



# **INVESTIGATING THE EFFECTS OF LEAN THINKING ON PRODUCTION PROCESSES WITHIN SMEEs**

by

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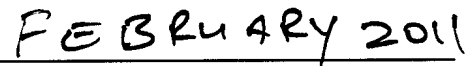
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## DECLARATION

I, Lucky Mokhalimetso, declare that the contents of this dissertation represent my own unaided work, and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.



Signed



Date

## **ABSTRACT**

Lean thinking and its principles, as described by Womack and Jones (1996) has been successfully applied to the manufacturing and operational environment, as evidenced by associated case studies.

Fostered by a rapid spread into many other sectors beyond the automotive industry, there has been a significant development and localisation of the lean concept in general.

This research study sets out to investigate the effects of lean thinking on production processes in a Small and Medium Engineering Enterprise (SMEE). It is hoped that the methodology adopted and the results of the study in the form of a concise lean principle model will assist SMEEs in the strategic planning of their manufacturing processes and improve their sustainability.

The case described here, where lean principles were adopted at a transformer manufacturing company (referred to as ABZ), was considered a success by most of those involved at the company. The production cycle time improved from 33 days to 4.5 days within a few weeks of the implementation. In addition; product quality, worker morale, and housekeeping also improved drastically.

## **ACKNOWLEDGEMENTS**

**The confidentiality of the company involved has been preserved by naming it ABZ.**

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## GLOSSARY

<b>Terms</b>	<b>Definition</b>
5S's	A system implemented to provide a de facto standardized house keeping in the manufacturing operations.
Andons	Refers to the operation visual displays of a work centre.
ABZ	ABZ a transformer company used as the case this research.
Heijunka	A Japanese term meaning production leveling, a key aspect of efficient flow in Lean manufacturing to correspond to longer-term demand.
Jidoka	A basis of the Toyota production system which translates as "automation with a human touch".
JIT	Just-in-time: An inventory management methodology whereby the movement of parts is co-ordinated to smoothly flow through the supply chain to meet customer demand at the right time in the right amount.
Kaikaku	A radical improvement of an activity to eliminate waste.
Kaizen	Continuous improvement and incremental improvement of an activity to eliminate waste. A key aspect in the application of lean principles.
Kanban	A system to regulate pull of products by signaling upstream production and delivery

KOS	Kodak operating system. The application of lean principles at Eastman kodak.
LDT	Large distribution transformers
Lean Principles	Originally a customer-focused manufacturing philosophy which attempts to do more with less by eliminating waste. Lean principle have now extended to multiple functioning within an organization
LM	Lean manufacturing. The traditional application of lean principles to a company's manufacturing processes
MD	Managing director of a company
MDT	Medium distribution transformers
MRP	Material requirement planning. A core scheduling algorithm system that helps determine precisely the sales based on current inventory and forecasts.
Muda	Japanese term for waste. Identification and elimination of work is a critical aspect of lean system.
Poke-yoke	A Japanese term which is translated as a mistake-proofing device to prevent a defect during order taking or manufacture.
SDT	Small distribution transformers
Siiton	The factory layout should encourage and ease the house keeping process, which Toyota refers to All movable items, such as material boxes should have dedicated positions on line indicated by symbols or lines on the ground.
SME	The term means Small and Medium-sized Enterprises
SMEE	The term means Small Medium Engineering Enterprises

TPS

Toyota production system. The manufacturing principles of the Toyota motor corporation which are considered to be the practical foundation of lean manufacturing.

WIP

Work in progress or work in process. Unfinished goods which represent one type of inventory categorization.

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# CHAPTER ONE: INTRODUCTION

## 1.1 Introduction

Small and medium engineering enterprises (SMEEs) can play a key role in the economic development of a country. However, due to the competitive nature in the current dynamic manufacturing environment, it is difficult for SMEEs to survive if they are not innovative and competitive. Innovation is therefore important for SMEEs, particularly in their production processes. However, a production system is a complex process which involves various components such as management skills, leadership style, and knowledge generation.

Lean thinking as a management philosophy, as demonstrated in this work, if embedded into an organisational culture, will assist companies effectively in their production processes. It is hoped that the outcomes of this research will assist SMEEs to realise the significance of lean principles as part of their strategic planning in their manufacturing processes and thus ensure their sustainability.

## 1.2 Background of the study

Lean thinking is a highly evolved method of managing an organisation to improve the productivity, efficiency and quality of its products or service (Womack, 1990). The researcher has gained an understanding, by perusing case studies in the literature, of how lean thinking has assisted companies such as Toyota, Kodak Media, Shanghai VW, Koito Manufacturing, etc. to be successful when applying it in their manufacturing processes.

Even though the companies are referred to as small and medium engineering enterprises, according to the SMEE 2006 survey in South Africa, the SMEEs in the Western Cape Province contribute 14.47% to the country's gross domestic product (GDP). Since the SMEEs contribