social changes**: Management and corporate mind-set
3. **Technical changes**: Business Process, Material support and Information systems

Further defining the above changes formed part of the research objectives. From the outset the Central Research Question was identified:

CRQ:

What Social (eg: cultural, corporate governance, employee relationships), Structural (eg: Corporate Hierarchy, supply chain management) and Technical (eg: shop floor, business process, equipment) changes occur within a company during their transformation to Lean.

This lead to the main objectives of the research

1.4. Research Objectives

To fulfil the CRQ outlined above, the following objectives were identified:

- Develop a theoretical framework that can be used to track the social, structural and technical changes in an organisation.
- Inform the framework with regards to the theoretical changes (social, structural and technical) that occur within companies who are/have adopted a lean philosophy.
- Via an in depth case study of one of South Africa's leading aerospace companies, determine what social, structural and technical changes occurred during their transformation to lean.

1.5. Research Methodology

A detailed single case study analysis of one of South Africa's leading 'lean' aircraft MRO facilities was conducted. A multiple case study approach was considered, with an ideal spread of between 4 and 10 cases. More than 4 cases should be selected if the empirical grounding of the research is to be convincing and preferably less than 10 as the complexity of the analysis becomes difficult to manage (Eisenhardt 1989). South Africa has only two known aircraft MRO facilities who have directly applied lean principles within their organisations. With this limiting constraint, an empirical approach would not suffice, and

therefore, one of the two local MRO's formed the basis of this investigation, and a detailed single case study approach was selected.

This necessitated the development of semi-structured interview questions; based around relevant theory questions that were ultimately linked to the central research question (Wengraf 2001). The theory questions were informed by the theoretical framework built around the Social, Structural and Technical changes (see Section 2.5 for the detailed development of the theoretical framework). The answers to the interview questions were then transcribed, and triangulated between different interviewee's responses so as to reveal the nature of their multiple perspectives (Leedy & Ormrod 2005). Section 4 outlines the detailed development of the theory questions and interview questions.

1.6. Delimitations of the research

- The first delimitation to the research is the assumption that the organisation being studied has implemented lean. There is much debate around the bias within lean audits (Taggart 2009), and so establishing whether the company has successfully implemented lean, will be based on their own lean audits conducted either by themselves or an external entity.
- The second delimitation to the research, being viewed in retrospect from previous authors' experience, is that not all intended persons to be interviewed may agree to take part in the interviewing process for confidentiality or other personal reasons.
- The third delimitation to the research depends on the extent to which lean has been implemented within the chosen organisation. Therefore identifying the changes that have occurred within the organisation is limited to those area's which have directly been the focal point of lean implementation.

1.7. Ethical Considerations

To obtain accurate and reliable data, the author may be required to interview employees holding managerial positions within the organisation. The author, at the discretion of the interviewee, will withhold any personal information pertaining to the interviewee and

organisation. The author is fully willing to accept any non-disclosure agreement which the interviewee or case study company may wish to impose.

As the author will be conducting interviews alone, it will be necessary to record the interview to ensure the accuracy of the results. This will require that the author make it clear to the interviewee that they will be recorded, and understand that if the interviewee refuses, that it may influence the outcome of the research at hand.

Other considerations to be taken into account are as follows (adapted from the University of the Witwatersrand's *Guidelines for Human Research Ethics Clearance Application (non-medical.*

1.7.1. With regard to informing the participant prior to the interview:
Participant Information Sheet written in a language understandable to the participant (or guardian) detailing what the participant will be told. This should include the following:

- Participation is voluntary, and refusal to participate will involve no penalty or loss of benefits to which the participant is otherwise entitled;
- The participant may discontinue participation at any time without penalty or loss of benefits;
- A brief description of the research, its duration, procedures and what the participant may expect and/or be expected to do;
- Any foreseeable risks, discomforts, side effects or benefits.

1.7.2. The participant will be formally invited according to the *Guidelines for Human Research Ethics Clearance Application (non-medical).*

1.7.3. The participant will then be asked to sign a consent form which will:

- Include a clear statement that the participant is consenting to his/hers involvement in the research.
- State clearly that the participant is free to withdraw from the study at anytime without prejudicing any current access to facilities. (If this is not made clear, the researcher risks the accusation that consent obtained by subtle coercion that is, the possibility of prejudice against the participant).

1.7.4. If asked to do so, a confidentiality agreement will be entered into with the participating organisation to further protect the interests of the company and its employees.

2. Literature Review

The following section gives an overview of both international and local aerospace companies who have implemented lean. Section 2.2 outlines existing lean theory in the context of the five lean principles identified by James Womack and Daniel Jones (J. P. Womack & Jones 2003). Section 2.3 covers the concepts of Lean Thinking and Systems Thinking. Section 2.4 covers existing theoretical frameworks that lend themselves to informing the framework used in the current research, specifically related to the Social, Technical and Structural change elements identified in Section 1.3. Section 2.4.4 outlines the process of selecting one of the existing frameworks as a basis for informing the framework used in the current research.

2.1. Previous work related to the topic

There exists much theory on the application of lean within various organisations, and therefore, one does not have to search far to find outstanding examples of its wide application, a mere look at a list of various Shingo Prize recipients will suffice (U.S.U. 2011) (The Shingo Prize is an award which was first introduced in 1988 for companies excelling in operational excellence and the application of lean). There are however, fewer examples of where lean has been applied specifically within the aerospace industry, more so in the aircraft maintenance repair and overhaul industries. The majority of the examples and case studies in the literature arise from international organisations, where the success and failure of lean is discussed along with the organisations' 'lessons learned'. (Browning & Heath 2009; Crute, Ward, Brown & A. Graves 2003; Krichbaum 2007; Scherrer-rathje et al. 2009).

Brief examples of such cases where lean has been sustainably applied within both international and local aerospace companies is given below.

2.1.1. Global Aerospace and Lean

As previously mentioned, lean has successfully been applied across various industries, however, the focus of the current research is on the aerospace industry, specifically the aircraft maintenance industry. To gain a better understanding of its application within the

aerospace industry, examples of its use within both the manufacturing and maintenance sectors were considered.

Globally, lean has been applied within various aircraft OEM's. Examples of its success can be found at companies such as Boeing, Lockheed and Cessna in the United States as well as Airbus in France. To understand the potential benefits that lean may bring to South Africa, it is necessary to consider successful examples of its application within these companies.

Boeing

Boeing began their lean transformation in February 1996 by implementing it throughout their Commercial Airplanes Division (Jenkins 2002). Based on the success of the initial rollout, Boeing expanded their lean transformation throughout the organisation. Today, lean has assisted Boeing to respond to customer orders more quickly whilst reducing costs and systematically improving operational performance (Warden 2000; Jenkins 2002). Final assembly on The Apache Program, Boeing 737 and Boeing 757 saw major improvements as a result of lean. Boeing implemented a Nine-Step plan in transforming their 737 and 757 assembly lines (Becker 2003), namely:

1) Value stream mapping and analysis of all processes
2) Balance the assembly line
3) Standardize the work
4) Put visuals in place
5) Point of use staging
6) Establish feeder/supply chain lines
7) Break-through process re-design along the main line
8) Convert the assembly line to a pulse line
9) Convert to moving line (One piece flow line)

After implementing these steps, Boeing saw reductions of up to 79% in employee travel, 81% in product travel and 48% in running costs within their Fabrication Division by 2003 (Becker 2003). Other improvements within selected divisions included reducing the number of parts within sub-assemblies by up to 49%, resulting in a 7% weight reduction and 9% cost reduction (Becker 2003).

More recently, Boeing has improved its output of 737's by 20% from 31.5 to 38 aircraft per month (Athol Franz 2013). It is forecast that the number will go up to 42 airplanes per month by 2014. It is reported that employee teams have been instrumental in increasing the flow on the Boeing 737 line through developing and implementing innovative efficiency improvements. (Athol Franz 2013)

Lockheed Martin

Lockheed Martin also began their transformation in the late 90's by introducing lean to small sections within the company. Due to the lack of a centralised drive towards implementing lean, Lockheed introduced the LM21 program in 1999 (EPA 2011). The program sought to drive the principles of Six Sigma and lean throughout the organisation to increase the overall operational performance of the company. LM21 has resulted in some $5 billion savings over the years. Driving the principles of lean and Six-Sigma also assisted Lockheed in being awarded the bid to develop the Joint Strike Fighter – JSF in October 2001 (EPA 2011). Strict government initiatives restricted funding being allocated to the development of new weapon systems. This required that lean be present throughout the company's supply chain, which included engineering, program management, suppliers and production – all of which Lockheed had in place (Puckett 2003). Overall, between 1992 and 1997, Lockheed saw improvements of 38% in manufacturing costs, 50% in inventory reduction and a 49% reduction in order-to-delivery times (Puckett 2003).

Airbus

Airbus began their lean journey in 2000, when they decided to challenge themselves to reduce costs, improve efficiency and reduce order-to-delivery times (UnipartLogistics 2000). They first implemented it within their Broughton Facility, where the wings for all Airbus civil aircraft are assembled. Since then, Airbus has taken a large drive to improving the flow of their assembly lines. Their first major step was introducing a single isle moving line for the assembly of aircraft. Completed in 2005, it is hoped that the moving line will bring long term savings of up to 15% on the fuselage assemblies. In the mean-time, airbus has witnessed a 44% reduction in their fuselage lead times (UnipartLogistics 2000).

2.1.2. Local Aerospace and Lean

Within South Africa, there are two major 1st tier suppliers, namely Aerosud and Denel SAAB Aerostructures (Haupt 2005). Both these companies have implemented lean at their facilities to reduce running costs, and to improve order-to-delivery times as well as overall plant efficiency (O'Hanlon 2010).

At Aerosud, some early improvements within their aluminium pressing operations saw drastic reductions of up to 93% in their tool change-over times (Keys 2009). After experiencing their initial success of lean, a lean programme called 'Galley 2008' was introduced within the company which resulted in a drastic reduction in design turn-around times. In the first year of implementing 'Galley 2008', Aerosud halved their design turnaround times (Keys 2009). Today, Aerosud is still actively involved in the lean philosophy. Recent developments in the industry suggest that Aerosud is to buy DSA (Campbell 2011). This is possibly due to major losses that DSA has incurred over the last few years (R328 million for the year to March 2010). DSA currently has had contracts to develop parts and sub-assemblies for OEM's such as Saab, Westland Augusta, Boeing and Airbus. Although DSA has a set structure to implement lean in their 'STEP' programme, they claim to still be within a 'turn-around' phase of its implementation (Campbell 2011). If Aerosud follow through with the acquisition of Denel SAAB Aerostructures, there may exist many opportunities for a great partnership between themselves and their sub-tier suppliers. There are plans to develop the Centurion Aerospace Village near Aerosud's premises which, when completed, will host their major supplier companies (AeroAfrica 2010). This will have the advantage of drastically improving logistical costs, and allow for the development of highly efficient supply chains throughout South Africa's leading aerospace companies.

With regards to South Africa's aircraft maintenance facilities, little information is currently available. A recent study suggests that lean is not at all present within local AMO's (Murphy 2011). The study found that out of nine AMO's situated within Gauteng, that two (22%) were aware of lean, and that none of them embodied the principles. At the time of writing this report, the author was aware of two aircraft maintenance facilities which were in the process of implementing lean, and to some extent, have embodied its core principles. The first company is Denel Aviation, whilst the second company cannot be named as it was used as the case study in the current research.

2.2. Summary of Lean Theory

The purpose of this section is to provide a the reader with a brief overview of lean theory. For the purpose of this research, the five lean principles were chosen as a starting point.

James P. Womack and Daniel T. Jones have covered much of the ground theory around lean and its five principles in their novel entitled 'Lean Thinking' (Womack & Jones 2003). Aspects of 'lean thinking' have witnessed as far back as 1104 in a ship yard in Venice, where ships were built for the Venetian Army (J. Womack 2004). The French made use of some of the 'lean lhinking' principles in 1675 when incorporating standardised designs into their field weapons in order to assist soldiers in making on-field repairs to their weapons. Evidence of 'lean thinking' is reported have been present in 1807 by the English , in 1822 by the French, 1850 by the Americans Armouries, 1914 by Henry Ford, the late 1930's by the German army, 1950 by Toyota in Japan and in 1990 by firms gravitating towards the process re-engineering movement (J. Womack 2004).

The following section outlines the five lean principles as recognised by Womack and Jones (J. P. Womack & Jones 2003). A summary of the five lean principles is given below:

1) **Specify Value**
2) **Identify the Value Stream**
3) **Flow**
4) **Pull**
5) **Perfection**

2.2.1. Specify Value

Value refers to the 'Ultimate Customer' (Womack & Jones 2003, pp. 15-19). It more specifically refers to the good or service for which the customer specifically needs and is paying for.

Value may refer to a particular part of a product, an aesthetic or ergonomic feature which the customer specifically requests or needs, a specific function which a product must perform, or a particular service which a service provider must provide. This therefore involves

identifying what the customer actually wants (Bicheno & Holweg 2009). Anything which the customer is not directly paying for or did not directly request may be termed as waste, or *muda* (Bicheno & Holweg 2009; Womack & Jones 2003; Lane 2007).

There exist many types of waste, however the main categories as outlined by Taiichi Ohno (1912-1990) are (Womack & Jones 2003; Bicheno 2012):

1) Transport
2) Inventory
3) Motion
4) Waiting
5) Overproduction
6) Overprocessing and
7) Defects

Bicheno (Bicheno & Holweg 2009) also identifies an 8th waste of 'Human Potential', relating to the waste of not empowering employees with the potential of doing more. Bicheno goes on to identify many other forms of waste, however, the most common seven wastes are outlined below:

Transport

This refers to the waste of resources put into transporting goods or information between points in the production line or business process. The number of transport and material problems are directly proportional to the likelihood of damage and deterioration. Also, the longer the distance needed to travel, the longer the communication links, and so the quality of communication may break down (Bicheno & Holweg 2009).

Inventory

Inventory refers to the build-up of work in process (WIP) or finished goods, as well as information. According to the Theory of Constraints (Eliyahu M. Goldrat & Jeff Cox 2004), inventory generally builds up in front of the process bottleneck (the slowest point in the production process). This waste incorporates value added time and capital, as well as space, whether it be information on a server or floor-space in a factory. Besides these more obvious

negative attributes, the build-up of inventory also hides defects and prevents the rapid identification of problems (Bicheno & Holweg 2009).

Motion

The waste of motion refers to the waste of human or mechanical motion. A motion whereby an employee must walk between stations (layout related) or place one component before they can place another (process related), refers to the waste that is 'motion'. The human dimension also relates to the importance of ergonomics for quality and productivity (Bicheno & Holweg 2009), whilst the machine element pertains to the importance of optimally sequencing production processes, or program sequences.

Waiting

The waste of waiting pertains to products or people that are required to wait for machines or person to complete a task in the production process (Bicheno & Holweg 2009). This also occurs particularly within the service industry, as customers are made to wait for the service provider. This waste directly affects the flow of products or information, and is strongly linked to the 3rd principle – Flow.

Overproduction

This is caused by a lack of scheduling or an excess allowance for internal quality costs. This was believed by Taiichi Ohno to be the most serious of the Seven Wastes, as it was the root cause of many problems and therefore waste (the author believes it to be the symptom of waste as well) (Bicheno & Holweg 2009; Womack & Jones 2003). Overproducing an item too early or for 'just in case something goes wrong' implies that there is a possible lack of suitable process controls (monitoring quality) or that the producer does not know their customers' exact demands, and therefore may be perceived as lacking relations with external customers. Although inventory, particularly WIP inventory can be sold to an awaiting customer, items that are produced as surplus run the risk of not being sold, which is a blatant waste of invested capital (Bicheno 2012).

Overprocessing

Overprocessing (or inappropriate processing) relates to the 'overkill' of conducting a process or activity which is set to perform a specific function. Overprocessing relates the use of a large machinery being used to conduct smaller jobs, and also to machinery that is not capable (in terms of process capability) (Bicheno & Holweg 2009) . Machines are therefore required to make more, in order to have a greater probability of producing an item within its specification limits. The author believes that overprocessing may also be attributed to the function that an item fulfils, and the deliberate steps taken to incorporate a specific design element into an item in order to achieve a certain function (may be perceived as 'over-engineering' an item). If too many functions incorporated into a design, this may be seen as direct form of waste, as the customer will have a large likelihood of never utilising that function. A concept called Value Engineering (VMS 2012) highlights this perception of 'overprocessing' as it forces one to think of an item's function against the cost of producing that item. Relating it to the 1st principle of Value, in that only make/produce/design that which the customer wants or needs. This will force one to consider the waste of overprocessing.

Defects

The waste of producing defects results in rework. Within the theory of Quality Costing, the failure of a defect is regarded as either an internal or external failure cost (Gryna et al. 2007). Internal failure costs relate to scrap, rework and delay, whilst the external failure costs relate to warranty claims, repairs, field service and also lost income. The key to the waste of defects is detecting them before they reach the customer. This more thoroughly covered by a philosophy called Total Quality Management, which puts quality (and in general continuous improvement) at the heart of the organization (Pycraft et al. 2010).

2.2.2. Identify the Value Stream

The value stream is the set of all the specific actions required to bring a specific product (whether a good, service or a combination of the two) through the three critical management tasks of any business (J. P. Womack & Jones 2003): The problem solving task, the

information management task and the physical transformation task. By using a technique known as value stream mapping, the entire value stream of a product or service is outlined on a sheet of paper; using a specific labelling system to show the different steps in the process. By doing this, it highlights the three main types of activities, namely, value adding, necessary non value adding, and non-value adding. These activities are defined as follows (Bicheno & Holweg 2009):

Value Adding (VA) – All activities unambiguously adding value

Necessary Non-Value Adding (NNVA) – All activities without which, the product cannot be completed, or deemed completed (eg: inspecting work before processing it further) and is also deemed business value adding.

Non-Value Adding (NVA) – The activities which are mainly highlighted by the seven wastes above, are those activities which the customer is not paying for, and have no direct influence on the outcome of the product or service.

The author believes that the concept of analysing the value stream, forces organizations to consider opening communication links with suppliers and customers in order to create a sense of transparency towards the product or process from its start to its end. As companies begin to outsource more of their core capabilities, so it becomes increasingly necessary for the organization to consider collaborating with suppliers and customers in order to convey the needs of the customer throughout the entire supply chain.

2.2.3. Flow

Once the entire process has been mapped and all obvious forms of waste have been removed, can one now progress to making the process flow. This is an intensive task, as it may include the entire redesign of a process or system, or the re-layout of equipment in a production process. Putting it simply, creating flow means to progress through the achievement of tasks along the value stream so that a product proceeds from its design to launch, order to delivery and raw material into the hands of the customer with as little process, demand and supply variation as possible (J. P. Womack & Jones 2003; Bicheno & Holweg 2009). With regards to the variation previously outlined, the expected lead time which is proportional the level of 'flow' is summarised in *Kingman's equation* below:

$$L = \frac{(C_a{}^2 + C_e{}^2)}{2} x \left(\frac{\rho}{(1+\rho)} \right) x T_e + T_e$$

Where:

L is the expected lead time, C_a is the arrival variance, C_e is the process variance, ρ is the utilisation (arrival rate/service rate or load/capacity) and T_e is the average process lead time or queuing time (Bicheno 2011) .

Kingman's Equation highlights the most important and influential aspects of lean (Bicheno 2011), as behind the mathematics lies :

- The Toyota view of:
  - Muda (waste)
  - Muri (overburden or over-working of machines and people) and
  - Mura (unevenness which is the variation pertaining to arrival rates and capacity)
- The Six Sigma view of reducing variation in both the process inputs and outputs (Gryna et al. 2007)
- The Seddon insight of eliminating failure demand which is linked to rework (Bicheno & Holweg 2009)
- Insights from Theory of Constraints (TOC) lie behind the variables ρ, when considering process capacity and T_e when calculating the correct buffer stock placed before individual processing points (Eliyahu M. Goldrat & Jeff Cox 2004)
- The views of Hopp and Spearman from Factory Physics, specifically around capacity inventory and response time in the context of demand, transformation and supply variation (Wallace & Spearman 2008).

2.2.4. Pull

The term 'pull' is associated with the customer, and the ability of the process to respond to the customer's demands. Instead of 'pushing' production through, against demand forecasts and internal failure demand. We wish for processes and products to be pulled through the system according to what the internal and external customer's exact specifications are (J. P. Womack & Jones 2003).

2.2.5. Perfection

Perfection is an iterative process, whereby once the first iteration of improvements have been made, the entire process is repeated. Perfection is the continuous improvement component of lean, whereby it forces managers to strive for an ideal state, for example – zero defects, zero work in process inventory (WIP), instantaneous change over times (Pycraft et al. 2010). Striving for perfection creates transparency as processes and activities become increasingly visible to sub-contractors, first-tier suppliers, distributors, customers and most importantly, employees (Womack & Jones 2003). It is this 'ideal' state which empowers and turns the wheel of change within organisations as employees and managers both seek to continuously improve. One way of implementing a culture of continuous improvement is to adopt Kaizen. Kaizen is the Japanese name for continuous improvement, and is both a philosophy and a set of tools (Bicheno & Holweg 2009). Kaizen is dedicated to continuous improvement in small increments, at all levels, forever (Bicheno & Holweg 2009; Lane & Shook 2007). However, in the context of Kaizen, one must be careful not to focus only on one part of the organisation. Organisations must avoid the 'push down – pop up' principle whereby if one seeks to improve through drastic changes in striving for quick wins; as one problem is pushed down, another will pop up (Bicheno 2010). This form of problem solving is often referred to as Sub-Optimisation (Bicheno & Holweg 2009).

In summary, the above section outlines the governing principles of lean as identified in Lean Thinking ((J. P. Womack & Jones 2003). Not outlined in the above section are the various tools and techniques which organisations adopt during a lean initiative.

Many authors have discussed the various tools and techniques used to implement the five lean principles (Lane 2007; Bicheno & Holweg 2009; J. P. Womack & Jones 2003; Pycraft et al. 2010). Two particular authors; Lane (2007) and Bicheno (2009) do not particular focus on the five lean principles, but rather cover a broad introduction to the tools and techniques used in lean and its compliments (Toyota Production System (TPS), Total Quality Management (TQM) and Just In Time (JIT)).

Pertinent to the current study, a summary of existing tools and strategies with descriptions of each is given below in Table 1. Table 1 also shows what level of change an organisation is required to make to fully implement the tool/strategy.

Table 1: Brief outline of existing tools and business strategies closely related to Lean (Arnold 2012; Bicheno & Holweg 2009)

Tool/Strategy	Description
Level 1: Those which require normalisation and/or corrective actions	
Quality Circles/Green Areas	Focus area where workers develop solutions to work related problems under the supervisions of a manager or team leader.
5S	Methodology that describes how to organize a work space for efficiency and effectiveness by identifying and storing items that are used around the workspace, maintaining the area and items, and sustaining the new order.
Level 2: Those which require redesign of layout and systems	
Cell Production	Arrangement of labour into semi-autonomous or multi-skilled teams where an entire product or complex component is manufactured.
Visual Management	The use of display boards and screens to display production volumes and performance charts
Kanban	A pull system whereby work is demanded at the rate of the internal/external customer using Kanban cards
Theory of Constraints (TOC)	A manufacturing paradigm where the system constraint is identified and optimised, whilst the rest of the system is subordinated to its rate of production/throughput.
Group Technologies	Parts, components or processes similar in geometry or nature are grouped together so as to reduce set-up time
Bench Marking	Is principle of comparing an organisation's business processes and performance metrics with the industry's best or best practices from other industries.
7 Wastes	Also referred to as Muda. They are discussed Section 2.2.1
Incentive Schemes	Used to promote specific behaviour of a select group of people over a specified period of time
Total Productive Maintenance	Closely related to lean, it focuses on improving machine availability through the better utilisation of maintenance and production resources.

Level Scheduling	Extending to suppliers and customers, it deals with the smoothing of demand and supply within both a manufacturing and service environment.
Level 3: Those which require restructuring	
Just in Time Manufacturing (JIT)	Strongly linked to Kanban, JIT focuses on reducing in-process inventory and its associated carrying costs by producing at the rate of demand
Theory of Constraints (TOC)	A manufacturing paradigm where the system constraint is identified and optimised, whilst the rest of the system is subordinated to its rate of production/throughput
Total Quality Management	This is a business management philosophy aimed to continuously improve the quality of processes and products
Six Sigma	Utilising a specific problem solving technique, Six Sigma focuses on gaining control of internal processes and reducing the number of defects using statistical techniques amongst others.
Lean Manufacturing	A business philosophy that aims to reduce all waste throughout the value stream of a product or process in order to fulfil the exact needs of the end customer.
Material Requirements Planning (MRP)	This is a production planning and inventory control system that is used to manage manufacturing processes
Manufacturing Resource Planning (MRP II)	This is a method which addresses the effective planning of all resources of a manufacturing company.
Activity Based Costing	A methodology whereby the activities involved in a manufacturing or business process are assigned accurate costs according to their consumption of resources
Bench Marking	Is principle of comparing an organisation's business processes and performance metrics with the industry's best or best practices from other industries.
Toyota Production System (TPS)	A major precursor to Lean Manufacturing, TPS was developed by Toyota, and was originally grounded in JIT

In summary, lean embodies many of the above tools and strategies within its five core principles as outlined in "Lean Thinking" (Womack & Jones 2003).

It is not of our interest to go into detail on each of these concepts, as they are not directly incorporated into the current research model. It is however, the author's view that lean was a term 'matched to the actions of the observed' as James Womack and Daniel Jones toured the world studying; what were in their views; organisations striving for operational excellence; and that the concepts behind many of the modern improvement initiative are all intertwined in a world view, or in systems thinking the 'Weltanshauung' of operations management.

Bicheno (2009) further recommends a Systems approach to solving problems. He states that a systems approach means the focus should be on the organisation or entity as a whole before attention is paid to its parts (Bicheno & Holweg 2009).

To identify key attributes of the systems approach, the following section discusses the two concepts of Lean Thinking and Systems Thinking.

2.3. Lean Thinking and Systems Thinking

Bicheno (2010) states that 'Systems Thinking' is not an easy concept, and that likewise 'Lean Thinking' is not easy to define. Many 'Systems Thinkers' such as Checkland, Ackoff, Demming, Senge, Forrester, Ohno and Seddon do not completely agree on their views of 'Systems Thinking'. This is also true regarding 'Lean Thinkers', where several lean academics were reported to have failed to reach consensus on the definition of Lean Thinking (LeanEdu, 2009. Cited: Bicheno 2010).

Lean Thinking is grounded in Toyota's production system, which has largely been studied by many experts, and was partly created by W. Edwards Deming. W. Edwards Deming was an advisor to the Japanese during the post war reconstruction of their economy. He carried with him, the systems approach to quality control, and set the world standard for manufacturing quality (Zokaei et al. 2010; Siriram 2012).

System Thinkers like Deming, use their judgement to ensure that what they seek to improve is more than just a small part of an obvious, bigger system. Systems thinkers take into

consideration the philosophies of Reductionism and Mechanism (Siriram 2012). Reductionism is the philosophy that everything can be reduced to simpler components, taking the formal system approach where the nature of the formal system concept is that it comprises a generalized conceptual model of a system engineered to carry out the various activities required to meet the root definition of the System (Siriram 2012). By considering an organisation as a system, Deming adopted a universal approach to transformation. It was a universal one that was guided by 14 universal principles, summarised by the following points (Joyce 2013):

1) Constancy of purpose – create a constancy of purpose towards continuous improvement with a plan to become competitive and to remain in business.
2) A new philosophy – management and corporate leaders must adapt to a new philosophy aligned with the new economic age – one in which common sense exists presently as the previous age's philosophies (adopted quote from Henry Ward Beecher).
3) Cease dependence on mass inspection – remove points in the process responsible for quality inspections by building quality into the process
4) End lowest tender contracts – avoid the philosophy of awarding business on price tagging alone by creating long term relationships grounded in loyalty and trust where a single supplier can be made a component of a larger quality system.
5) Improve every process – related to the concept of continuous improvement, strive to always improve the system of production and service in terms of time, quality and cost.
6) Institute training on the job – adopt a culture of on learn by doing, which can be started by first explaining *What* the job is, and *why* it is being done.
7) Institute leadership of people – requires that management reconsider their role as one of providing assistance and leadership – not supervision. The manager's role should be to coach their staff and to improve the system.
8) Drive out fear –fear is a barrier to improvement, drive it out so as to create an environment of optimism and not pessimism.
9) Break down barriers – eliminate departmental silos in an organisation. People in various departments must work as a team striving for a common goal.

10) Eliminate exhortations – substitute object driven management and numerical (often unrealistic) targets with sound leadership.
11) Eliminate arbitrary numerical targets – management must focus on quality and not the traditional quota.
12) Permit pride of workmanship – remove the annual merit rating, and promote pride in workmanship, something that cannot always be measured in terms of quality and numbers.
13) Encourage education – institute a vigorous program of education and self-improvement.
14) Top management commitment and action – create a management structure which promotes the presence of management on the floor, where they are put to work in re-enforcing a culture focussed around the customer and quality.

Deming intended that all the principles be adopted through the transformation process. A statement by Lloyd Dobbins explains this: "*The way not to depend on mass inspection (point 3) is to continually improve the process (point 5), to do that you will need quality supplies (point 4), finding a quality supplier takes time (point 1), to do so you will need to adopt the philosophy (point 2" and "We want our people to work together, but it's hard to do so without point 8, 9, 10, 11 and 12"* – Lloyd Dobbins

Lastly, in the context of lean, Bicheno & Holweg (2009) emphasises the use of systems thinking when applying lean principles. He warns against thinking of lean as a box of tools to be used when required. He emphasises that tools are cause and effect actions, not interactions; and further stresses the importance of adopting a holistic approach in its application.

2.4. Development of a Theoretical Framework

As previously outlined in Section 1.3, transformational changes was summarised into three themes, namely:

1. **Structural changes:** Supplier and customer relations, corporate hierarchy
2. **Social changes**: Management and corporate mind-set
3. **Technical changes**: Business Process, Material support and Information systems

As there are no existing frameworks that could be used to observe these changes, it was necessary to develop a framework for assessing them. It should be emphasised at this stage that a systems approach was adopted when identifying key change elements and as such, an organisation-wide view was taken with regards to these change elements. The three themes identified above are by no means complete, and thus require further definition. Figure 3 below illustrates a Systems View of the three types of organisational changes identified in Section 1.3.

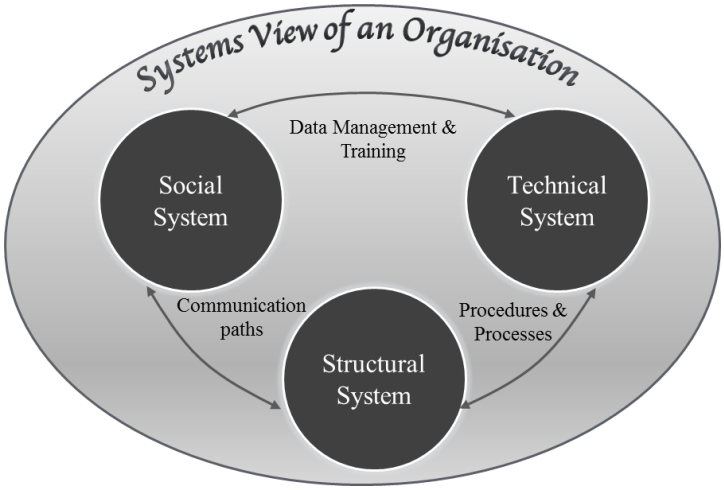


Figure 3: Organisation as a set of systems (Contextual View)

Three existing frameworks were identified to encompass various aspects of organisational change, namely, the Baldridge Criteria for Performance Excellence, The Shingo Transformational Process Framework and the Lean Enterprise Architecture (LEA).

A summary of each framework is given below:

2.4.1. **The Baldridge Criteria** (NIST 2011)

The Baldridge Criteria were established in 1988 as part of evaluating companies for the Malcom Baldridge National Quality Award. The award and its governing criteria are managed by the National Institutes of Standards and Technology (Gryna et al. 2007). The framework within which the criteria for the Baldridge Award are distributed is shown below in Figure 4.

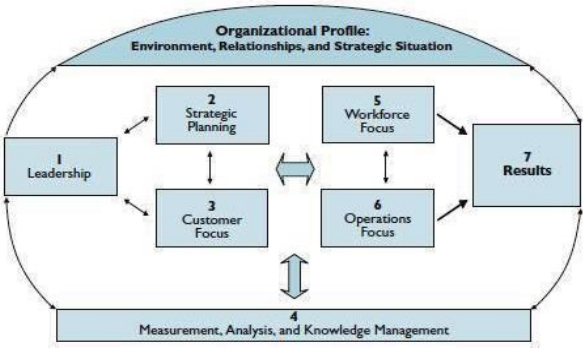


Figure 4: Baldridge Criteria for Performance Excellence Framework: A Systems Perspective (NIST 2011)

Companies are evaluated against the criteria spread across seven categories shown in the centre of the framework. The level to which a company satisfies each given criteria is determined by a Board of Examiners who consist of experts from U.S. business and education, health care, and non-profit organisations. The seven categories are listed below with definitions beneath each one. Note that the information below was obtained from the Baldridge Criteria for Performance Excellence (NIST 2011).

1. **Leadership**

   This category examines how the organisation's senior leaders' personal actions guide and sustain the organisation. It also looks at the organisations governance system, and how ethical, legal and social responsibilities are fulfilled.

2. **Strategic Planning**

   This category examines how the organisation develops strategic objectives and action plans. It also looks at how the strategic objectives and action plans are implemented and changed to suit the required circumstances the business finds itself in. It also looks at how progress is measured.

3. **Customer Focus**

   This category examines how the organisation engages its customers for long term success within the market place. The engagement strategy includes how the organisation listens to the voice of their customers, builds customer relationships and how the organisation uses customer information to identify opportunities for improvement.

4. **Measurement, analysis and knowledge management**

   This category examines how the organisation selects, gathers, manages, analyses and improves data and knowledge assets. It also looks at how it manages information technology and how the organisation uses review findings to improve its overall performance.

5. **Workforce focus**

   This category looks at the organisations ability to asses workforce capability and capacity needs. It also focuses on how the organisation engages, manages and develops the workforce to utilise its full potential in alignment with the organisation's mission, strategy and action plans.

6. **Operations focus**

   This category focuses on how the organisation designs, manages, improves and protects its work systems and processes that deliver customer value and achieve organisational success. It also seeks to identify the elements which sustain its success.

7. **Business Results**

   This last category examines the organisations performance and improvement in all key areas including product and process outcomes, customer focussed outcomes, financial outcomes and market outcomes. Performance levels are examined relative to those of competitors and other organisations with similar product offerings.

2.4.2. The Shingo Prize for Operational Excellence

The Shingo Prize was established as an award for companies who are considered to be at the pinnacle of operational excellence (*The Shingo Guidelines* 2010). This award, like the Baldridge award is weighted against various criteria. They differ slightly from each other in their application. The Shingo Prize Model and Application guide is what its name suggests; a guide. It serves as a generic framework on how to go about making the relevant changes to an organisation in order to move it towards 'Operational Excellence'. The guidelines are meant to be grounds upon which businesses can begin to weight themselves so as to establish the areas they need to focus on. The framework also adopts a systems view of the functional areas within which a company is required to perform (*The Shingo Guidelines* 2010). The guiding principles are embedded within the transformational process outlined in Figure 5 below:

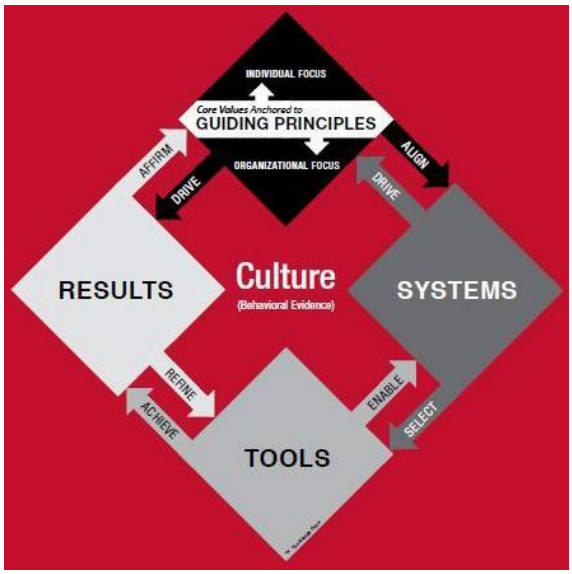


Figure 5: Shingo Transformational Process (*The Shingo Guidelines* 2010)

The Shingo framework is made up of various dimensions consisting of 10 specific guiding principles of operational excellence. The guiding principles were compiled by some of the best organisations in the world as a foundation for their philosophy of operational excellence. These guiding principles are supported by more fundamental principles. Table 2 below summarises the four main dimensions along with their guiding principles (*The Shingo Guidelines* 2010).

Table 2: The Four Shingo Dimensions and their Guiding Principles

Dimension	Guiding Principle
Cultural Enablers	Respect every individual
	Lead with Humility
Continuous Improvement	Focus on Process
	Embrace Scientific thinking
	Flow and Pull Value
	Assure quality at source
	Seek perfection
Enterprise Alignment	Create constancy of purpose
	Think Systematically
Results	Create Value for the Customer

The four dimension of the Shingo Prize Framework are discussed below. The information is summarised from the Shingo Guidelines (*The Shingo Guidelines* 2010):

1. **Cultural Enablers**

   This dimension focuses on developing a culture in the organisation based around continuous improvement. It guides the practitioner towards developing an organisational culture which is grounded on respecting every individual and leading with humility. It contains supporting principles emphasising the nurturing of long-term relationships with both customers and suppliers, developing people and expanding their knowledge, empowering and involving everyone in achieving the organisation's vision and lastly to assure and support a safe working environment.

2. **Continuous Improvement**

   This dimension focuses on setting goals in alignment with Shingo's advice: "Improvement means the elimination of waste, and the most essential precondition for improvement is the proper pursuit of goals. We must not be mistaken, first of all, about what improvement means. The four goals of improvement must be to make things: "easier, better, faster and cheaper." – Shigeo Shingo (*The Shingo Guidelines* 2010) This dimension uses guiding principles which embrace scientific thinking

using models such as the PDCA (plan, do, check, act) cycle. It focuses on creating flow and pull along the organisations core value streams. Continuous Improvement is directed towards assuring quality at the source through a combination of three principles, 1) do not pass defects forward, 2) stop and fix problems and 3) respect every individual. The last guiding principle of Seeking Perfection consists of eight supporting principles which focus on stabilising and standardising processes, relying on data, insisting on direct observation, focussing on the value stream by keeping it simple and visual, identifying and eliminating waste and lastly integrating any improvements into everyday work.

3. Enterprise Alignment

This dimension focuses on executing strategies and plans by guiding organisations in developing management processes that align activities with both philosophy and direction, in ways that are simple, comprehensible, actionable and standardised. It elaborates on management processes that are built around scientific thinking with more emphasis on cycles of learning than on the perfect plans. Underlying this dimension are principles taken from W. Edwards Deming's "14 Points". The first guiding principle focuses on creating constancy of purpose by aligning leaders' philosophical and strategic directions. To do this, it poses a second guiding principle which promotes systematic thinking, which aids in sustaining a lean culture focused on continuous improvement. It further utilises 4 supporting principles which teach leaders to 'see reality' by doing what John Bicheno terms 'Going to the Gemba' (Bicheno & Holweg 2009). It is a process of going to 'blind spots' and using the five senses to begin a process of enquiry. The supporting principles go further to elaborate on focussing on the 'Long-Term' and lastly to align systems and strategy.

4. Results

This final dimension consists of a single guiding principle which aids in promoting flow along the value stream. It focuses on creating value for the customers, investors, employees and communities through the use of three supporting principles. The first supporting principle insists on 'measuring what matters' through having a robust measurement system that provides timely feedback that is accurate and aligned with strategic priorities. The second supporting principle focuses on aligning the

behaviour of employees with the core values of the organisation by emphasising that personal values drive individual behaviours. It further emphasises that it is the leaders' responsibility to ensure that the values of individuals are aligned with the values of the organisation. The last supporting principle elaborates on identifying cause and effect relationships within the organisation, and the links between them.

2.4.3. Lean Enterprise Architecture (LEA) (Mathaisel 2005)

The Lean Enterprise Architecture is an architectural framework used for enterprise reengineering in the design, construction, integration and implementation of a lean enterprises using systems engineering methods (Mathaisel 2005). The LEA uses a multiphase approach structured on the transformational life cycle phases. It was developed for the U.S. military aerospace (MRO) industry and avoids rushed approaches often adopted during lean implementation (*Pearce and Bennet, 2005; Laraia et al., 1999* Cited: Mathaisel 2005).

LEA was designed to organise the activities of transforming an organisation towards being a lean enterprise by providing a framework that guides the transformation process from the organisation's current state to its desired future state. It uses a phased approach as outlined in Figure 6 overleaf.

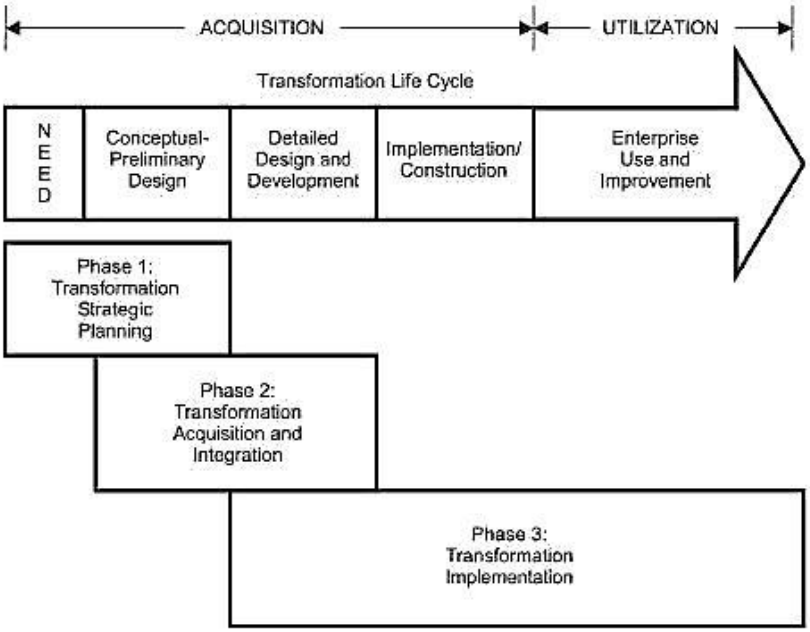


Figure 6: Lean Enterprise Architecture Phases (Mathaisel 2005)

Phase 1: Transformation and Strategic Planning

The first Phase of the transformation involves developing a strategic plan to focus the effort and energy of the organisation towards the achievement of common goals, objectives and performance metrics. The LEA depends on an organisation being focussed upon a central vision set forth in a carefully conceived plan. Within the first phase, the strategic plan should encompass the three critical change elements of the transformation process which includes infrastructure, lean operations and personnel change management.

Phase 2: Transformation, Acquisition and Integration

The second phase consists of a requirements package, acquisition plan, integration plan and a change management and communications plan. They are outlined below (Mathaisel 2005):

Requirements package: Consists of a statement of work for the transformation to be done, including its scope and specifications, a contract data requirements list and acceptance

criteria including a delivery schedule. The requirements package addresses the major cultural aspects of the transformation process, and highlights the need for IT integration.

Acquisition plan: This outlines the strategy for managing the elements of the transformation. Dominant contracting methods are decided on, whether it involves project management method or design and construction method, the selection of the contracting method is influenced by the available internal resources.

Integration plan: Integration plan includes establishing the appropriate lines of communication, both vertically and horizontally within the organisation. The integration plan needs to take into consideration the expected outcomes after implementing other initiatives. Using existing integration strategies such as Integrated Process and Product Development (IPPD) and Integrated Master Schedule (IMS), will provide a sufficient foundation to manage the change process.

Change Management and Communications plan: This plan governs the strategy of sustaining any change that has been implemented. It involves looking at all the areas of change management, including strategy, training and supporting management systems. Mathaisel (2005) mentions that a successful lean transformation depends, in large part, upon how effectively management communicates with those affected by the transformation. He elaborates that the communication must address, at a minimum, what is happening, why it is happening and how it is happening.

Phase 3: Transformation Implementation

This phase is centralised around a strong vision, continuous improvement and progress measurement. It necessitates the role of managers becoming leaders who promote innovation and organisation. To do this requires that the necessary personnel are well versed in program management, best lean practices, financial management, vendor selection, administration support and other functions that are deemed necessary to help integrate company and general contractor personnel efforts.

Summary of existing frameworks:

The Baldridge criteria is generally used as a set of guidelines which companies can adopt in order to move closer towards performance excellence (NIST 2011). It does not favour either service or manufacturing environments. Similar to the Baldridge Criteria, the Shingo Prize guidelines give one a broad understanding of what needs to be done to move closer towards operational excellence. Its guiding principles are somewhat abstract, and rely on successful practitioners to understand them (*The Shingo Guidelines* 2010). The LEA however, approaches the transformational process from a 'project management' point of view. It accommodates for change, what areas need to be considered and what parts of the transformation need to be taken on and when. For the purpose of the current research, it was necessary to select a suitable framework that would encompass the relevant system elements, so that changes to each system element could be observed independently. In this form, an existing framework would act as a means of informing the theoretical framework developed in the current research. The selection of a suitable framework is outlined in Section 2.5.

2.4.4. Framework Selection

The approach taken toward selecting a suitable framework involved the separation of each framework into various 'change themes'. From a systems perspective, the 'change themes' were considered as elements of the three larger systems. The choice of grouping the change elements within the three systems was based on the initial definition of each system given in Section 1.3.This method, although subjective in nature, allowed the author to systematically identify which existing framework would ultimately inform the three systems the most. Table 3 summarises the various change elements identified within each existing framework, whilst also aligning them with a suitable system as previously identified in Section 1.3.

Table 3: Change elements identified within existing frameworks

System	Baldridge Themes	Shingo Themes	LEA Themes
Social System	Knowledge Management	Knowledge Management	Training
	Leadership	Problem Solving	Goal Alignment
	Incentives and Appraisals	Continuous Improvement Culture	Transformation management
	Organisational Culture		Personal Change Management
Structural System	Internal Customer Relations	External Customer Relations	Horizontal Communication
	Supplier Relations	External Supplier Relations	Vertical Communication
	External Customer Relations		
Technical System	Resource Management	Data Management	Management Systems
	Financial Measures	Business Processes	Business Processes
	Regulatory and Quality Environment	Measurement System	
	Performance Measures		

The Baldridge criteria was found to inform the theoretical framework the most, not only from an individual systems point of view, but from a broader organisational perspective. In total, 11 change elements were identified, compared to the 8 change elements identified in the Shingo and LEA frameworks respectively. A positive aspect arising from the detailed nature of the Baldridge criteria is that it would allow the theoretical framework to be applicable across industry types. The Baldridge criteria lends itself well to the social changes, relating to employees, customers and suppliers; information management changes, pertaining to the way information is created, protected and transferred, and also equipment and technological changes. Section 2.5 covers in more detail how the Baldridge Criteria was used to inform the theoretical framework.

2.5. Structure of the Theoretical Framework

The aim of this section is to illustrate to the reader how the Baldridge criteria was used to inform the theoretical framework and how it fits into the analysis outlined in Section 2.3. As a single case study was chosen as a means of gathering data, the external validity of the research becomes very limited (Yin 2009; Leedy & Ormrod 2005). The research would be externally valid if it establishes a domain to which conclusions are applicable (Leedy & Ormrod 2005). For the current research, the three organisational changes (Social, Structural and Technical) previously identified formed the basis of this domain.

At his stage, it is necessary to illustrate the process that was adopted in developing the theoretical framework, and its link to the CRQ. Figure 7 below graphically illustrates how this was done.

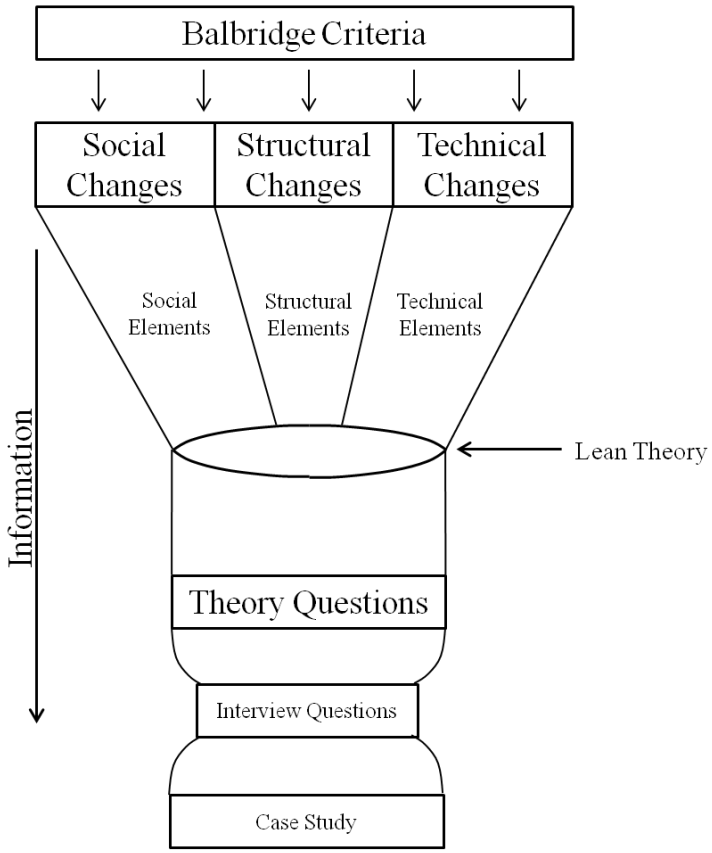


Figure 7: Graphical illustration of Theoretical Framework used in the current research

Figure 7 illustrates how the CRQ was associated with the three organisational systems previously identified. Contained within each column are the Social, Structural and Technical change elements identified in Table 3. In the context of these change elements, it was necessary to illustrate to the reader the method by which the change elements were grouped, with their link to the Baldridge Criteria. This is shown overleaf in Table 4. A suitable definition of each change element is given in the last column. To avoid reproducing the Baldridge Criteria, the reader is referred to the '*2011-2012 Criteria for Performance Excellence'* (NIST 2011) in the Digital Appendix as a cross reference to the information contained in Table 4.

Table 4: Summary of the themes identified in the Baldridge Criteria

System	Change Element	Baldridge Section	Description
Social System	Knowledge Management	4.2.a, 1.1.a, 5.2.c	Contains details pertaining to the timely transfer of knowledge and how it is managed. It takes account of the core competencies and capabilities within an organisation.
	Leadership	1.1.a, 5.2.c	Refers to leadership structures within the organisation, and how managers 'lead'.
	Incentives and Appraisals	1.2.a, 1.1.b, 5.1.b, 5.2.a,	Refers to existing performance recognition schemes and the way they are structured at various levels in the organisation, both horizontally and vertically. It specifically looks at the mechanisms used to create customer and business focus.
	Organisational Culture	P1.a, 1.1.a, 2.1.a, 2.2.a	Looks at how the organisation's vision, mission and values are created and cascaded within the organisation. It takes into account various decision making styles as well as the work environment that managers create on a day to day basis.
Structural System	Internal Customer Relations	1.1.b, 7.3.a	Takes into consideration internal customer awareness, and the types or reporting mechanisms used
	Supplier Relations	6.1.a	Looks at the type of external suppliers and whether there is any form of collaboration with them. It looks at whether there are any crucial supply chain requirements, specifically regarding both organisations' quality systems.
	External Customer Relations	3.1.a, 3.1.b, 3.2.a, 7.2.a	Takes account of the customer expectations and how these are cascaded down the organisation. It looks at the communication mechanisms between the organisation and its customers. It also looks at how the organisation obtains market related information and how it uses this information.

Technical System	Resource Management	4.2.a, 4.2.b, P.1.b, 1.1.a	Looks at organisational capabilities and role matching. Accounts for the various forms of equipment within the organisation and workforce input towards continuous improvement
	Financial Measures	4.1.a, 7.5.a	Looks at the short term and long term financial performance measures and how these are converted to operational measures. It takes into consideration departmental budgets set aside for continuous improvement and their level of flexibility.
	Regulatory and Quality Environment	P.1.a, 1.2.b, 6.2.b	Takes into account the quality management system, and how this has been integrated into operations by looking at the work processes and procedures, specifically how they are created, maintained and improved.
	Performance Measurement	4.1.a, 4.1.b, 5.2.b, 5.2.c, 6.1.b, 6.2.a, 6.2.b	Looks at operational performance measures and the management of this data. It looks at the organisational performance measures, and levels of customer satisfaction

Figure 8, Figure 9 and Figure 10 summarise Table 4 into a systems view of the three main systems and their change elements.

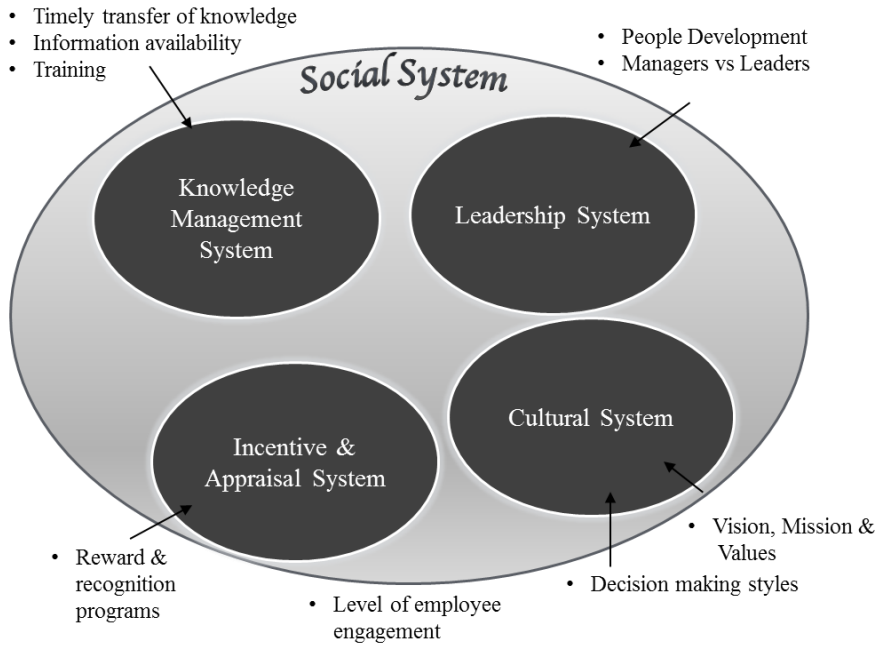


Figure 8: Social System and its 4 core change elements

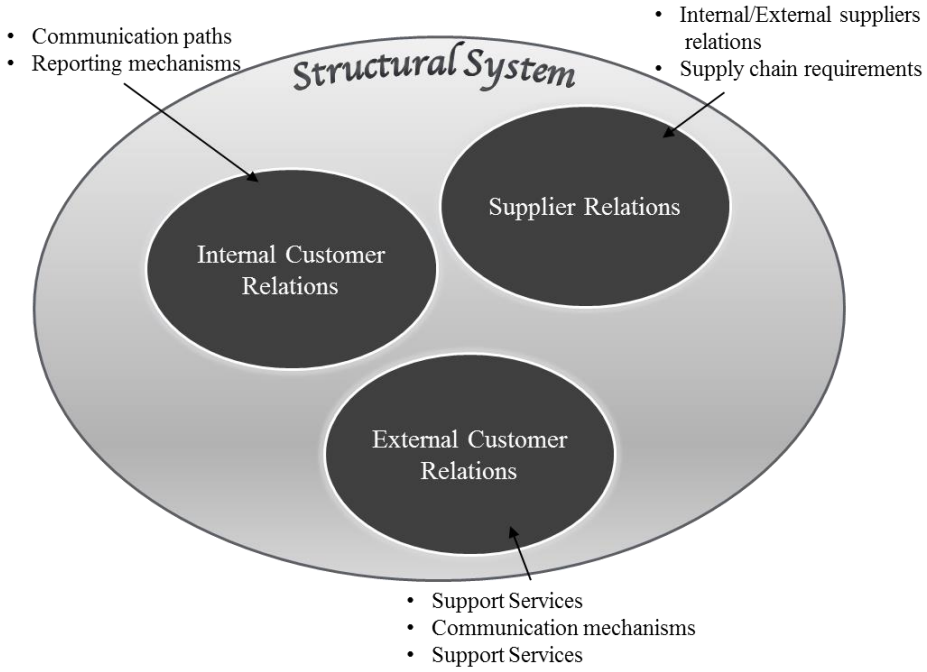


Figure 9: Structural System and its 3 core change elements

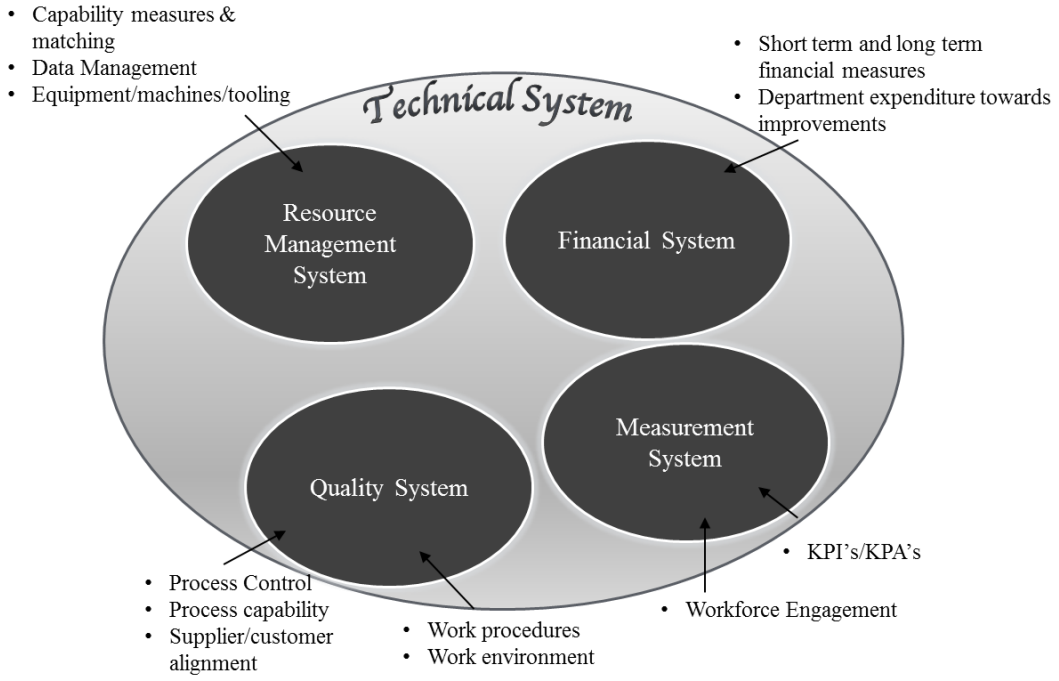


Figure 10: Technical System and its 4 core change elements

In the context of the 11 change elements, lean theory was used to identify how these change elements may change during the implementation of lean, whilst theory questions and interview questions were developed in order to ultimately compare the expected 'theoretical changes' to the changes identified in a single case study. Section 3 and 4 these concepts on more detail.

3. Informing the Theoretical Framework

As the current research is focussed around a single case study, it was necessary to build sufficient theory around the themes identified in Section 2.5**Error! Reference source not ound.**. To understand the changes that an organisation may go through in implementing lean, it was necessary to consult relevant literature. Since the notion of lean manufacturing is not merely confined to a set of well-defined techniques, but represents a broad approach to managing an enterprise (Womack & Jones 2003), such an approach was taken in gathering relevant theory, and thus numerous examples of its successful implementation were

considered - whether having implemented selected lean tools or having adopted a lean philosophy. Further to this, Riis *et al*. (2008) suggest that lean draws on a number of more specific focal areas, such as Total Quality Management, Just-in-Time, Reduction of Waste, Business Process Reengineering and Flow Manufacturing. They mention that working with lean entails many aspects of an organisation that include production planning and control, production engineering, quality management, product development, the supply chain and lastly cultural issues. Riis *et al.* (2008) also mention that to become effective, many functional areas within the company must be involved – and thus may be required to change. For the current research, these 'functional areas' are the Social, Structural and Technical Systems which from a systems view, encompass all the aspects of an organisation identified above.

The approach taken by the author was one in which each main system element (social, technical and structural) was considered separately and was then scrutinised from the point of view of the literature. This would enable sufficient detail to be extracted with regards to their specific change elements (considered systems from here on) within each broader system element. By doing this, it illustrates the changes that an organisation may go through over the course of their lean implementation. For an organisation to adopt any of the lean principles, whether in a juvenile or mature stage, this would inherently require it to adapt any one of the smaller system elements identified within the Social, Structural and Technical Systems, and therefore, linking the 5 lean principles into the analysis below would not be relevant here. The lean principles are generally applied in order from identifying value to striving for perfection (J. P. Womack & Jones 2003). The current framework attempts to group these changes by identifying which systems they influenced. Lane (2007) suggests that if one had to implement a 5S strategy previously outlined in Section 2.2 that it will influence all 5 lean principles, but to what extent will require further insight. In the context of the current framework a 5S strategy may affect the way in which people conduct their daily work due their work area being more organised and structured. This may affect the Quality System (and thereby on a higher level the Technical System) as the person's work procedure may become inherently simpler, whilst it may also affect the Resource Management System as a requisite of 5S methodology is to utilise input from the workforce in implementing it and in so doing, build on their individual capabilities – thereby influencing the Knowledge Management System (Bicheno 2012). 5S also requires a cultural shift with regards to

people's daily work habits, and house-keeping, affecting the Cultural System. Incentive schemes may be put in place around the principles which 5S may drive – predominantly around daily house-keeping. Therefore, on a high level a lean tool like 5S will influence mostly the Social System, and to some extent the Technical System, whilst the Structural system may be influenced through the increased visibility (in terms of shop floor visibility) between internal customers and internal suppliers.

To build a more detailed view of the changes that occur in an organisation striving for operational excellence by implementing a lean strategy, the following section is based around what the theory suggests, and further explains the influences that various lean practices have on the broader systems and their system elements.

The results from the literature are discussed in the following order:

1. **Technical System**
    a. Resource Management System
    b. Quality System
    c. Measurement System
    d. Financial System

2. **Social System**
    a. Knowledge management system
    b. Incentive and Appraisal System
    c. Cultural System
    d. Leadership System

3. **Structural System**
    a. Internal customer relations
    b. External customer relations
    c. Supplier relations
    d. Corporate Hierarchy

3.1. Technical System

3.1.1. Resource Management System

"A manufacturing strategy is about creating operating capabilities a company needs for the future" - (Hayes & Pisano 1994). These operating capabilities pertain to both the personnel capabilities as well as the technological capabilities within an organisation. To grow, and sustain an organisation, regardless of whether it is implementing any improvement initiative shall require that the organisation invest in its own well being (Arnold 2012).

The difference between an average organisation and one which has fully embraced the principles of lean is in its ability to be flexible. This relates to an organisation's ability to respond quickly to customer demands and absorb both process variation and demand variation (Womack & Jones 2003; Bicheno 2011).

Upton (1995) also believes that whether you are referring to products, production volumes, procedures and manufacturing processes, that flexibility is related to the mobility and performance of the organisation across a specified range. This range is governed by the capability of both people and equipment within the organisation. With regards to the actual capability and experience of the workforce, it has been found that the level of experience in the workforce is directly proportional to the number of products produced and indirectly proportional to the change over times between products (Upton 1995). This implies that if fast change-overs are witnessed in an organisation, combined with a relatively large product mix, that one can expect to find a high level of experience amongst the workforce. The corollary of this is that in order to have a relatively large product mix, whilst maintaining quick change-over times, that it would require that an organisation have an experienced workforce. Although this may seem obvious to most, it emphasises the need to manage resources within the organisation, and understand the organisations current capability. Upton (1995) concluded that people are daring with regards to trying new things, and that with sufficient experience they can utilise their natural senses to continuously improve the system through constant analysis. These improvements will ultimately push the system towards being more flexible in meeting the customer's needs

(Drucker 1990) believes that every decision that is made in a company should meet the ultimate customer's needs as well as the manufacturing system's requirements and needs which in turn should exploit the strengths and capabilities of a company's particular manufacturing system. He believes that the greatest impact of viewing a company as a system is not as a result of its manufacturing processes, but rather as a result of the social and human concerns within the company, relating to the career paths of the workforce and focussing on transforming functional managers into business managers who are more akin to being leaders.

Therefore, a company's key resources lie in the capabilities of its workforce and information systems. For a company to survive requires that they both work in harmony to satisfy the customer's needs, and therefore the key indicators of lean implementation having changed the Resource Management system would be if :

1. The workforce engage in continuous improvement
2. The organisation's core capabilities have changed

3.1.2. Quality System

The company's quality system is linked to its work procedures, information management, regulatory and health and safety environment (NIST 2011).

Durbin (2012) believes that most lean initiatives will have an impact on the regulatory requirements within an ISO or QS environment. He stresses that particular attention should be paid towards the documentation of activities, the reviewing of existing procedures, verification of the results and re-establishing effective process controls. An area of lean which co-insides with the above statement is embedded within Kaizen documentation (Doolen et al. 2008).

In general, it is believed that the group responsible for quality within an organisation is very open to lean initiatives, except where there is the perception that the integrity of the documentation and data gathering procedures are threatened (Durbin 2012)

By virtue of the first two principles of Lean Thinking; Creating Value and Identifying the Value stream, it becomes obvious of their effect on the procedures and quality system within

an organisation. In a well regulated environment such as the aviation industry - specifically of interest in the current study - effectively creating a new work procedure or process through removing wasteful steps and redundancies will often require that internal procedures be updated. If a significant change is made, it will often require the approval of the body responsible for quality within the organisation (ISOQAR 2012).

These changes may take time, and ultimately be rejected in some cases. This will directly influence the extent and time taken to implement an initiative such as lean.

Therefore, the key indicators of lean implementation having changed the Quality System would be if:

1. Work processes and procedures have changed due to its direct influence through continuous improvement exercises.

3.1.3. Measurement System

To sustain change in an organisation requires an effective measurement system. This requires that the correct KPI's and KPA's are in place to monitor and measure the process improvements (Found 2007). It requires that they go beyond the traditional financial performance measures.

Drucker (1990) states that traditional cost accounting methods confine themselves to the measurable and thus give objective answers. If intangibles are to be considered in the greater scheme of things, traditional cost accounting methods will raise more questions than answers. It is thus crucial that the business impacts (turn-around times, quality and level of employee engagement) are integrated into the measurement of performance. (Drucker 1990).

Traditionally, managers should be responsible for implementing the correct measures and revamping them (Upton 1995). This is done through performance appraisals, and quarterly and yearly reviews, however, to become a lean organisation requires that they be tracked daily, and in some cases hourly (Lane 2007).

A company's measurement system is its back-bone in any improvement initiative. Mathaisel (2005) emphasises that best practices continue to demonstrate the benefits of a strategic plan

which is used to focus effort and energy of an organisation toward the achievement of common goals, objectives and performance metrics. If highlighting the need for a central vision - which will be covered in subsequent sections – without a suitable measures to gauge the performances of individuals, teams, departments and ultimately the entire organisation with respect to the central vision, driving employee behaviour and obtaining their buy-in becomes increasingly challenging.

Short term and long term measures should be adopted towards the improvement process, which can later be incentivised to further drive employee behaviour. Existing incentives may work against new KPI's and KPA's developed for the initiative (NIST 2011; Bicheno 2011). All should be considered and monitored on a continual basis. Measures should be included which cover ethical issues, track achievement as well as the effectiveness of action plans. These should cover all departments or at least all the deployment areas within the organisation (NIST 2011).

The performance measures should also extend to the company's suppliers, or in lean terms down the value chain, tracking their performance (NIST 2011). Plans should be developed to deal with bad suppliers through means of collaboration. This will be discussed in more detail under Section 3.3.3.

Therefore, the key indicators of lean implementation having changed the Measurement System would be if:

1. Employee performance measures and data management had changed since its implementation
2. Trends of Organisational Performance and Customer Satisfaction have changed since its implementation

3.1.4. Financial System

Goldratt and Cox (2004) often refer to the Bean counters of organisations (Eliyahu M. Goldrat & Jeff Cox 2004). This bad connotation comes as a result of the conflicting interests between traditional accounting methods and ones which are embedded on the shop floor and continuous improvement.

General Motors and General Electric adopted new cost accounting methods that gave them the competitive edge to become worldwide leaders in their industry. With their traditional cost accounting methods, most benefits brought about by change were considered in terms of labour cost savings. It ignored the costs of 'not producing' whilst only taking into consideration the costs of producing (Arnold 2012).

Drucker (1990) creates an ideal future business in which he proposes a change from manufacturing accounting to manufacturing economics which integrates manufacturing with business strategy. In the context of lean, this business strategy encompasses the vision and goals which are focussed on continuous improvement.

Bicheno (2009) highlights the differences between lean accounting and accounting for lean. Lean accounting involves the streamlining of financial process by reducing the number of transactions and increasing the overall efficiency, where accounting for lean tries to improve decision making to enable lean operations. Past accounting systems contradict what lean tries to improve. They are slow reacting, in that they give results on a monthly basis, and reflect whether targets are met on a quarterly, bi-annually and annual basis. Cochrane and Johnson (cited by: Bicheno & Holweg 2009) believe that this way of managing a company is backwards. They emphasise how targets and measures are first established, after which physical solutions are worked out. Lean contradicts this in that it starts with a purpose (what needs to physically happen to improve the system) and then reinforces achievement (through developing the correct KPI's) around the problem/solution. Simply put, accounting for lean differs from traditional accounting in that it strives for improvement based targets and goals more than it strives for financial based targets. Finally, Deming is quoted to have said that managers should not use financial targets to control financial results, instead, manage the relationships that produce these results (Bicheno & Holweg 2009).

Therefore, the key indicators of lean implementation having changed the Financial System would be if:

1. The cost accounting system had been modified to adopt lean
2. Financial measures were improvement based, and operationally focussed

3.2. Social System

3.2.1. Knowledge management system

Bicheno and Holweg (2009) state that several authors suggested that learning needs to progress through four stages:

1. Unconscious Incompetence where you neither understand or know how to do something, nor recognise the deficit.
2. Conscious incompetence where you still do not understand or know how to do something, but can recognise the deficit
3. Conscious competence where you understand or know how to do something, although demonstrating the skill or habit remains extremely difficult
4. Unconscious competence where you have had so much practice that it becomes 'second nature' and can be performed and taught to others very easily.

Considering this form of learning, and taking it to the work environment on the shop floor, the importance of having personnel within each level of learning becomes clear. By recognising this form of learning ensures that there occurs the smooth transition of knowledge between employees on each level (Bicheno & Holweg 2009; NIST 2011). With a highly experienced workforce lying in stage four of the learning process, it is imperative that these individuals are identified and used as guides in teaching and developing other employees within the first three stages of the learning process.

One way of doing this would entail for a particular project (whether linked to continuous improvement or not), that individuals and teams ensure that the lessons learned from the project are captured in an adequate format, including ideas for potential projects that come up during the individual/team's work (Tonder 2011). New ideas are implemented for the next time the same project or a similar project is run. Once the ideas have been implemented, it will be necessary to monitor the implementation, learning from the new system, and if possible, build in reviews to collect customer, stakeholder and demand information. Successful 'lessons learned' should be identified, recorded and spread across the department or organisation (Mccarron 2006). This process of keeping and tracking lessons learned can aid in shifting employees between the various stages in the learning process as outlined before.

Therefore, the key indicators of lean implementation having changed the Knowledge Management System would be if:

1. Organisational Learning methods within the company have changed
2. The methods of passing knowledge between experienced and novice employees have changed

3.2.2. Incentives and Appraisals

Incentive's and appraisals are usually handled by the Human Resources (HR) department within an organisation. If this is the case, it is proposed that they should support the cultural aspects of lean transformation as well (Henderson, Largo, 2000; Cited: Ahrens 2006. Managers will be required to liaise with HR and become more participative in selecting the correct KPI's and KPA's for their department – over-and-above what the traditional system would allow. Traditional piecework incentive schemes usually educate workers to produce inventory, or in some cases, produce defective parts (Henderson, Largo, 2000; Cited: Ahrens 2006). Therefore, HR should be tasked to develop systems where the team is paid for high productivity, quality and continuous improvement. They need to ensure that the system can also adapt to changing customer demands (Ahrens 2006).

However, this is assuming that lean has been implemented from a more top-down approach, and is being driven from an executive level. If this is not the case, managers still need to try and adopt measures which are linked to improvement, quality and time (Lane 2007). This aids in creating a focus centred on continuous improvement within the department or organisation. Denel actively identifies these material issues: KPI's are used throughout the group to measure and monitor performance towards achieving key goals and targets. The group executives are assigned the responsibility to implement the KPI's and driving performance, as well as ensuring that the processes for sustainable improvements are embedded within the key focus areas of the organisation (Denel SOC Ltd 2012).

Overall, incentive schemes and practices should be adopted that reward those who adopt and 'live' the behaviours around continuous improvements. This will show the visible commitment from management towards the lean approach, driving others to follow in the

steps of their 'rewarded' colleagues (Christodoulou 2008). Bicheno (2009) and Lane (2007) emphasise the effect that incentive schemes and performance measures have on driving employee behaviour. They emphasise the importance of aligning them towards improvement, and that misaligned measures can lead to counter-productive behaviour. They need to be aligned with what you want to achieve.

Therefore, the key indicators of lean implementation having changed the way in which Incentives and appraisals are structured would be if:

1. The appraisal schemes of the company or department where lean has been implemented have changed.
2. KPI's and KPA's within the company or department where lean has been implemented have changed

3.2.3. Cultural System

Corporate culture consists of habits, beliefs, values and behaviour. It is up to management and leaders to create a culture necessary for business success. Miller 1984 cited: Gryna et al. (2007) identify eight primary values that promote employee loyalty, productivity and innovation, namely:

1. Purpose - is the vision sated in terms of the product or service and benefit to the customer.
2. Consensus - pertains to the decision making styles which are adopted by managers in various critical situations.
3. Excellence – knowledge for continuous improvement should be striven for by employees in a pervasive environment created by managers.
4. Unity – emphasises on employee participation, and an environment in which they can take ownership of their work.
5. Performance – relates to the individual and team rewards; that along with the correct performance measures can both guide employee behaviour and illustrate how they are doing with regards to improvement and growth.

6. Empiricism – means to manage by fact with the scientific method forming the basis of this value.
7. Intimacy – relates to the sharing of ideas, feelings and needs in an open trusting manner without the fear of punishment.
8. Integrity – is the norm which managers should follow to act as role models for ethical practices

By judging the level at which each value exists within the organisation allows for a gap analysis to be done. Action plans can be developed towards guiding corporate culture towards one of continuous improvement (Denel SOC Ltd 2012). Found (2007) states that lean has a number of cultural requirements that include promoting lean leadership at all levels, from top to bottom, and creating leaders with a clarity of vision who live the system and its values.

Philosophies such as TQM, JIT, TPS, SQC and Lean all provide aspirations for people, but the question remains whether these people who work towards these philosophies; work within a trustful environment that shares responsibility. Does it have the sufficient leadership to sustain such an environment? Greenleaf 1998, pp. 79 cited by: Castle *el al.* (2000) recall from an essay edited by Spear's in which he questions, "Can the key leaders accept that optimal performance rests, among other things, on the existence of a powerful shared vision that evolves through wide participation to which the key leader contributes, but which the use of authority cannot shape? And can that key leader be persuasive enough that responsibility for generating and maintaining that vision is widely accepted as a serious obligation?"

These statements help highlight some of the main factors which are required to create and sustain the eight values highlighted previously. Leaders are essential in an organisation, and are central in guiding the organisation through the process of change.

Therefore, the key indicators of lean implementation having changed the Cultural System would be if:

1. Any of the eight primary values as identified above have changed

3.2.4. Leadership System

Bass and Ovolio (cited: Found 2007) suggest that leaders are charismatic individuals who inspire and motivate others to go 'beyond contract' to perform unexpected tasks, and that these leaders create new vision and facilitate change.

Derick *et al.* (2009) propose five essential actions that leaders can perform to help provide leadership on the lean journey (Derrick & Contact 2009):

1. They must be teachers
2. Build tension not stress
3. Eliminate fear and promote comfort
4. Lead through visible participation not proclamation
5. Build lean into personal practice.

These actions are what differentiate managers from leaders. Found (2007) proposes that management styles have been long rooted in the military and churches, where clear lines of authority were established rather than clear lines of communication. These, now outdated styles developed functional leaders, who had a single function that was to assign responsibility from top to bottom so that individuals could be held accountable for poor performance and mistakes. In contrast to this, Figure 11 below illustrates how upper management within a lean organisation serve to offer support to those on the shop floor. Operators are allowed to assume greater responsibility and are made accountable within their work environments.

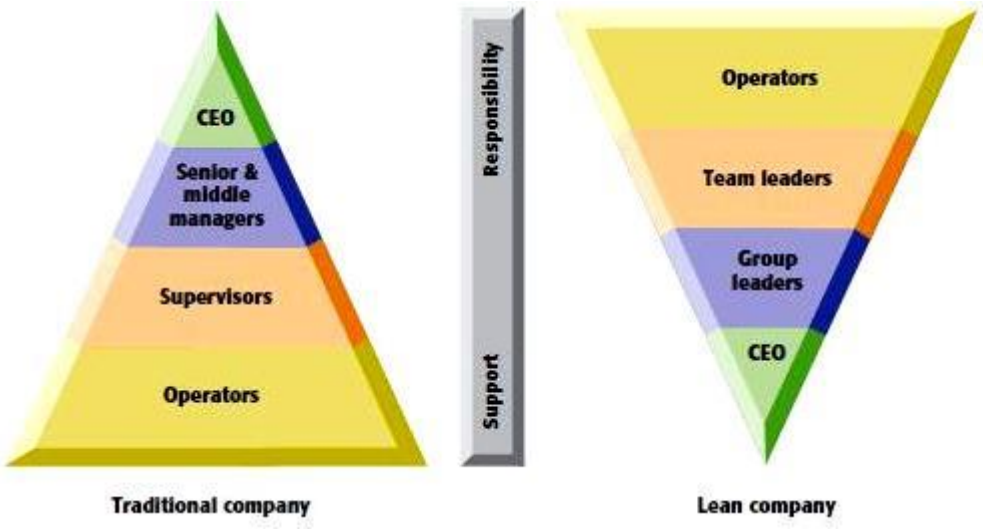


Figure 11: Management Hierarchies in a traditional company and a Lean company (Found 2007)

Therefore, the key indicators of lean implementation having changed the Leadership System would be if:

1. Organisational management had changed towards a more guiding role
2. With respect to the above actions, managers were considered to be 'managers' more than 'leaders'

3.3. Structural System

3.3.1. Internal Customer relations

Drucker (1990) emphasises that the ideal organisation would require more of a drastic change than the factory's physical structure. It will require, above all, different communication and information. He contrasts this with the traditional plant where each department or sector reports separately upstairs, and reports to them what they asked for. He goes on to say that the ideal factory will be one where each person and collectively each department will have to think through what information they owe to whom, and what information they will need from whom. This information will be required to flow horizontally and vertically creating a factory

which will for the better part, be an information network linking internal suppliers and customers

This information network will have to extend throughout the entire organisation as Ahrens (2006) emphasises that a lean factory floor does not make a lean enterprise, and therefore the vertical links would have to extend from an operator on the shop floor to the top executive within the organisation. Womack and Jones (2003) propose rethinking the functional departments into value streams, and that this for the better part, would require reorganising the entire company. Ahrens (2006) explains that Ohno did not clearly emphasise this, however he clearly explained the function of internal customers and suppliers within the organisation.

It is imperative that the information network between internal suppliers and internal customers be established at the outset. Found (2007) emphasises that lean does not start or end at the production process; that it begins by first breaking down the communication barriers in order to make information visible, transparent and easily accessible. This may be extremely difficult and costly in organisations built around a central ERP system, as they generally prescribe an in-process inventory inserted between two subsequent processes. The consequence of this is that operators may miss the opportunity to get to know who is the sender and who is the receiver of goods and information in the business process (Riis et al. 2008).

It is thus crucial that lean is fully integrated into the management philosophy, and that the idea of continuous improvement is also transferred into the organisational functions which support both the manufacturing and operations (including any ERP system). It is thus imperative that all departments understand their roll in the lean transformation process, and that they identify with their internal customer and supplier (Ahrens 2006).

Therefore, the key indicators of lean implementation having changed the Internal Customer Relations would be if:

1. Employees had become more aware of who their internal customer was
2. Communication paths between employees had changed (means of communicating, the ease with which information is transmitted).

3.3.2. External customer relations

The lean philosophy revolves around the concept of the ultimate customer being the starting and ending point (Bicheno & Holweg 2009), and therefore, having robust relations with external customers quickly becomes obvious. Whether providing a service or manufacturing a product, understanding what the customer truly wants and needs requires that close relations be held with them and that a method of closed-loop thinking be adopted.

Closed-loop Thinking requires understanding how changes within the system ripple across the value stream affecting the work/behaviour of other employees in the same department, in other departments, external customers, suppliers, and other stakeholders. (*The Shingo Guidelines* 2010)

The most common cause of failure with regards to new product development is that the requirement of the customer was either missing or poorly defined in the beginning (Grieco 2002; J. P. Womack & Jones 2003; Bicheno & Holweg 2009). The linkages between product and customer should be clearly defined. Grieco (2002) goes on to mention that companies with a highly integrated product development all possess three common characteristics for building the customer into the process:

1. A clear methodology for developing product definitions which are based on how well the customer's wants and needs are understood. This involves applying closed-loop thinking in analysing the risks and assessing existing regulations.
2. The consistent and effective application of a variety of methods for capturing the voice of the customer.
3. A superior value proposition is then considered which will deliver a competitive advantage. This is internalized before the product is designed

Therefore, the key indicators of lean implementation having influenced External customer relations would be if:

1. Employee perceptions of their external customer needs had changed
2. Communication with their external customer had changed (means of communicating, the ease with which information is transmitted)
3. The way in which the company obtained market information had changed

3.3.3. Supplier relations

Moving to the other end of the value chain, suppliers form an integral part of an organisation's lean initiative. Womack (2003) identifies the value chain from the supplier all the way through to the ultimate customer. In order for customer's needs to be passed down the value chain, suppliers have to adopt a proactive approach to customer service and be prepared to exceed customer expectations. This also means that customers will have to release their traditional hold on the process and encourage suppliers to take ownership of the processes in which they are involved (Moyano-Fuentes & Sacristán-Díaz 2012)

This may require the restructuring of the supply chain through a process of vertical integration. Lamming 1996, pp. 183 Cited: Moyano-Fuentes & Sacristán-Díaz (2012) coined the term "Lean Supply" within the automotive industry, emphasising that suppliers are critically important in aspects of quality, productivity and flexibility. Lean supply is consequently associated with level scheduling and optimisation.

Rebolledo *et al.* (2011) go further and emphasise that prime contractors with a broad knowledge base, as within the aerospace industry, need to maximise the learning that occurs in their relationships with their suppliers. They highlight a valid point in that the knowledge and expertise required in technologically advanced fields makes it almost impossible for prime contractors to generate all the knowledge required around a particular product (Rebolledo & Nollet 2011). Therefore, contractors have to rely on their suppliers to provide access to complimentary sources of knowledge which can aid them in the initial developments of the product or service which they are offering.

On the contrary, some contractors mandate that their suppliers implement a specific standard or system to meet their requirements. Contractors may go as far as to specify a 3rd party who will conduct the registration of a particular quality certification for their suppliers. Johnson (2004) highlights that many industries often struggle with the socio-technical aspects of this process, as the quality certification clearly outlines the technical aspects that suppliers are required to adopt, however they often fall short on social changes that are required to support the mandated initiative.

Womack (2003) and Haupt (2005) identify three types of suppliers (first, second and third tier) which spread across the entire supply chain. They identify that the basic communication

occurs at the first tier. Lyons, *et al* (2004) cited by: Moyano-Fuentes & Sacristán-Díaz (2012) propose that the relationship should not only exist between the manufacturers and the first tier suppliers, but that they should extend to second and third tier suppliers too, and that this will have favourable effects on the company's overall results. They elaborate further and mention the favourable effects of adopting various information and communication technologies; such as a suitable ERP system; down the supply chain.

Therefore, the key indicators of lean implementation having influenced Supplier relations would be if:

1. The company changed the way in which they communicated with suppliers

4. Research Methodology

As part of last objective of the research, it was necessary to conduct an analysis of a suitable organisation/s upon which to compare the theoretical changes against. This would require that a particular approach be utilised in order to extract relevant data to answer the Central Research Question outlined in Section 1.3. The following pages are intended to outline the design and development of the relevant tools and methods that were used in gathering the data.

4.1. Types of Analyses

There are various types of methods and analyses adopted by qualitative researchers. Depending on the research question at hand, it is generally required that an approach be selected before data is gathered (Richards & Morse 2013; Yin 2009). Some of the recognised approaches are outlined in Table 5 below:

Table 5: The Fit of Method and the Type of Data (Richards & Morse 2013)

Method	Description	Types of Data
Ethnography	Involves the researcher (usually an anthropologist) studying a single tribe or institution in order to better understand the culture that exists within it.	Participant observation; field notes; unstructured interviews, focus groups
Grounded Theory	The researcher seeks to construct new theory or prove existing theory that is *grounded* or entirely based on data	Nonparticipant observation; interviews, conversations recorded in diaries and field notes
Phenomenology	Phenomenology offers a descriptive, reflective, interpretive, and engaging mode of inquiry from which the essence of a particular experience may be elicited.	Audio recordings, in-depth interviews or conversations with participants, phenomenological literature.

Discourse Analysis	This is the study of "language in use". The focus is on interpreting speech and written communication	Interviews which are usually audio recorded, documents and other media accounts
Case Study	Case studies are studies of a social unit or system. It is generally 'bounded' and studied in its natural setting as a whole.	Participant observation; field notes; unstructured or semi-structured interviews; documents; records; focus groups

4.2. Type selection

Based on the belief that the type of Research question informs the method to be used (Yin 2009; Richards & Morse 2013; Leedy & Ormrod 2005), it was decided that a single case study be utilised. A single case study offers the opportunity to observe a vertical slice through the organisation as opposed to several horizontal slices which a multiple case study approach would offer. Further, a mixed method approach has the advantage of potentially increasing the number of dimensions within the same project (Richards & Morse 2013), and so it was decided that an embedded single case study be utilised as a method of gathering data. A brief outline of the method is given below:

Embedded Single Case Study

An embedded case study is an empirical study whereby various units of measurement are used to gather data as evidence. It allows for more detailed level of enquiry where the goal is to describe the features, context and processes of a particular phenomenon (Yin 2009). An empirical study in this context is a study which involves gaining knowledge by means of direct and indirect observation. The phenomena being studied are the changes that an organisation experiences during their implementation of lean.

4.3. Case study Selection

For the current research, the author chose to target organisations well known for their implementation of lean. There were a few factors which influenced the selection of a suitable organisation upon which to base the study on:

1) Due to the bias within lean audits (Taggart 2009), this would nullify any conclusions drawn with regards to their 'level' of lean implementation. (Mathaisel 2005) goes further to say that there are 'no true established measures of categorical leanness'. Add to this the potential cost implications of conducting recognised lean audits using 'established measures'; determining the level of lean implementation of a participating organisation was not considered in the current research.
2) Based on previous research (Murphy 2010), large fleet maintenance facilities were omitted from the search, as it was found that in South Africa, their level of lean implementation was limited. This left only a two locally based organisations who had directly implemented lean principles. Of these two one agreed to participate in the research.

Therefore, the research was limited to the level of lean implementation that the organisation had adopted. This refers to the extent to which the organisation had implemented some or any of the lean principles. For the current research, so long as the organisation had formally began implementing lean as a dedicated initiative, it would prove to be a satisfactory candidate for observing any changes that had been brought about through its implementation.

4.4. Types of evidence

(Yin 2009) outlines the six most common types of evidence used in a qualitative study. Table 6 overleaf gives a description of each, as well as their respective advantages and disadvantages.

Table 6: Six common types of qualitative evidence (Yin 2009)

Type of evidence	Description	Advantages	Disadvantages
Documentation	Letters, memoranda, email correspondence, personal documents such as diaries and notes	• Stable, can be reviewed repeatedly • Broad coverage – long span of time, many events	• Retrievability – can be difficult to find • Reporting bias – reflects bias of author • Access – information may be deliberately withheld.
Archival Records	Service records, often in the form of computer files and data	• Same as above	• Same as above, however, accessibility may be limited for privacy reasons
Interviews	In case study research, interviews are usually guided conversations, rather than structured queries	• Targeted focus • Insightful – provides perceived causal inferences and explanations	• Bias due to poorly articulated questions • Response bias
Direct Observation	Involvement in meetings, factory work, side-walk activities, field visits	• Covers events in real time • Covers context of case	• Time consuming • Reflexivity – event may proceed differently because it is being observed
Participant Observations	Serving as a staff member in an organisational context or being a key decision maker in an organisational setting	• Same as above • Insightful into interpersonal behaviour and motives	• Same as above • Bias due to participant observer's manipulation of events
Physical Artefacts	A technological device, a work of art, or some other physical evidence	• Insightful into technical operations	• Selectivity and availability of artefact.

Based on Table 5, and the type of evidence made available to the author by the case study company, the current research focussed on using four types of evidence. namely:

1) Documentation in the form of field notes and memo's from meetings and conversations
2) Interviews in the form of semi-structured interviews with dedicated personnel
3) Direct observation conducted through everyday work and conversations
4) Participant observation through involvement in meetings and daily work

4.5. Questionnaire Design and Selection of Respondents

4.5.1. Theory Questions

The current research adopted the qualitative research model: CRQ (central research question)-TQ (theory questions)-IQ (Interview questions) (Wengraf 2001). By combining this approach with the systems approach, this formed the basis upon which to create a sufficient number of theory questions which could ultimately answer the central research question:

CRQ:

What Social (eg: cultural, corporate governance, employee relationships), Structural (eg: Corporate Hierarchy, supply chain management) and Technical (eg: shop floor, business process) changes occur within a company during their transformation to Lean.

Each element shown within Figure 8, Figure 9 and Figure 10 highlight the areas within the organisation which were monitored for change. Aligned with each change element, were relevant theory questions. Figure 12 below highlights each Theory question and its link to answering the CRQ.

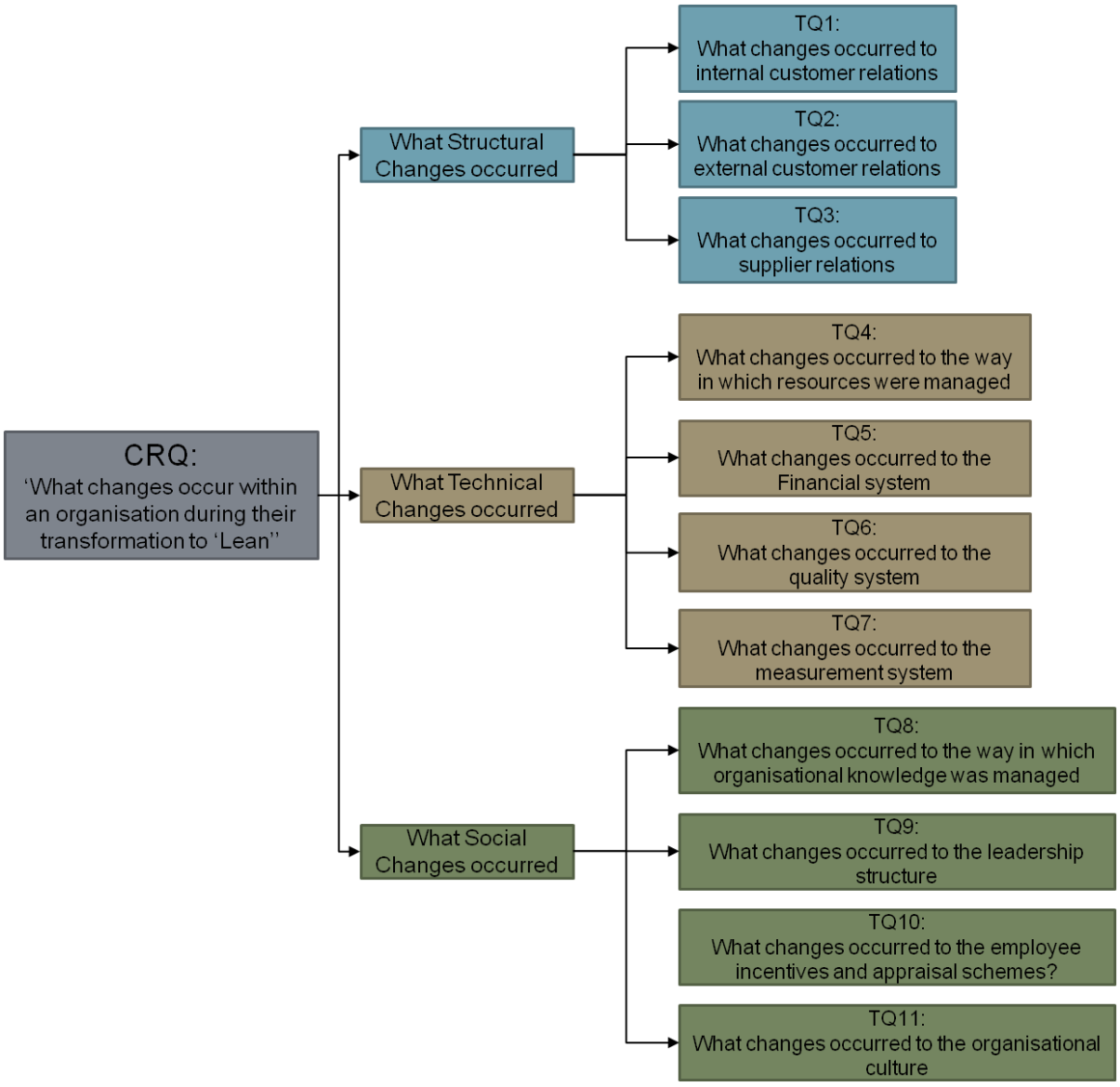


Figure 12: Link between CRQ and TQ's

The above diagram was used to 'categorise' the changes that occurred within the organisation, linking them with the sub-system elements shown in Figure 8 and Figure 9 and Figure 10. Interview questions were developed under each theory question. The interview questions were derived from general theory covered in Section 3, however many were aligned with the Baldridge criteria (*see Digital Appendix for the Baldridge Criteria*)

4.5.2. Interview Questions

As mentioned above, the interview questions were grouped under the relevant theory questions. To extract any changes that occurred within the organisation, it was necessary to conduct the interview based on the present and the past. It was established that the company considered for the current research began their lean initiative in 2010. Interview questions were thus prepared in two parts: The present and the Past. Appendix A contains a list of all the interview questions grouped within each category as shown in Figure 12. Questions about the present state are shown. Questions pertaining to the organisation's past state were reworded versions of the present state questions; in the past tense. It was the author's intention to ask the questions based around the past, in retrospect of what the respondent had witnessed, and then to ask the questions based on the present. For example:

TP1 – Present : Do you currently have performance measures in place to monitor all employees performances?

TP2 – Past: Did you have performance measures in place to monitor all employees performances

Crucial to asking questions based on the past, was to ask the questions based around the time just before the company began implementing lean, which for the case study company, varied between 1.5 years and 2.5 years depending on which department the lean principles were knowingly being implemented.

4.5.3. Participant Selection – within Hierarchy

Eisenhardt (1989) proposes an ideal response from between four and ten respondents. Fewer than four would leave little empirical grounding upon which to base the results, and more than ten would potentially provide too much data that would become too complex to handle. For the current study, it was desirable to have at least 9 respondents spread across various departments within the organisation.

The process of selecting participants was based on a recently updated corporate organogram. This was scrutinised and divided up into the various departments of the organisation. As the

current approach considers the organisation as a whole, it required that an individual be selected from within each department. In total, 16 invitations were given out with 13 respondents agreeing to be interviewed. According to Ahrens (2006), if lean implementation is not integrated into the organisation's management system, it is very likely to be unsuccessful. Based on this statement, it was desirable to interview employees from the shop floor level through to the executive level. Figure 13 illustrates the spread of respondents that were obtained within the chosen company, and which department they were from. The respondents for a particular set of questions are shown in yellow blocks, with a code (R1,R2…R13) appended at the bottom. Figure 13 is a modified form of Company X's corporate organogram.

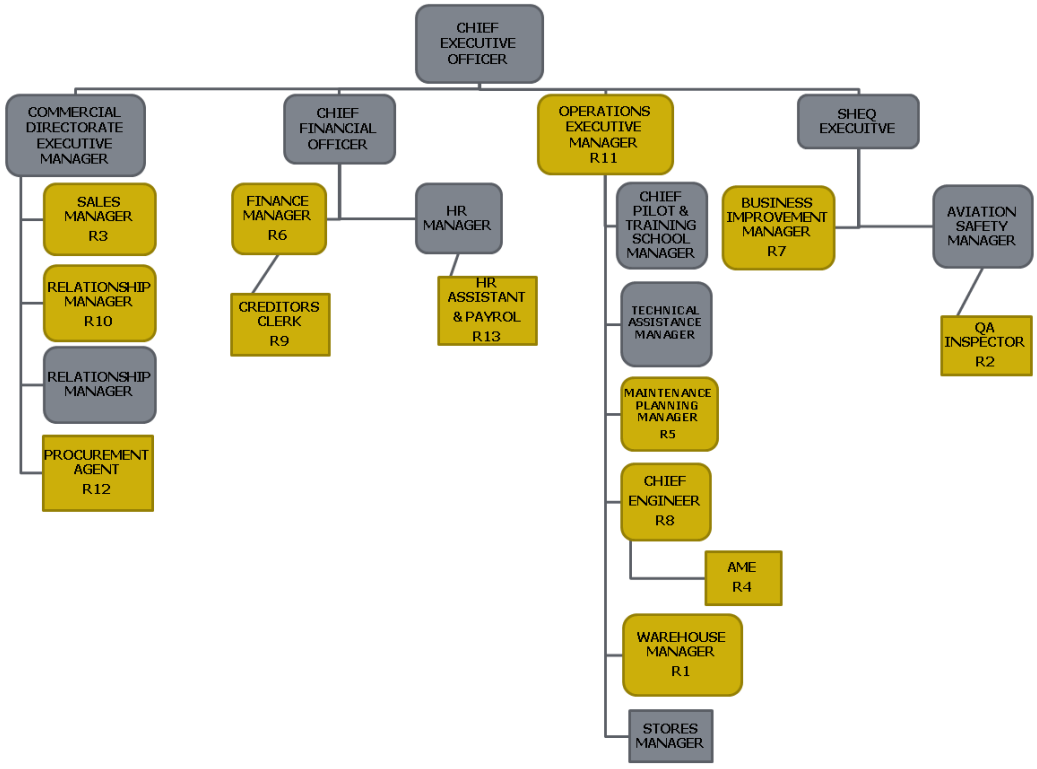


Figure 13: Diagram illustrating the spread of employees that were interviewed

Before the interviews were conducted, the author worked beside employees (specifically within the warehouse/logistics department) for the first two weeks. This allowed for the author's presence to be felt by employees in all departments, whilst it also allowed for the author to gather field notes around operational activities. A specific point of contact where

the author had a chance to interact with employees was during the lunch hour inside the cafeteria. After relationships were established, and people were aware of the author's intentions, formal invitations were sent out according to the guidelines stipulated in Section 1.7. A sample invitation is given in Appendix B. These were handed out in person, upon which if the potential respondent agreed to take part, a date was arranged, with a second interview scheduled for contingency purposes.

4.5.4. Pilot Study

Two pilot studies were completed to establish the ideal way of interviewing respondents, and to further refine the interview questions.

The first pilot study was done through analysing the changes that occurred within an organisation as a result of its quality system, specifically the ISO9000 set of standards. A similar set of questions was created, and only a single employee interviewed. The study was done using a single recording device (namely the author's mobile handset using software specifically downloaded for the interview). Although the study was done at a different organisation, it allowed the author to gauge the sensitivity of the respondent to being recorded, the time it takes to conduct the interview and whether the format of the questions allowed information to naturally flow in the form of a conversation.

From the first pilot study, the following information was gathered regarding the interview process and format of the questionnaire:

- The respondent did not react well to being recorded from a device placed between the author and herself. It seemed to create an artificial barrier which took time to overcome. This effectively resulted in the first few questions being answered very briefly.
- The format of the questionnaire had two problems.
    1 It did not have any prompts which the author could use to further explain the question if the respondent so wished.
    2 The font size was also made too small, which resulted in the author loosing sight of the question. A consequence of this was that the natural flow of the interview was disturbed.

- By asking the interviewer questions based on the present and then asking them the same set of questions based on the past seemed to agitate the respondent. This was discovered by first asking the respondent the first five questions in the present, after which the same set were asked in retrospect of the respondent's experiences that she had gathered over the past few years. After discovering this, the author began asking whether any changes had occurred once the present tense of the question had been asked. It was found the latter method relaxed the respondent, but also, retained the general theme of the question in the respondent's mind which allowed them to recall more detailed information from the past.

As a result of the above problems, the author made modifications to the format of the questions and interview process, namely:

- A particular pen was acquired which allowed the author to record the interview whilst writing notes on a digital matrix paper. This allowed the interview to flow better as the author did not have to hastily write down notes. The pen had the ability to record whilst referencing the time of the recording against the special digital matrix paper for later reference, and so minor references could be written in the form of single key words.
- Premeditated prompts were added beside the questions to aid the author in directing the conversation toward the question being asked.
- The font of the questions was doubled in size, with the rows of questions being alternately shaded. This acted as a place holder for the question being asked.

The second pilot study was done at the participating organisation used for the current study. The first and second interviews were used to check whether the changes made from the first pilot study were successful. Some minor changes in the way the questions were asked was made. This occurred for each interview. It was discovered that managers and executives preferred a question by question interview with a 'no time for small talk' atmosphere, whilst employees on the shop floor preferred to engage in a conversation, where the questions were 'embedded' within the discussion. Whilst changing the style of the interview, the same information was obtained through the coding process, and so this approach was taken forward.

4.5.5. Processing interviews – Transcribing, Coding and Sorting

Once the interviews had been conducted, they were transcribed verbatim in MSWord 2007 and coded in QSR NVIVO 10 qualitative software. The method of coding was adopted from (Wengraf 2001) and modified to suit the case at hand. A code was developed as a 'theme' within a particular element of each system. For each sub-system element, these themes were aligned with the key indicators highlighted in Section 3 as the questions were largely based around the theory gathered in Section 3. These themes were populated with responses from relevant respondents who were asked questions related to each theme. Coding according to these themes was necessary as more information was often revealed in the respondents answer than what the question intended on eliciting, and so information pertaining to another theme was often elicited.

First, the interviews were transcribed. In total, 13 interview recordings were transcribed. The transcriptions were initially grouped to respondents. The process of coding the transcriptions began by grouping themes within the responses from identical sets of questions ultimately linked to a core system through a change element. Field notes from the observations were also included in the coding process in order to back the evidence obtained from the interviews. Figure 14 overleaf illustrates how the coding process worked.

The reader is referred to the Digital Appendix for the detailed transcriptions and codings. (Please note that the transcriptions and codings contain sensitive information related to the case study company, and that the author entered a non-disclosure agreement which prohibits any reproduction of the transcriptions outside the University of the Witwatersrand).

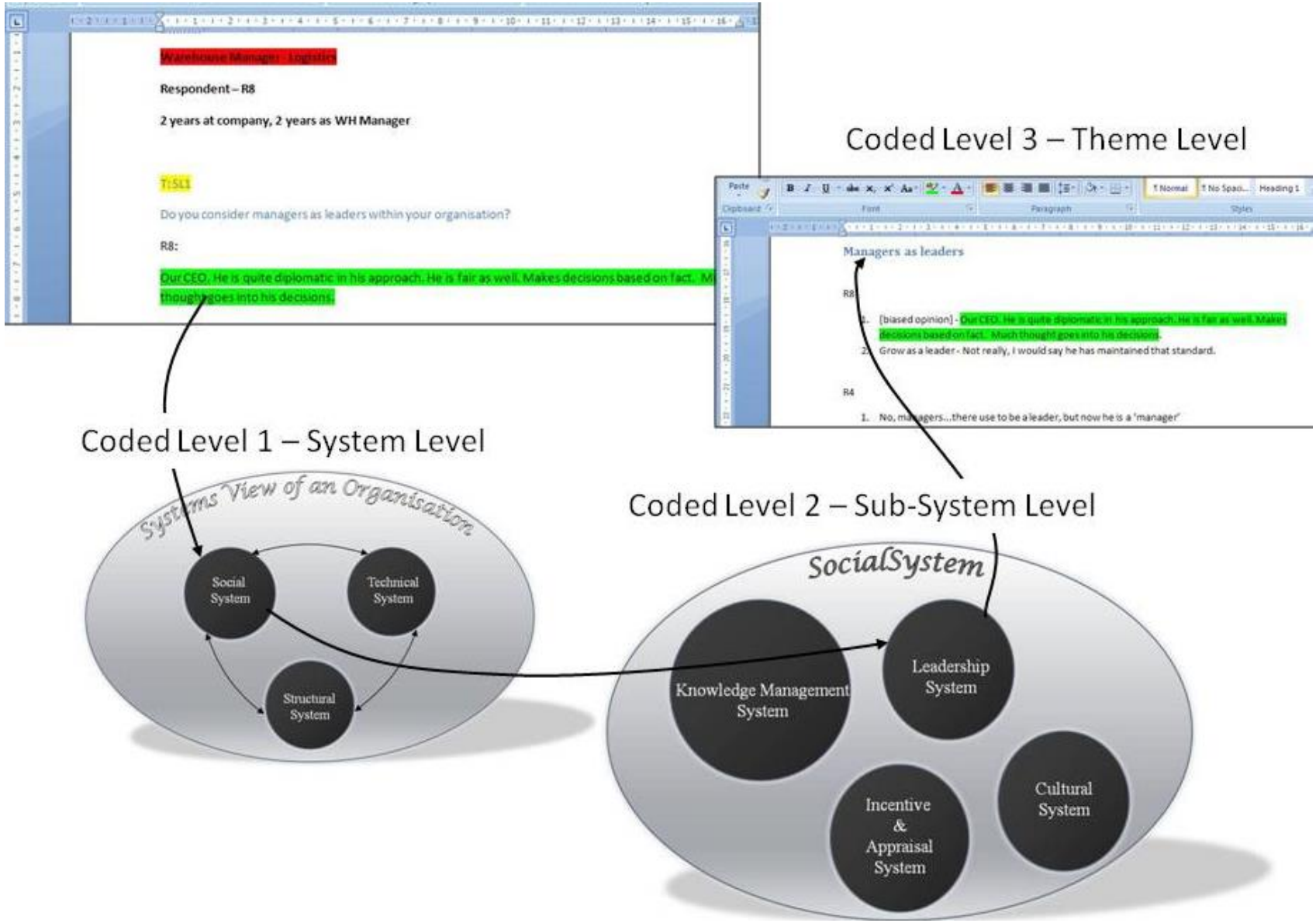


Figure 14: Diagram illustrating method of coding

5. Results and Discussion

5.1. Introduction

Five weeks were spent at a South African aircraft maintenance organisation. In this time, first participant observations were gathered by means of hand written memo's. These memo's were not published within this report for confidentiality reasons, however the general results and individual experiences have been linked to the responses from the 13 respondents that were interviewed. Respondents were interviewed across all departments as mentioned in Section 4.5.3. The results were summarised with respect to each change element within each major system. With the nature of the company being departmentalised, the result was that only particular individuals were able to respond to particular questions. This lead to certain respondents only being able to answer questions linked to certain change elements. The author asked questions relevant to the person, and the position they held within the company. The results below are a summary of the 5 week observation period combined with responses from 13 semi-structured interviews. Each change element was considered separately in order for clear references to be made to Section 3.

5.2. Company overview

For confidentiality reasons, the company at which the case study was conducted is referred to as Company X. The author first learned about Company X and their implementation of the lean principles in February of 2012. Company X has been implementing lean since mid 2010.

Company X offers four main services. The first is the sale of new and used aircraft to both the corporate and private sectors. Secondly, they offer full maintenance, repair and overhaul facilities to these sectors. Thirdly, Company X offers logistics services with regards to the spare parts used on their aircraft, and lastly, they offer training services for engineers and pilots. Sensitive details pertaining to the exact services that the company offers could not be disclosed, as inferences could be made by either internal personnel or customers who may read this report in the future. An executive director was used as the key informant within the

company to ensure that the results that are presented in the following sections are not sensitive in nature and are both accurate and trustworthy.

After requesting permission, the company duly allowed the author to conduct the case study over a 5 week period. An agreement was made to allow time to conduct interviews and obtain results whilst the author was tasked with assisting Company X's logistics departments in streamlining its internal operations. The author was tasked with numerous jobs whilst working within the logistics department, and thus was able to develop good relationships with personnel within the department and throughout the organisation. This also provided the author with a good opportunity to assume the role of participant observer.

For details pertaining to particular change elements which were not observable within the logistics department, the author relied on the results obtained from 13 semi-structured interviews conducted in other departments (16% of the total head count in Company X). Overall, a broad picture was obtained of the influences that lean has had on the company in the last 2 years.

Most of the changes were found to be prevalent within the MRO department where lean had been formally implemented. Other departments, although unintentionally aligned with some of the lean principles, were not directly influenced by its formal implementation. In some cases, it was found that within a particular department, specifically the culture within it, was not at all aligned with what was suggested by the literature in Section 3.2.3. Another factor found to influence the results was related to the evolutionary changes that occurred within the organisation through their natural growth cycle. Compounding this, specifically with regards to cultural changes, were the effects brought about through the company's policy of rotating the CEO and main executives. This was found to unsettle the organisation with regards to their leadership and cultural practices.

Albeit these minor differences, every effort was made during the interview and coding processes to differentiate the changes brought about through lean and those brought about by Company X's 'evolutionary changes'. The results are discussed below.

5.3. Social System

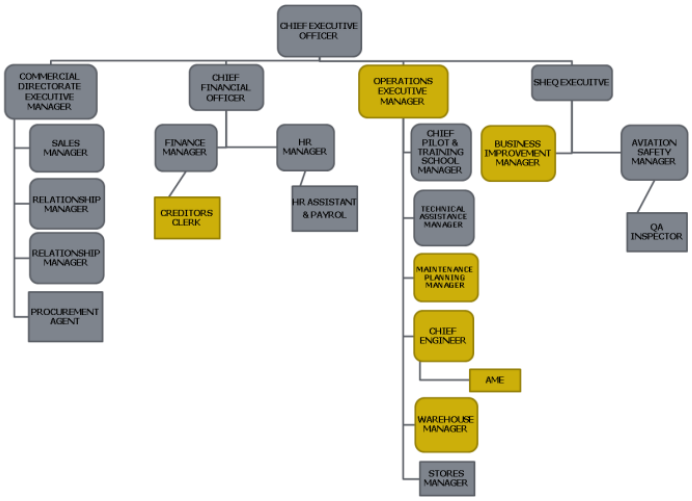
Results for the social system were obtained on a broad basis in that the change elements contained within the Social System were applicable to each department within the organisation. To give an overview of the respondents who participated in sharing information related to each change element, and also to show their position within Company X, a modified version of Figure 13 was given below each heading with the participating respondents shown in yellow. The respondents were also listed within brackets below each heading whilst the question numbers were referenced in a second set of brackets.

5.3.1. Knowledge Management

(R5, R4, R1, R7, R8, R11, R13) (SO1 – SO8)

The following analysis attempts to answer TQ8 as outlined in Figure 12

TQ 8: What changes occurred to the way in which organisational knowledge was managed?



This sub-system element was broken down into two main themes pertaining to Organisational Learning and the Timely Transfer of knowledge. Organisational Learning encompasses the knowledge and data that is captured on a day-to-day basis, including information that is shared with regards to continuous improvement. The mechanisms used to capture, store and pass this knowledge on are discussed. The Timely Transfer of knowledge pertains to Company X's succession planning and the manner in which experienced employees pass down their knowledge to new, up and coming employees. The spread of data was mainly

gathered vertically within the department where lean had formally been implemented, however, a single respondent was interviewed outside of this department, namely within HR.

Organisational Learning

As mentioned in Section 3.2.1, lean promotes the gathering and dissemination of organisational data in the form of a 'lessons learned log'. This ensures the capturing of daily changes with regards to small improvements, and aids in transitioning between the various stages of learning. Although this 'lessons learned log' is present in various forms throughout Company X, there was no concrete evidence linking it to the implementation of lean.

Data is currently gathered towards daily operations, however in a more informal manner. Although mandated to pass down knowledge as part of the senior personnel's job description, no formal sessions were, or are presently scheduled. 'Lesson's learned' relating to daily snags - not normally forecast in aircraft operating manuals – is handed down in an informal manner according to R3. An example of this is the informal meetings that are held between an AME and their apprentice. Not linked to the lean implementation was a case where R3 - an AME - kept his own personal log of what lessons he had learned on the shop floor. He would then share this information with his subordinate in order to formally teach them. Presently, R3 does not continue this practice, but rather carries 'mental notes' which he shares with apprentices working beneath him. He mostly shares this information during times when he and the apprentice are not busy. Although it was reported that a formal log was kept regarding minor technical and non-technical issues, again, evidence of its implementation being directly linked to lean could not be established, and therefore lean made no change to the way in which organisational knowledge is passed down on the shop floor. There was also no evidence of the implementation of quality circles.

Primary training relating to the aircraft regulations, technical training and company procedures has been formally carried out for the last two and half years at Company X, and was mandated by the CAA. Company X also began formally implementing lean principles two and half years ago through implementing tools such as 5S and Kanban on the shop floor. Employees were formally trained on what to do and how to do it without ever been told of its relation to lean. This aided in obtaining employee buy-in, and once satisfied with the results, selected employee's were sent on a lean course in order for them to begin understanding the changes, and to further promote their participation in the program. It was reported by R1 that

the lean course "streamlined his thoughts", and that it has given him a new perspective on how to go about things. Evidence of this was found in the same manager's intention to hold Kaizen events every Wednesday, which would focus on improving his employee's work environment and their work processes. Before he would do this, he mentioned that it would be imperative for him to send his department on the same lean course in order to better understand why they would be conducting such practices.

Timely transfer of knowledge

Strongly linked to organisational learning, ensuring that employees pass on their knowledge before leaving the company - whether through better employment prospects or retirement - is imperative. They therefore need to have succession plans in place to deal with this.

It was reported by respondent R8 that "some guys don't openly transfer their knowledge" and suggests that the organisation relies on the same informal means mentioned above to ensure that employees transfer their knowledge. This is also backed by R8's reply that "it comes with experience, where you know what parts [for aircraft repairs] you will need early".

Respondent R7 reported that it is very seldom that an employee would resign and leave a vacuum, implying that there was an employee sufficiently trained to take their place. Company X currently has a policy whereby they offer applications for new job openings to internal employees. Evidence of this was seen on numerous advertisements placed on notice boards situated throughout the company. As this is an internal policy, it was not driven by lean, and lean to this extent has not had an influence on the policy.

Respondent R11 concluded that the transfer of knowledge occurred through two means; recurrent training and their apprentice program. With the apprentice program being aligned with R8's response and the 'informal means' of transferring knowledge, as well as the fact that the recurrent training is mandated by the CAA; lean has not had an influence on the timely transfer of organisational knowledge.

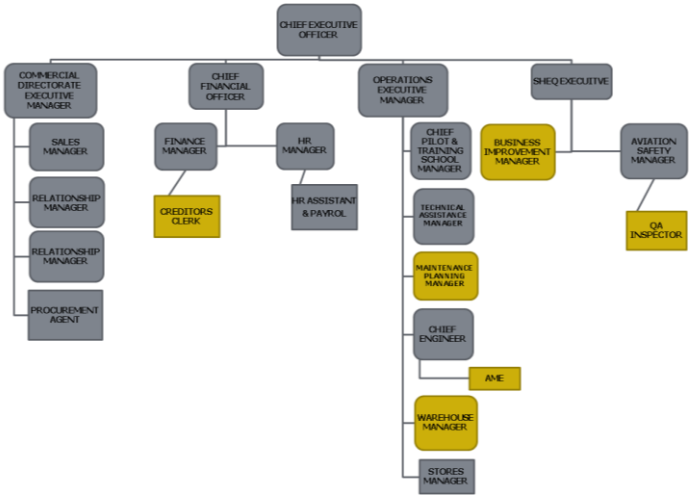
Overall, it was found that Company X indirectly shared some of the lean principles with regards to organisational learning, however lean itself has had little influence on the way in which organisational learning currently takes place.

5.3.2. Leadership

(R5, R1, R7, R2, R13) (SL1 – SL3)

The following analysis attempts to answer TQ9 as outlined in Figure 12:

TQ 9: What changes occurred to the leadership structure?



Leadership was broken into two themes which collectively embodied the 5 leadership actions as outlined in Section 3.2.4. The Guidance and Leading theme covers the principles that deal with Leading through practice; Building lean into personal practice and Leaders as teachers. The second theme, Managers as Leaders, links the common perception of respondents of whether they think their managers carry out the five leadership actions as outlined in Section 3.2.4, or whether they discretely manage their subordinates.

Guidance and Leading

The first action of a leader as outlined in Section 3.2.4. is to teach. Respondents in this regard were asked which leaders participated in organisational learning. Five respondent's views were obtained, from which two concluded that within the MRO division that their manager participated in organisational learning and lead by example. There was evidence within the MRO division that local managers were building lean into personal practice. This was evidenced through the red-tagging of items to be disposed of (5S implementation), and also evidenced by the fact that particular managers occasionally used lean terminology whilst talking with their subordinates.

With regards to developing future leaders in Company X, two respondents concluded that there were no structures in place to uplift managers, and that in their opinion it was up to HR

to grow new leaders within the organisation. This response does not align with that of a lean organisation, where it should be up to the existing leaders to focus on developing people, and growing them into future leaders. In one particular response, the respondent mentioned that "we [Company X] don't take care of our problems", that they know how to approach problems, but that no root cause analysis is ever done and placed on record.

From these responses, it appears that Company X lacks internal leadership. Whilst leadership is recognised within the MRO department where lean has been formally implemented, the company lacks the organisational culture that promotes the development of leaders.

Managers as Leaders

Six out of seven respondents agreed that in general, the organisation consists of more 'managers' than leaders, in that they did not fulfil the five actions as outlined in Section 3.2.4. Further, one respondent involved in quality assurance within the MRO division mentioned that he sees his manager very little. One manager viewed the CEO as a type of leader in that his approach was diplomatic and fair and that his decisions are based on fact. However, the manager did not think that the CEO was growing as a leader, and that he "has maintained his standard".

These reactions may indicate that the company has a culture that does not support the development of leaders. In one instance, a respondent suggested that there used to be leaders, but now there are 'managers'. The company does however realise their predicament and are actively taking part in developing their employees. They recently sought the services of an Industrial psychologist who has and is also set to develop personal profiles of each employee. The intention is to establish whether employees are correctly matched to their job, and also to coach them through developing themselves. The positive reaction from five respondents strongly suggests that the psychologist's presence is welcomed within the organisation.

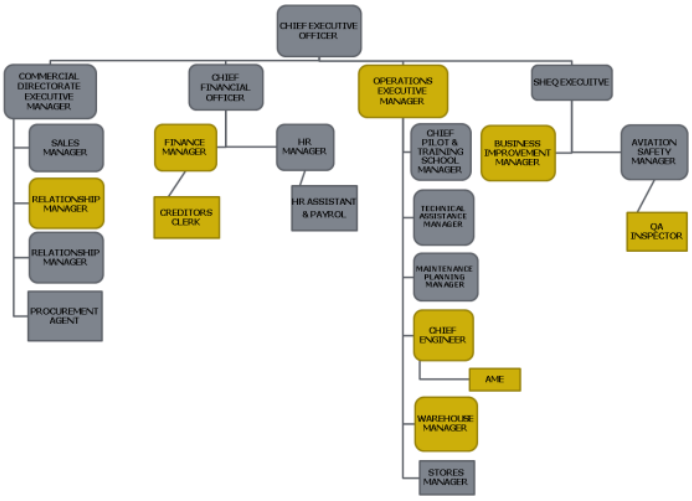
Overall, Company X has not experienced substantial changes with regards to their leadership structure as a result of lean. In some cases, the changes have been negative which suggest that lean has not been correctly 'administered' to the workforce and middle management. This may be explained by virtue of the fact that there exists mainly one change agent within the Company who is driving the lean initiative, namely R11.

5.3.3. Incentives and Appraisals

(R5, R1, R7, R2, R13, R11, R6, R8, R10) (SV1-SV9)

The following analysis attempts to answer TQ10 as outlined in Figure 12:

TQ 10: What changes occurred to the employee incentives and appraisal schemes?



With reference to Section 3.2.2., to drive the implementation of lean requires that incentives be aligned with continuous improvement, quality and time. The Incentive and Appraisal system was found to be governed by the strategic objectives of each department and employee, from which KPI's and KPA's were established. These formed the two themes, namely Appraisal Schemes and then more specifically individual KPI's/KPA's

Appraisal Schemes

From the outset, it was established that employee appraisals are conducted on a bi-annual and annual basis. Company X continues with 'normal business' practice in this sense. Passed changes that occurred to the appraisal scheme included a retention policy that was adopted, but has since been dropped. Employee's were motivated to stay at the company, as their bonuses were paid out in a piecemeal fashion over five years, compounding until their entire bonus had been paid for that period. This change was not linked to lean at all, and was an initiative which was driven from the CEO. Although it was successful, Company X no longer has issues with employee retention and relies on their reputation to retain experienced employees.

It was established that all the departments reviewed their employees against objectives that were set at the beginning of the year. Firstly, the CEO would derive the company's main corporate objectives from which departmental objectives were set. These were then cascaded down by managers, until objectives were set for each employee in the business. Managers are generally rated on the performance of their department as a whole, as well as their individual performances. Managers are required to develop the objectives for each of their employees, and in so doing have opportunities to set objectives related to continuous improvement. There were two cases that were discovered where managers within the MRO department had set objectives relating to improvement projects. Both these managers have been exposed to lean through detailed courses, of which one of them is the principal change agent within Company X. In one particular case, the one manager generates monthly reports to gauge how well his employees are performing with regards to improvements projects. This change has come about in the last two years and was found to be strongly linked to the lean initiative. It was found that the MRO department was able to gather specific data (for example, OEE and repair turn-around times) upon which to factually base their decision making, however, other departments were found to lack these elements.

KPI's and KPA's

It was the intention of the author to establish what predominant KPI's exist within each department. It was established that within the MRO and logistics department, that manager's KPI's were recently being focussed towards human factor issues, for example to ensure the job satisfaction of their subordinates. Another KPI linked to the lean initiative required that a particular turn-around time be achieved for internal part order. This year long KPI was assigned to the warehouse manager responsible for issuing helicopter spare parts; and who had also attended a lean course set the previous year. Observations suggest that the turn-around time was not achieved within the set deadline. The Finance department had began implementing KPI's linked to continuous improvement. R6 suggested that they have to come up with improvement projects so that they can improve work rates, and reduce physical waste.

In general, it was found that the KPI's had remained consistent throughout the departments, and had not substantially changed since the inception of the lean initiative by Company X.

There was also no indication that short term goals (smaller than quarterly objectives) were set, specifically embodying continuous improvement.

Aside from the above mentioned KPI's, Company X awards a prize at their year-end function with the intention to motivate employees to work as a team, and achieve over and above their objectives. A cash prize is awarded to an employee within each department based on a departmental vote. Based on three out of four respondent's views, it was found that this created a sense of jealousy within the departments, and thus was not entirely achieving its purpose of driving employee behaviour.

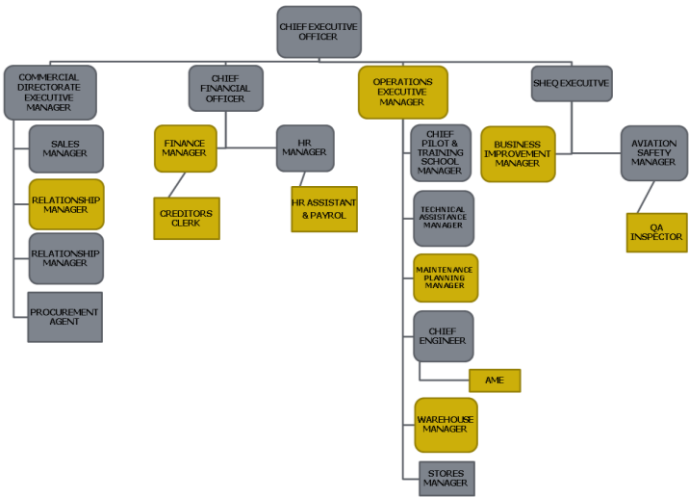
Overall, the incentive schemes within the organisation were found to be influenced very little by lean implementation, with only three out of nine respondents (30%) identifying KPI's and objectives linked to continuous improvement projects. Two of these respondents were based within the MRO department with the other being based within the logistics department. All three respondents have also reported having had formal training in lean.

5.3.4. Culture

(R5, R1, R6, R2, R7, R11, R10, R4, R9, R13) (SC1-SC9)

The following analysis attempts to answer TQ11 as outlined in Figure 12:

TQ 11: What changes occurred to the organisational culture?



With reference to Section 3.2.3, eight primary values were identified, and used as a guide in establishing the type of culture that exists within Company X, and whether lean has had any major effects on it. Questions which elicited these results are covered in Table 7 in Appendix

A, prefixed by SC. The themes that were established revolved around the eight primary values, namely:

Purpose

With regards to acquiring a purpose, it was identified in Section 3.2.3 that it is imperative for an organisation to be focussed. This requires that they possess a vision driven by a central mission statement and guided by corporate values which the company must uphold. In the case of Company X, respondents R5, R1, R6, R2, R7 and R11 did not know the companies vision, mission and values off hand. Although placed on posters throughout the organisation, they all objected to the length of the statements that appeared on the poster. As lean is being driven from middle management within Company X, it inherently has little effect on influencing the vision, mission and values of the company. It was found that the vision and values of the company are decided on by the executive managers of Company X, and will therefore express little consideration towards driving the lean initiative as only one member of the executive management team is responsible for lean implementation.

Consensus

In asking respondents what type of environment was created by management during critical times that the company faced, it was largely established that R2, and R5 (based in the MRO and logistics department) felt that a consultive (root cause type analysis) was taken towards solving problems. R13 on the other hand did not formally respond to the question, however it was later established that a general consensus (team discussion) approach was taken towards solving problems. By having clearly defined the differences between the two approaches, it was found that the problem solving approach taken by R2 and R5 was aligned with existing lean methodologies, specifically root cause analyses (eg: 5 why and fish bone diagram techniques).

Excellence

There was no explicit evidence that showed an environment which distinctly promoted continuous improvement. Based on field observations, no Kaizen events or rapid improvement programs were in place on the shop floor within the MRO department. If

anything, the company has not driven a culture of striving for perfection, and so no changes to this part of the culture can be reported.

Unity

With reference to R2, R5 and R13, they all reported that they were given responsibility for solving problems, and to take full ownership of their work without the influence of their superiors. Although R5 suggested that his superior drives the solutions to the problems, it was not made clear as to how this was done. When establishing whether this had changed, it was found that sharing responsibility had always existed, and that lean has had no influence on the way in which responsibility was disseminated. Directly within the MRO department, R4 suggested that if they as the AME identified opportunities for improvement, that they were put in charge of following through with a solution.

Performance

The only evidence of rewarding employees and team members based on the correct performance measures was given by R5, and is covered in Section 5.3.3. In summary, R5 produced monthly reports related to improvement projects given to employees. R11 however intends on driving new KPI's in the future which he will use to track daily performances of employees, and ultimately incentivise them.

Empiricism

As mentioned in the above point, R11 intends on driving employee behaviour through newly established KPI's. The author was partially involved in the early stages of this new program, with the establishment of tracking labels, and visual management boards within the logistics department. These were intended to be used as a pilot within the logistics department to gauge employee response and their general buy-in. As this was a direct lean initiative, this element of corporate culture was largely influenced by lean, specifically in the MRO and logistics departments, and is changing continuously. With regards to other departments, the SAP ERP system is largely used to track measures, which allow for cost of quality reports and inventory turn-over reports to be developed and issued, however the response of this system was found to be slow, and does not lend itself to continuous improvement exercises. When asked about changing the SAP system to accommodate new measures, R1 (who

recently made changes to the part capturing system on SAP) responded by saying that it was extremely time consuming and expensive, and so they avoid it where possible.

Intimacy

When asked of this, R2, R5 and R1 suggested that there existed a feeling of mutual trust between employees within their departments. This was further evidenced by R1's firm consideration towards his employee's feelings, and ideas. It was often witnessed where a problem was encountered, and R1 would often seek the advice of his subordinates in an attempt to make them part of the decision making process. This however was found to be largely inherent in R1's personality, and considering his short exposure to lean, the author believes that it has had little influence on driving this behaviour. Where lean will have a direct influence, will be when R1 carries forth his intention to run Kaizen events every Wednesday. This will act as a means to further build a relationship with his employees.

Integrity

When asked whether managers lead by example with regards to ethical practices R5 and R13 concluded that their managers do, and that they always did. R11 is the accountable manager, and so it falls within his job description to follow ethical practices as dictated to by the CAA. The author witnessed this on a day to day basis, and although leading by example with regards to ethical practices, lean has had no influence on this element of corporate culture.

In summary it was found that the Social System underwent many evolutionary changes, and in some cases, did not reflect the changes anticipated by the theory covered throughout Section 3.2.

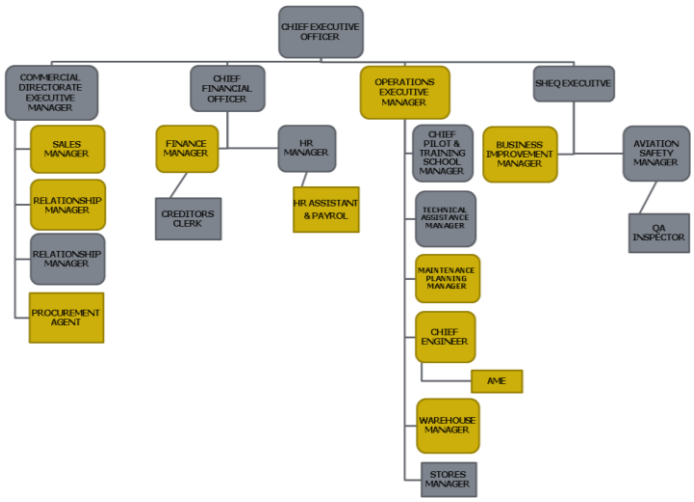
5.4. Technical System

5.4.1. Resource Management System

(R1, R6, R4, R7, R10, R8, R3, R11, R12, R13) (TE1-TE8)

The following analysis attempts to answer TQ 4 as outlined in Figure 12:

TQ 4: What changes occurred to the way in which organisational resources were managed?



The Resource Management system was broken into three main themes: Workforce input towards Continuous Improvement - like it's name suggests, identifies direct links towards continuous improvement and lean. Core Competencies and Capability considers the organisations present and past capabilities and core competencies. Lastly Equipment encompasses the hardware (tooling, machinery and computer systems) and software (ERP systems and Management Information Systems (MIS)) used within the Company's support systems.

Workforce input towards continuous improvement

This section attempts to reveal departments who were aligned with continuous improvement, which were not necessarily directly linked to the lean initiative. Some departments were found to 'unconsciously' be following some of the lean principles, and therefore were not directly linked to the lean initiative being carried out at Company X. This study is focussed

on the changes brought about by lean, and so it was necessary to establish a direct indication of its 'conscious' existence within departments.

It was known to the author which respondents had been taken on a lean course the previous year, and so it was anticipated that implementation of lean tools would be present within their immediate departments, namely MRO and logistics.

R1 made reference to conducting Gemba walks that he previously did not do before attending the lean course. Having a name associated with an action acts as a constant reminder to R1 to carry out the function of 'Going to the Gemba' – or going to the source.

Both R4 and R8 made reference to taking time out to identify opportunities for improvement. They identified improvement meetings which are held with the principle change agent. In these meetings, R4 and his associates were given the opportunity to request changes or modifications to existing tooling and equipment. R8 has an 'open door' policy where employees on the MRO floor can go to him with equipment and process problems. R8 goes further to motivate senior employees (namely the AME's) to come up with improvements, and that if the person comes up with a good, cost effective idea that it will be considered for implementation. R11 confirmed this by saying that "what the guys generally want in terms of continuous improvement are tools to do the job.''

One major change within the MRO department was the implementation of a Kanban system for consumable parts. R11 reported that the new system reduced internal inventory levels, but most importantly reduced the turn-around times of obtaining consumable parts.

In order to further reduce inventory levels within the warehouse, and better control stock levels, R11 and R1 have intentions of 'pre-kitting' parts for specific service intervals, and in so doing will also smooth demand on the warehouse – a concept aligned with level scheduling.

In formally implementing 5S, R11 had the workshop floors painted throughout the MRO and logistics department in order to better detect misplaced parts and dirt, thereby increasing the shop-floor visibility. Once the unused parts, WIP, refuse waste and scrap were identified, they were tagged and removed. Cleaners are currently permanently employed to maintain the

cleanliness of the floor, whilst workshop personnel are responsible for organising the tools and parts in their work area's.

Within the commercial departments, R3 commented that there have not been many changes with regards to processes and office equipment. He suggests that everything is "subject to finance" implying that the changes are driven in a top-down manner in contrast to the bottom-up cycle witnessed in the MRO department.

Within the quality department, new processes and procedures take considerable time to implement. This was confirmed by R1 when he requested changes to be made to SAP, of which besides being expensive, took considerable time to implement. He reported that the last changes that were made to the "binning" function within the program took 6 months to implement. With regards to changing corporate procedures, R7 reported that it took a substantial amount of time to obtain the new procedure from the person requesting the changes, and that if modifications were made, that they were not implemented immediately, as in some instances, approval by Company X's holding company would be required.

Capability

When considering the core competencies and capabilities of Company X, it was the author's intention to establish whether company's capability had changed with regards to its core competencies and processes. The focus of this section was on Company X's core competencies and whether they had changed or become more focussed with the advent of lean. It was mentioned before that Company X has training policies linked to the CAA requirements, however, the question here, was whether formal training had been given to grow employees into leaders who were better equipped to assist in implementing lean and growing the organisation to better fulfil the needs of the customer.

At this point, it should be mentioned that Company X is implementing new policies with regards to the apprenticeship program. They are not directly linked to lean, and if anything, contradict the core characteristics of lean. Company X is currently undergoing changes with regards to employing apprentices. Although they are employing more personnel, and training them until fully qualified (registered AME), they have no retention policy in place to prevent

them from leaving the company and even go as far as to aid them in moving towards other MRO's. Having identified the Sale of helicopters as their core competency (respondents R11, R6), they wish to promote the growth of their competitors by allowing their staff to easily move between other MRO's and themselves. The idea behind this is to grow the MRO market in order to provide better service back-up of their brand, and thus further grow their position within the market place. These changes are being driven from their holding company, and are not related to the lean initiative within Company X.

The negative effects of this were evidenced in a response from R4, in that many of their experienced AME's have left. He explains that there is currently a large gap between AME's with 10 years experience, and new AME's who are required to lead apprentices whilst having little experience of their own.

The only evidence that was gathered with regards to growing employees into a position where they would be better informed to make decisions relating to continuous improvement was that the MRO department formally sent employees on a lean course in order to better align them with an atmosphere of continuous improvement.

Equipment

With regards to the tooling and equipment being used within Company X, much evidence was gathered linking changes that were brought about by lean. R11, R4, R1 report having regular meetings where employees within the MRO department were given an opportunity to request new tooling in order to make their jobs easier. Each area demarcated for an aircraft has been equipped with a computer and work table. A pokoyoke (fail safe) relating to 5S is included in the work benches by means of a slanted work surface. The slanted surface prevents the accumulation of un-necessary documentation. Employees using the work stations gave their input into the design.

Also, each aircraft work-station has been equipped with sufficient tooling to do the job, with tools being housed in shadow boards to allow for easy access – a direct influence of the 5S initiative which was first implemented.

R11 reports the continuous efforts that are also being made towards streamlining the work processes, and documentation.

Although the work processes and documentation have been modified, no attempt has been made to streamline internal communications. Many employees still rely on emails, which take up a considerable amount of time. R11 reports having received over 150 emails, of which most of them are generated internally from other departments, taking up much of his time.

As mentioned previously, although changes are made to the internal reporting systems, the local aerospace industry (specifically a requirement of the CAA) requires that processes and procedures be mapped. As SAP is used as the core means of managing information, employees were found to be reluctant to make changes to it, as the time saved in streamlining processes and procedures, is often offset by the time taken to modify the system.

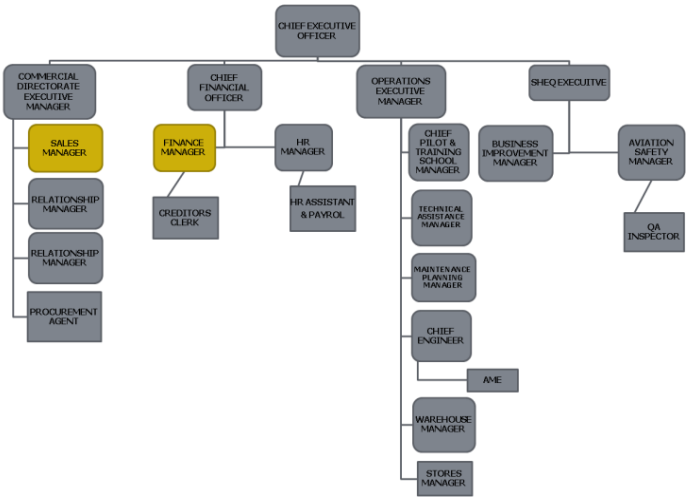
In summary, most of the changes being brought about by lean with regards to Capability, Capacity and Equipment needs have largely been witnessed within the MRO department where lean has been formally implemented. Other factors related to evolutionary growth have resulted in many of the changes occurring throughout the Resource Management system.

5.4.2. Financial System

(R6, R3) (TF1-TF6)

The following analysis attempts to answer TQ 5 as outlined in Figure 12:

TQ 5: What changes occurred to the Financial system?



In obtaining information of whether there were any changes to the financial system, namely in the way that their cost accounting system was structured, very little information could be obtained

for confidentiality reasons. The author therefore focussed on whether there had been any financial considerations that were taken towards accommodating for continuous improvement. Questions were related to departmental expenditure, and whether KPI's linked to continuous improvement were financially incentivised.

As is the case in most organisations, a specific amount of capital is awarded towards departmental expenditure. Company X was found to be no different. There were no set budgets set aside for continuous improvement. It was found that departmental budgets were based on a corporate budget governed by Company X's holding company. The CFO of Company X had the job of dividing up the CAPEX among departments within the company. Although improvements are made on the shop floor with regards to tooling and equipment, these expenses were found to be charged to the overall departmental budget and not a separate budget made solely for continuous improvement.

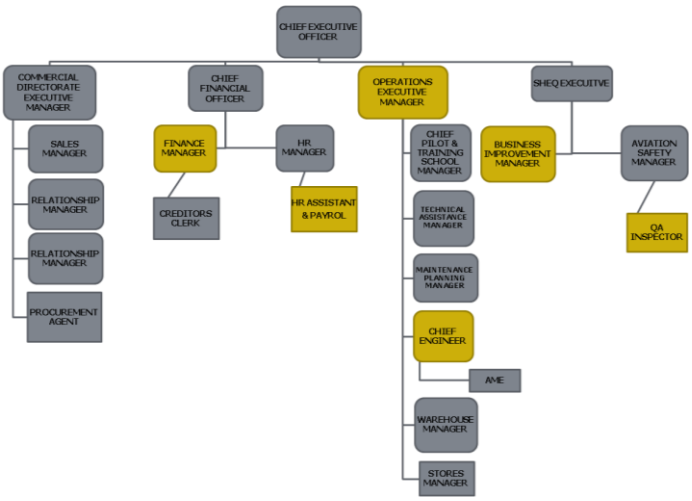
With regards to financial measures, the company was found to still utilise traditional measures relating to work and machine efficiency, however details on the matter were not solicited to respect Company X's privacy policy.

5.4.3. Quality System

(R2, R7, R8, R11, R13) (TW1-TW5)

The following analysis attempts to answer TQ6 as outlined in Figure 12:

TQ 6: What changes occurred to the quality system?



One main theme was established around the quality system, namely Procedures and Practices which focuses on the work process and procedures that govern the way in which the company is run. These are further defined by the regulatory

environment within which the company operates. The regulatory environment within which Company X operates is dictated to them by the CAA. For traceability purposes, the quality system which Company X has adopted are the ISO set of standards. They are currently ISO9001:2008 accredited, and are striving towards being ISO14001 accredited in the future.

Work processes and procedures

As mentioned, Company X is ISO9001:2008 accredited. They are therefore bound by operating procedures and processes which increase the traceability of parts. The procedures are kept up-to-date within a manual of procedures (MOP) file. It was understood that the CAA do not dictate to Company X on how to go about setting their own procedures, but only that they abide by them. The work processes and procedures are controlled by the quality department. They are responsible for training staff in becoming acquainted with the operational and quality related procedures. In this regard, R7 suggests that the company "has two parents", their holding company and the CAA. In modifying any work procedure requires the approval of the quality department and in some cases the holding company as well. This largely hinders the implementation of any improvements that are made to the procedures. A procedure is generally modified when it is clear that something is wrong with it, or where there is an obvious redundant step. The job of continuously streamlining processes is left up to the employee, who is often asked to supply an MS Visio flow chart of their updated procedure. In general, the quality department follows up on procedures and ensures that they are being followed. With the implementation of lean within the MRO department, some of the procedures are being re-mapped in order to drive out waste, however within the commercial and financial departments, it was not clear that any changes had been made to their procedures.

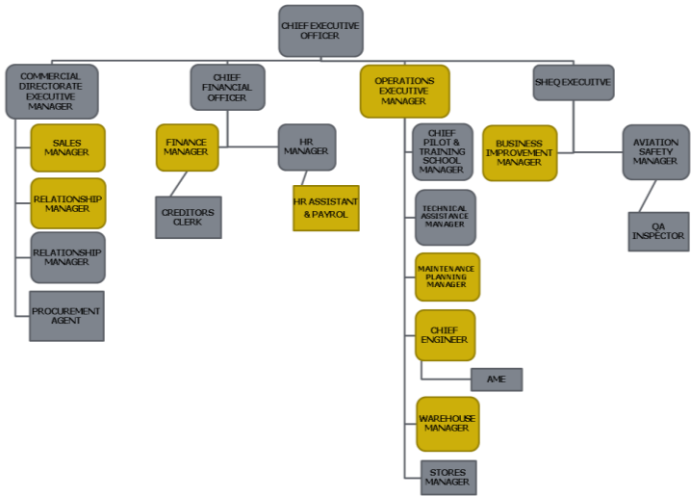
With regards to incident reports and investigation reports, R11 reported that once they have all the information that it is down to a brainstorming session to come up with solutions. Again, these practices are held within the MRO department, and no information could be obtained regarding these practices within other departments. Therefore, with regards to the work processes and procedures; the lean principles of team work and eliminating waste are predominantly witnessed within the MRO department.

5.4.4. Measurement System

(R5, R10, R13, R1, R3, R7, R11, R8) (TP1-TP20)

The following analysis attempts to answer TQ 7 as outlined in Figure 12:

TQ 7: What changes occurred to the organisation's measurement system?



The measurement system forms a critical part in the sustainability of lean as mentioned in Section 3.1.3, and should therefore be present in each department. Changes occurring to the measurement system were traced within two themes: Employee performance measures and Data Management (strongly linked to Section 5.3.3). The means through which both internal and external customer satisfaction is measured was covered under the theme; Organisational Performance and Customer Satisfaction.

Employee Performance Measures and Data management

Within the MRO department, many changes have occurred since R5 and R11 began driving the implementation of lean practices. R5 mentions that their KPI's have changed into something more measureable. They have sufficient access to work related data to track performance on the floor. For the last two years, the MRO department has been tracking the number of 'defects' caused by personnel working on the floor. Implementation has begun in logistics with the implementation of tracking stickers on delivered parts. The author was personally involved in this project, and made recommendations for its implementation.

Pertaining to individual performance measures, the MRO department tracks the percentage use of personnel, their productive hours per aircraft, the total number of man hours per aircraft, as well as other measures not mentioned by the respondent. Each metric is tracked

and reports are sent to employees if problems arise. R11 claimed that Company X uses OEE to track both the performance of personnel and the organisation as a whole.

These measures have largely been influenced through the implementation of lean, and are currently crucial in sustaining it, as well as aiding in its implementation within other departments.

Organisational Performance and Customer Satisfaction

In tracking organisational performance, various reports are generated. The predominant one that is used to guide company objectives, and is driven on a group level is the customer satisfaction report. Company X utilises a web-based survey in which customers can give feedback regarding the service they received. This feedback is captured by the holding company, and the results are summarised for each company within the group. The results are used to drive initiatives within individual companies in the group. In Company X, the report is used to drive and create customer focus. R1 reported that the customer satisfaction report was powerful, as it displayed the customer satisfaction levels for each department and also each company within the group in a graphical format.

Other internal reports pertaining to the cost of quality are generated within the MRO department on a quarterly basis, with the reports being placed on notice boards throughout the company. This includes Cost of warranty (external quality costs), cost of returns (rework costs) and other general cost of quality reports. On the MRO side, daily operations are tracked in morning meetings where the status of each aircraft is discussed with all MRO personnel present.

In terms of tracking customer demands, R3 stated that a rolling forecast is kept of what customers have been demanding. This aids in ‘pre-equipping’ aircraft during assembly.

Again, R11 and R5 have driven these reports within the MRO department as part of implementing lean, however, besides the customer survey that is conducted on a yearly basis, such data is not kept within other departments, which suggests that no attempt is being made to implement lean in those departments.

In summary, the Technical system has undergone a relatively large change during Company X's lean implementation, with many operational aspects being influenced, specifically related to the equipment and tooling within the Resource Management System.

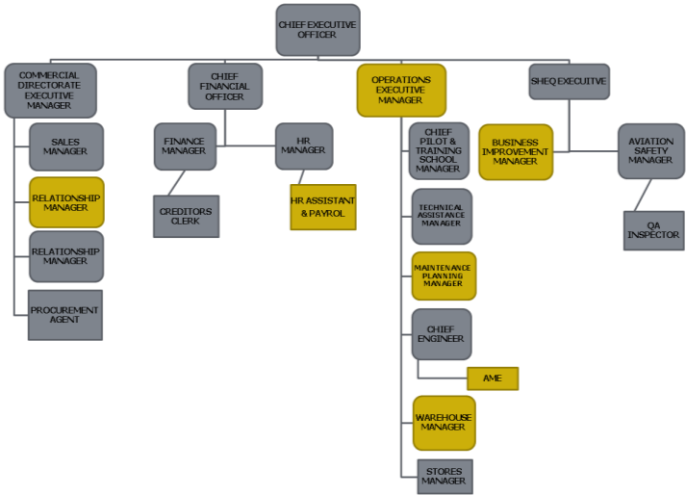
5.5. Structural System

5.5.1. Internal Customer Relations

(R5, R1, R7, R12, R11, R13, R10) (STI 1 – STI 3)

The following analysis attempts to answer TQ1 as outlined in Figure 12:

TQ 1: What changes occurred to internal customer relations?



Internal customer relations were split into two themes. The first theme: Internal Customer Awareness deals with an individual being able to identify with their internal customer, meaning that they are also consciously aware of their needs. The second theme, Communication addresses the type of communication links that are present between internal customers and suppliers. All six of the respondents could identify with their internal customer. It is worth noting at this point that R1, although identifying with his internal customer, mentioned that the MRO department was his internal customer and that "as much as they are our internal customers, I think it's a force of habit to **not** consider them as a customer. Personally, I consider them as being part of the process, and not necessarily as a customer." The author questions whether this 'habit' was developed before he attended the lean course. As he was exposed to the

concept of identifying his value stream, perhaps this change in perspective was a direct result of the lean course itself.

It was found that R1, R11, R7 and R12 were able to identify with their internal customer as well as their internal supplier, where the other respondents either had difficulty in doing so, or they considered themselves as a first point of contact, and did not think that the question was applicable to them. It was interesting to note that R12 had been moved from the logistics department into the commercial department in recent times, and so could easily identify with her internal customer (logistics), and knew in detail their needs in relation to hers, as well as the organisations.

However, respondents R7 and R13 from the Quality and HR departments respectively; identified the entire organisation as their internal customer as the nature of their work requires it.

No conclusions could be made with regards to the above analysis of whether lean was a major influence on employees being able to identify with their internal customer. The only positive result in this regard of lean's ability to change ones perceptions of their internal customer and their needs, was in the case of respondent R1.

Communication Paths

With 100% of the respondents being able to identify with their internal customer it was necessary to establish whether the relationship was characterised by open communication, or whether communication between the internal supplier and customer were restricted. When asked how, respondents predominantly identified email and then telephone as their key means of communication. Set meetings were scheduled on a morning, weekly or bi-weekly basis with set agenda's. This is summarised in a statement by R5, "With our commercial directorate, we have separate meetings to review open job-cards. For the engineers, they have the morning meetings, but otherwise the stuff generally happens during the day. The MRO planning personnel have a weekly meeting. Stores, there is no weekly meeting." These meetings aid in re-establishing direct links which email and telephone cannot support. These means of communication have not changed at the company since the inception of lean, and so it has not had a perceivable influence on the means by which employees communicate with each other. The only distinct difference, is that within the MRO department, Visual

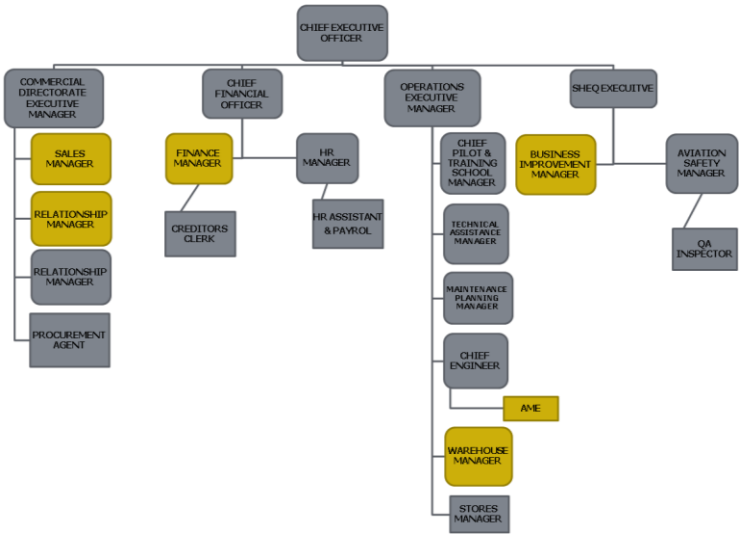
management was beginning to take place on notice boards. Specific to the logistics department, notice boards were placed at strategic locations where employees often pass. This often acted as a silent reminder, or a point of contact where requirements are passed down to individual personnel responsible for a particular process.

5.5.2. External Customer Relations

(R1, R4, R10, R3, R7, R6) (STE1 – STE12, STM 1 – STM 5)

The following analysis attempts to answer TQ2 as outlined in Figure 12:

TQ 2: What changes occurred to external customer relations?



As mentioned in Section 3.3.2, for a company to have an integrated approach to product development, three principles were required to be present, namely:

1. A clear methodology for developing product definitions which are based on how well the customer's wants and needs are understood. This involves analysing the risks and assessing existing regulations.

For this principle, it was necessary to first establish what the Perceived expectations of the customer were. This formed the first theme of this section; *Perceived Customer Expectations* where the trends of the customer requirements were analysed. This would assist in tracking the evolutionary growth of the company.

2. The consistent and effective application of a variety of methods for capturing the voice of the customer.

The second principle requires a suitable means of communicating with the customer. This therefore formed the second theme of this section; *Communication*. This theme covers how Company X communicated with their customers, and obtained actionable information from them.

3. A superior value proposition is then considered which will deliver a competitive advantage. This is internalized before the product is designed (Grieco 2002)

To become competitive requires the use of market information. It is imperative that a company know their position within the market in order to identify gaps between themselves and their competitors. This formed the third theme of the analysis; *Market Information* and reveals the way in which Company X obtains information relating to the market and their competitors.

Perceived Expectations of the Customer

As Company X has multiple points of contact with their customers, their perceived requirements may differ at various levels within the company. To alleviate this, respondents were asked for their perception of what the customer required. Respondent R1 does not formally have contact with the end customer, and so his perception of what the customer requires is based on what upper management conveys down through the organisation. His perception was extremely broad and 'unfocussed'. This is where being able to identify with the critical Value streams within the company become embedded within the lean initiative, and therefore may have an effect on his 'perceived customer expectations'. R4 identified crucial requirements of the customer as in his opinion, being an AME requires him to develop a personal relationship with the customer. As this was the case, R4 identified minor, but very important customer requirements. Some of these required that the AME personally assist the customer with minor repairs not scheduled through Company X. These minor repairs were often perceived as 'snags', which the AME would fix, although not necessarily required of him. R4 perceived fulfilling these person customer expectations as crucial to maintaining a close relationship with the customer. R10 and R3 identified broader requirements, and that every year, the customer demands "more and more". They collectively

identified the fact that markets are becoming increasingly competitive, and that overall factors such as training, on time delivery, pricing and reliability are major factors which according to R3 become "tighter" every year.

In the context of lean, these expectations have not changed as a result of its implementation. Company X has always driven a customer oriented work environment, and although broader economic factors are to blame for fluctuating customer expectations, their expectations are conveyed through a means not related to the lean initiative. What is interesting to note from the observation, was that the 'perceived customer' requirements were linked directly to the nature of the relationship between the respondents and the customer. Lean can have an influence on the understanding of the customer requirements in the context of the respondent's position within the company, however, no evidence was found and so lean was identified to have had no influence on perceived customer expectations, and that 'evolutionary growth' would be the reason for any changes in their perceptions.

Communication

Once contact has been made with the customer, maintaining communication with them is crucial within the aerospace industry. Respondent R10 and R3 respectively hold positions as Relationship and Sales Manager. These roles require that they formally keep in contact with the customer on a continual basis. The first means of communication was established to be email, after which communication is done telephonically. Finally, to ensure they maintain a presence with the customer, they have scheduled visits where they travel to the customer in order to have personal contact with them. During these interactions, any formal customer complaints are directed through them. R3 and R10 are both responsible for driving through the customer complaints and queries and ensure that they are resolved. R10 has the authority to open a Corrective Action depending on the seriousness of the problem. A Corrective Action may require potential process and system changes on Company X's behalf in order to 'close it'. R3 does it more personally, in that "I keep the lines of communication open... Questions are cascaded down until the problem is found." It was found that these systems were not linked at all to the lean initiative within the company, and so identifying whether the roles of R3, R10 and R4 have changed as a result of its implementation would require broad inferences to be made on the author's behalf, and would thus not be factually grounded.

Market Information

With regards to obtaining market information R6 and R10 identified that the CAA offers a service through which information pertaining to their competitors can be obtained. R10 identified that they as Company X are market leaders within selected segments, that there were no indications that Company X benchmarked themselves against their competitors.

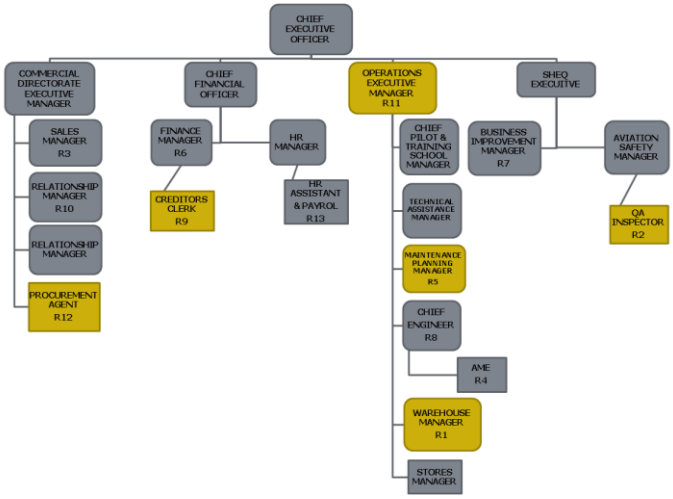
Both R6 and R10 confirmed that Company X had experienced growth within the last three years, although specific information was not provided of the growth that Company X had experienced within the respective market segments that they serve.

5.5.3. Supplier Relations

(R5, R1, R2, R9, R12, R11) (STS1-STS7)

The following analysis attempts to answer TQ3 as outlined in Figure 12:

TQ 3: What changes occurred to external customer relations?



Supplier relations within lean fall into the Value chain analysis. Through identifying the value chain, a company automatically enables itself to identify where the value adding, necessary non-value adding and non-value adding processes exist. By identifying waste within the value chain that extends into first and second tier suppliers, a company may be required to adopt Supply Chain management strategies to assist in both identifying and driving out waste. This formed the theme of the current section. Question were asked that were related to the way in which internal and external suppliers communicated with personnel in Company X. R12 and R9 are responsibly

for ordering helicopter parts and paying suppliers respectively. R12 and R9 both identified that Company X does not manage their supply chain. On a higher level, it was found that the holding company uses sub-contractors to manufacture, store and deliver parts to their subsidiaries. This was found to have a significant effect on the Lead times of particular parts that were delivered from overseas. R12 and R9 predominantly dealt with local suppliers, however they identified that none of their suppliers have adopted changes towards operationally aligning themselves with their customers, specifically Company X. Due to the vast ERP system that Company X employs, this makes it particularly difficult for suppliers to merge into the system, as they may be perceived as a security threat to the holding company. R11 identified Company X to be a relatively small player within their supplier's supply chain, and so he concluded that trying to get them to collaborate might be difficult, and that if a supplier performs badly, that they 'drop them'. This shows no evidence of collaboration with local suppliers. Contrary to this, R1 proposed that Company X were going to be implementing KPI's for their local suppliers, particularly their repair agents; "Its still in the pilot phase, but we intending to set some KPI's for our suppliers as of next year to see, and monitor their efficiencies. Have some sort of leverage against them." This suggests that Company X has not fully adopted the lean principles, and in some cases are restricted due to rules imposed on them by their holding company. Where evidence of lean and TOC did feature, was when R1 began talking about their spare part lead times coming from their overseas supplier, and that it was almost impossible to accurately predict buffer inventories due to variation in their spare part lead times. He identified that the increasing lead times were countering what one of his KPI's were, which was to reduce stock levels by 20%.

As R1 is the closest to the supplier, in that he is the point of contact once the part is delivered, any problems being experienced within the value chain were reflecting badly on his department. After considering this, R1 suggested that in the near future he intends on establishing personal contact with his suppliers, and would prefer to take over processes previously completed higher up in the value chain (by the creditors clerk). This would offer a great opportunity to improve his repaired part's lead times. However, what the author noticed was that no formal analysis was done (value stream mapping, or process mapping) during this initiative. This shows that although in its infant stages within the logistics department, lean is beginning to have a profound effect on the way R1 thinks, which directly affects the way in which he runs his department.

5.5.4. Summary

Lean has only been applied within the MRO and Logistics departments, and although Company X has been used as a bench mark with regards to some of their processes and practices, they have not yet fully integrated lean into their organisational value system. This is evidenced by the lack of lean implementation within departments that lie further up the value chain such as the commercial department who specifically deal with customers and suppliers. Lean has mainly been implemented on an operational level, and therefore, its changes are predominantly being witnesses in areas directly beneath the MRO and logistics department.

The Theoretical Framework developed for the purpose of the study consisted of many 'touch points' which lean ultimately should influence. By adopting a reductionist approach in segmenting a company into various systems, it allowed for the changes within each aspect of the business to be considered. One of the most powerful features of the framework, although not covered in this report, was its ability to extensively examine the status of lean implementation. Although no quantitative measures were put in place to measure the level of lean implementation, a scoring system could be appended to the framework, weighting the level of implementation for each sub-system element against its 'ideal state'. In this case, it was shown qualitatively, that Company X is in a juvenile stage of lean implementation, and that the changes have not yet being embedded in the company's culture.

In considering this, it was found that the Theoretical Framework developed in this research could be used as a possible guide for implementing a lean initiative. Based on the results from the research, one may infer that the Technical System should be the first point of focus in anticipating the changes to be made with regards to equipment, work procedures and processes. With regards to Company X, it is anticipated that the Structural System changes will occur next, whilst the Social System will undergo changes throughout the implementation of their lean initiative. Although not completely understood in the context of the current research, it is anticipated that the progressive changes of these Systems can be used as a guide for any company wishing to implement lean.

6. Conclusions

In fulfilling the first objective of the research, a theoretical framework was successfully developed in order to track the social, structural and technical changes that an organisation may experience during their implementation of lean. To do so, a systems analysis combined with the Baldridge Criteria for Performance Excellence was used as a means of informing the theoretical framework. In satisfying the second objective of the research, theory was used to identify possible changes that a lean organisation would go through. To satisfy the last objective of the research, these changes were then compared to a single case study of one of South Africa's leading 'lean' aircraft MRO's. After scrutinising the results against that which theory suggests, the following conclusions were made:

6.1. Social System

- Contrary to what theory suggests, no significant changes were found to have occurred with regards to the way in which organisational knowledge is managed within the company.
- With regards to Leadership, the responses from the respondents suggest that there exist more managers than leaders, and that there is very little evidence of lean's influence on the way in which people are groomed to become future leaders.
- The Incentive and Appraisal schemes within the company had not changed significantly. The only significant change that was identified was related to the KPI's that were set within each department. 30% of the respondent's KPI's had changed as a result of lean implementation.
- The company's organisational culture had changed in three out of eight key areas. Namely the way in which problems were solved, the way in which individual performance was measured and the way in which data was gathered.

6.2. Technical System

- With regards to the way in which Resources were managed within the company, it was found that personnel within the MRO department made an effort towards continuous improvement, although some of the improvements were found to take

time to implement. ‘Hangar improvement meetings’ were developed to give employee’s the opportunity to become stakeholders in the process of improving their immediate work environments, specifically regarding the tools and equipment they used**.** In considering the core competencies and capabilities of the company, it was found that external factors dictated the way in which they were managed. lean had little if no influence on this. The largest change within the technical system was found to have occurred to equipment and tooling within the MRO department. Many of the improvements made were related to the 5S principles of lean.

- No conclusions could be drawn surrounding the Financial system. Not enough detail could be extracted as much of the information was considered confidential.
- The quality system has undergone various changes as a result of lean. Particularly regarding work processes and procedures. These were continuously scrutinised for waste, and improvements are being made on a continual basis.
- The measurement system of the company has not changed significantly, although an existing ERP system is being used to extract data used in organisational decision making. One of the key measures which were found to have been monitored was Overall Equipment Effectiveness (OEE). These measures were again found to dominate within the MRO department where lean principles had been formally implemented.

6.3. Structural System

- All personnel that were interviewed across the organisation could identify with their internal customer; however communication links between them have not changed, and in some instances were found to have become disjointed.
- External customer relations had not changed at all as a result of lean, particularly within the MRO department. Respondents had conflicting views of what the external customer’s expectations were – which is not aligned with a lean organisation.
- Supplier relations had changed somewhat. With the influence of lean, and being able to identify with their Value Stream, respondents within the MRO department; more specifically the logistics division; identified the need to collaborate with their suppliers in order to better manage their supply chain.

In answering the central research question:

CRQ:

What Social (eg: cultural, corporate governance, employee relationships), Structural (eg: Corporate Hierarchy, supply chain management) and Technical (eg: shop floor, business process, equipment) changes occur within a company during their transformation to Lean.

The following summary was made.

Overall, the Social, Technical, and Structural changes that had or had not occurred within the organisation were to some degree influenced by the level lean implementation within the company. It was later discovered, and is also prevalent within the research results; that Company X is still in an early stage of lean implementation, and has not tended to the deeper aspects of lean which influence the underlying structure and culture within the company. The corporate culture was found to be almost opposite to that of a lean company according to the theory that was gathered in Section 3.2.3. These factors influenced the results of the current study, and were also diluted by the evolutionary and so further recommendations were made for future research.

6.4. Review of the Theoretical Framework

To satisfy the CRQ identified in Section 1.3, it was necessary to develop a theoretical framework which could be utilised to track the social, structural and technical changes that occur within an organisation implementing lean. The statements below conclude the applicability of the theoretical framework in the context of the current study, whilst highlighting potential benefits and shortcomings of using such a framework.

6.4.1. Ability to differentiate between evolutionary changes and those brought about by lean

Considering the three main systems of the theoretical framework, and their change element constituents, it was found that the framework succeeded in taking a vertical slice through Company X. It was found to elicit sufficient detail around particular changes within the organisation. It was found that evolutionary changes could be distinguished from changes brought about through the company's lean initiative. As evolutionary changes will almost always be present within any organisations, whether a mature organisation or within an organisation experiencing rapid growth, the framework proved to be a sufficient means for gathering relevant qualitative data.

6.4.2. Advantages of the systems approach

One advantage of the framework which was realised after conducting the study, is that it has the potential to highlight focus area's for organisation's wanting to implement a lean initiative. It offers insight towards the changes that organisations should expect to make to their system elements if they wish to implement lean. For the enthusiastic practitioner, this information may be largely valuable, specifically in the early stages of lean implementation. For example; based around the cultural system with reference to the vision, mission and values of an organisation: by highlighting the need for a goal orientated approach, organisations who have not yet put systems in place to convey their vision, mission and values, may experience difficulty in sustaining any long term changes brought about by lean.

6.4.3. Application across improvement initiatives

Due to the generic nature of the Baldridge criteria used to inform the theoretical framework, it inherently allows for the framework to be applicable across various improvement initiatives, specifically customer focussed initiatives such as Six Sigma, Lean and TQM. One of the disadvantages however of the current theoretical framework, specifically to those not well versed in the theory of Six Sigma, Lean or TQM is that the framework is largely grounded in qualitative evidence, which is inherently subjective in nature. This allows for various interpretations to be made when reviewing the results of a similar study. This leads on to recommendations for further research.

7. Recommendations for further research

- Quantitative metrics should be linked to the social, technical and structural systems in order to elicit more objective data.
- The same framework should be used on a company with a higher level of lean implementation in order to gain a better understanding of the influences that lean has on an organisation.
- To further validate the theoretical framework that was used, it is recommended that the same approach be taken across multiple companies within another industry.
- The System changes should be linked to a time-based study in order to observe whether there is a clear order in which the Social, Technical and Structural changes occur.
- An investigation into the interdependence of the various System changes should be completed in order to establish clear correlations between changes occurring in one system to changes occurring in another.

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Appendix A - List of Interview Questions

Table 7 below lists all the interview questions. Note that only the 'Present' type questions are listed here, the 'Past' questions were simply reworded, and are given in the Digital Appendix.

Table 7: List of Interview Questions

Questionnaire: Present		
Respondent Details		
Position within Company	_____	
Years at Company	_____	
Years in Current Position	_____	
Any Previous Positions	_____	
Respondent Interview ID	_____	
Structural System		
Question Ref.	**Question**	**Prompts**
STI1	Are you aware of who your internal customer is?	
STI2	Do you consider them in this way?	As your customer
STI3	How /what are the formal ways of reporting to your 'internal customers'? (Both vertically and horizontally)	email, weekly/daily meetings, telephone, person-person
STM1	What is your market position?	Where do you sit in the market place within you industry
STM2	Do you know the relative growth of your organisation within the market place?	relative to competitors/similar companies in other market sectors
STM3	What changes are normally required to give you a competitive advantage in the market place?	good prices, good service, reliability, consistency? Are these changes generated internally/from the market place

STM4	How do you collect and analyze data pertaining to competitor's performance and projections of your future performance?	
STM5	Do you know your current market share within your industry/market segments?	
STS1	What are your key types of external suppliers?	service, parts, logistics, etc
STS2	What mechanisms do you use to communicate with your suppliers?	email, telephone, person to person
STS3	What influence do your suppliers have on innovations and systems within your company?	quality systems, tracking systems
STS4	What are your crucial supply chain requirements?	
STS5	Do you manage your supply chain?	
STS6	Do you have a formal way of determining which suppliers are performing badly?	
STS7	How are poorly performing suppliers dealt with?	
STE1	What expectations do your customers have of your product/services?	
STE2	Do you have formal customer support services in place?	financial -credit operational - internal consultants who consult to improve customer systems
STE3	What mechanisms do you use to communicate with customers	email, phone, person-person
STE4	How do you listen to customers to obtain actionable information?	information that can be used to better your products/ services
STE5	What technology/means of communication do you use to listen to your customers?	website feedback, social media, satisfaction surveys

STE6	How do you obtain information on your customer satisfaction relative to their satisfaction with your competitors?	
STE7	What are these trends?	
STE8	How do your customers seek information/product support?	communication mechanisms: email, phone, person to person, website
STE9	Do these vary between market segments?	parts sales, helicopter servicing
STE10	What do you use to build a more customer-focussed culture?	Teach about internal customers, convey customers requirements down the organization, allow workforce to interact with customer
STE11	What do you use to identify opportunities for improvement and innovation?	suggestions box, open to suggestions, specific tools such as kaizen (don't mention name, explain concept, 5S
STE12	Do you use the effective 'voice of the customer' or rather the Customers direct requirements to support operational and strategic decision making and innovation?	
STH1	What is your workforce profile/hierarchical breakdown (to operators level)?	(Obtain present one)
STH2	What are their respective levels of education?	

Technical System		
Question Ref.	**Question**	**Prompts**
TE1	How do you ensure that hardware and software used to manage processes within your organisation are reliable, secure and user friendly?	Central server, cloud computing, employee specific access
TE2	In the event of an emergency, how is information continuously supplied to the workforce, suppliers and customers?	ie: If computer system fails
TE3	Do you 1)recruit, 2)place and 3) retain new members of your workforce?	retention policies?
TE4	Do you utilise input from your customers to determine key work system requirements?	Use customer requirements to dictate internal functions/operations
TE5	What is your current work system?	eg: SAP
TE6	What tools, if any have been put in place to assist your work environment?	display boards, jigs, cranes, etc
TE7	Are working aids designed by management or personnel working on the equipment?	
TE8	What are your organisations core competencies, and which are most crucial to your businesses success?	ame, pilots, services abroad?
TF1	What are your key 1) short term and 2) long term performance measures?	For company as a whole

TF2	How frequently are these measures tracked?	
TF3	Do you use this information to support organisational decision making?	
TF4	What are the current trends related to departmental expenditure budgets relative to inflation?	separate budget for 'process improvements' or all put under one budget
TF5	What are the current trends in the organisation's turnover?	(SENSITIVE) % increases between market sectors ie: north africa servcing VS Local, exports VS local (logistics)
TF6	What are the current trends in the organisation's profits?	(SENSITIVE) % increases between market sectors ie: north Africa servicing VS Local, exports VS local (logistics)
TW1	What regulatory environment does your company operate under?	Pertaining to Quality
TW2	What are the applicable: 1) health and safety regulations 2) Accreditation 3) Certification 4) Registration requirements 5) Industry Standards 6)Environmental 7) Financial 8) and Product regulations?	1) safety standards 2) SACAA, FAA 3) ISO9001/ AS9100 4) Specific for AMO's 5) Linked broadly to aviation 6)ISO14001? 7) specific auditory requirements 8) and Product regulations?
TW3	How does your organisation promote ethical behaviour?	MOP/Work instruction/regular check-ups

TW4	What measures are in place to ensure ethical conduct?	Ethics code of conduct/ general code of conduct
TW5	How do you respond to breaks in ethical behaviour?	Disciplinary/written warnings/extra training
TP1	Do you have performance measures in place to monitor ALL employees performances?	
TP2	What are they linked to?	output, quality, etc
TP3	How do senior managers communicate key decisions/performance criteria?	general meetings, work instructions, job description
TP4	How are senior manager's performances reviewed?	including the ceo
TP5	What measures are in place to ensure ethical conduct?	
TP6	What are your main KPI's for tracking achievement and effectiveness of your action plans?	Turn-over, throughput
TP7	How do you ensure that your measurement system covers all key deployment areas and stakeholders?	Which areas of the organisation are covered. What are their individual measures?
TP8	How is data selected and information collected for tracking daily operations?	SAP or regular check-ups
TP9	What are your 1) short term and 2) long term performance measures?	
TP10	How frequently are these measures tracked?	

TP11	Do you use this data and information to support organisational decision making and innovation?	drive through change using facts and figures
TP12	What analyses are performed to support these reviews and ensure conclusions are valid?	
TP13	Is there a 'lessons learned' approach to performance reviews?	of both people and processes?
TP14	What information/data is used to prioritise actions for continuous improvement?	Throughput/OEE/Efficiency/Quality/Profit/loss
TP15	How do you manage change with regards to capability and capacity needs?	hire more, re-allocate, cross train
TP16	How do you monitor the level of workforce 'engagement' (interest in their job)?	absenteeism, safety consciousness, productivity?
TP17	How do you invent new work processes? Is this readily accomplished?	In group or dictated by management
TP18	What are your current key measures and trends relating to process and organisational performance?	productivity, cycle times, etc
TP19	How do you evaluate supplier performance?	
TP20	How are 'bad suppliers' dealt with?	if quality is substandard, lead times, etc.

Social System		
Question Ref.	**Question**	**Prompts**
SO1	Do you promote organisational learning?	Provide time, tuition, courses
SO2	How does management create an environment for employee training?	Training centres, MOP
SO3	How is organisational data, including lessons learned and other knowledge used to ensure: 1) Accuracy of work 2) Integrity and pride 3) Security and Confidentiality?	
SO4	How is past data and information, including 'lessons learned' made available to the workforce?	MOP File, meetings, white boards
SO5	How do you ensure the timely transfer of organisational knowledge?	New comers processed?
SO6	Do you promote a working environment that ensures the rapid identification, sharing and implementation of best practices?	
SO7	How do you ensure the transfer of knowledge from departing or retiring employees?	Mentorship programmes, etc.
SO8	What is the current capability of your workforce capability?	**Scale of 1 (bad)-5 (good).** Refers to ability to build and sustain relationships with customers, innovate and transfer to new technologies
SL1	Do you consider particular managers as leaders within your department/organisation?	
SL2	Do this individuals continuously seek to improve their leadership skills?	Attend management/leadership courses, team building exercises
SL3	Who are the main leaders that participate in 1) Organisational learning 2)Succession Planning 3) Development of future organisational leaders?	By position: ceo, financial director, operations manager

SV1	What are your organisations main product offerings?	Service, Maintenance, logistics
SV2	What are your organisations core competencies, and which are most crucial to your businesses success?	ame, pilots, services abroad?
SV3	What are your stated: 1) Vision 2) Values 3) Mission	Do you know them off hand? On website (show printed picture)
SV4	How does management set the organisations central vision, values and mission?	Conveyed from France
SV5	How is the vision, values and mission conveyed down through the organisation?	Posters, meetings, website
SV6	How is the vision, values and mission conveyed to suppliers and customers?	website, email, letterhead
SV7	Would you say that management 'live' the vision, values and mission of the organisation/their department?	
SV8	How is data collected with regards to the organisations strengths, weaknesses, opportunities and threats?	
SV9	Do you have strategic objectives with deadlines for meeting them? If so, are they quarterly, annually, bi-annually set?	
SV10	Are they split into long term and short term goals?	
SV11	What do your strategic objectives relate to?	Innovations of products/services, operations improvements (lead times, etc), overall business model?
SV12	How are the action plans deployed throughout the organisation to your workforce, suppliers and partners in order to achieve your strategic objectives?	Notice Boards, email reminders, measurements
SI1	How does senior management recognise good performance?	
SI2	What reward and recognition programs are there to reinforce good performance?	Incentive Schemes/similar

SI3	What reward and recognition programs are there to reinforce customer and business focus?	Discounts for customers, rewards for achieving goals
SI4	How is senior management's performance reviewed?	including CEO, etc
SI5	Do you have policies, benefits and services in place that support you employees?	UIF, Workman's comp, Sick pay fund, provident/pension fund
SC1	Do your employees know the company vision?	If so, how is it conveyed
SC2	What decision making styles are prevalent during critical times? 1) Command 2) Consultive 3) Consensus	Command - dictatorial, fire fighting Consultive- root cause, fair Consensus-Team work, accepting
SC3	What environment does management create on a day-to-day basis?	1) Continuous Improvement - search for opportunities 2)Survival - do what is necessary to get through the day
SC4	Were you given responsibility/accountability of a challenging task without bad interference from your superior?	good interference in the form of advice and guidance is fine, so long as the problem was not solved by the superior
SC5	Do you have performance measures in place for employees on all levels? What are they linked to? Are there any key benefits?	Incentive Schemes/performance appraisals
SC6	Does management have access to sufficient data which can factually back them in their decision making?	Departmental Figures/cycle times
SC7	Is there a feeling of mutual trust between employees?	sharing of ideas, issues, personal problems
SC8	Does management lead by example with regards to ethical practices?	Follow procedures
SC9	Do you foster an organisational culture that is characterised by open communication	Between departments

Appendix B – Sample Interview Invitation

Participation Agreement

UNIVERSITY OF THE WITWATERSRAND,
JOHANNESBURG

SCHOOL OF INDUSTRIAL ENGINEERING

INTERVIEWER DECLARATION

I, Tyron Mansfield am dedicated to upholding the following agreement between myself and _____(respondent name) for the completion of my MSc Research. I agree to uphold the criteria for ethical conduct as outlined by *The University of the Witwatersrand, Guidelines for Human Research Ethics Clearance Application (non-medical).*

9. With regard to informing the participant prior to the interview:

   Participant Information Sheet written in a language understandable to the participant (or guardian) detailing what the participant will be told. This should include the following:

   - Participation is voluntary, and refusal to participate will involve no penalty or loss of benefits to which the participant is otherwise entitled;
   - The participant may discontinue participation at any time without penalty or loss of benefits;
   - A brief description of the research, its duration, procedures and what the participant may expect and/or be expected to do;
   - Any foreseeable risks, discomforts, side effects or benefits:

10. The participant will be formally invited to participate in the interview.
11. The participant's details shall remain anonymous and only their responses will be considered.
12. They will then be asked to sign a consent form which will:

- Include a clear statement that the participant is consenting to his/hers involvement in the research, and not to treatment; or remuneration
- State clearly that the participant is free to withdraw from the study at anytime without prejudicing any current access to facilities. (If this is not made clear, the researcher risks the accusation that consent obtained by subtle coercion that is, the possibility of prejudice against the participant).

Sign_____, Date_____

UNIVERSITY OF THE WITWATERSRAND,
JOHANNESBURG

SCHOOL OF INDUSTRIAL ENGINEERING

Invitation to participate in a semi-structured interview

Dear **(Planner Manager)**

I am currently conducting a Case Study Analysis of **(participating company)** South Africa as part of the Research component of my **MSc in Industrial Engineering (50/50)**. As I am sure you are aware, I will be present at **(participating company)** for 5 weeks. During this time, I will be assisting **(participating company)** (specifically within the logistics department) whilst obtaining results for my study.

What is it about?

I intend to ask you a few questions relating to specific practices that the company has adopted over the last few years. Areas that your questions may relate to (but not all) are:

1) Internal Customer Relations
2) External Customer Relations
3) Supplier Relations
4) Market position
5) Corporate Hierarchy
6) Organisational Learning
7) Leadership
8) Corporate Vision, Values and Mission
9) Data Management Systems
10) Financial indicators
11) Work Procedures
12) Performance and Process Measures

You will only be asked questions that relate to your expertise and experiences within the company. Any questions that you feel you do not know the answers to; there is no need to give a statement. I may ask for a referral to someone who you think might know the answer.

How long is the interview?

The duration will depend on the number of questions and your level of engagement, however it should never exceed more than 1 hour. Based on the number of questions that I will be asking **(±10),** I anticipate that our discussion should be no longer than **20 minutes.**

What can you expect?

I will ask you to read over and sign a consent form, in which I declare to keep you anonymous with regards to any information you may provide. I intend to interview various people from other departments, so no circumstantial claims can be made towards any information that you may provide.

None of the **questions** are **personal**, and will require general information. A sample question is shown below:

- ***What expectations do your customer's have of your services/product?***

I may record the interview in order to aid me with my transcriptions. It will also help in speeding the interviewing process up, as well as create a more relaxed atmosphere, where a general conversation can be held instead of a question-answer dialogue.

I will require two interviews over the next two weeks. The first will relate to your past experiences within the company, whilst the second will relate to you experiences at present.

If you have any other questions pertaining to the details of the interview, please feel free to contact me.

Sincerely,

Tyron Mansfield
University of the Witwatersrand,
Johannesburg

RESPONDENT CONSENT

I, _____ hereby give consent to participate in the interview process to be conducted by **Tyron Mansfield**. I agree to give information that is accurate and correct, and will otherwise object to answering any questions for which the answers are unclear or unknown. I understand that the information that I will be supplying is for University Research purposes only. I also understand that I am free to withdraw from my participation at any time.

I **do/don't** mind being recorded for the duration of the interview.

Proposed dates for the Interview:

1st Round Interview_____11/2012

2nd Round Interview_____11/2012

Name: _____ Sign:_____ Date: _____

Digital Appendix

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1. **Baldridge Criteria**
2. **Individual Questionnaires**
3. **Respondent Transcriptions**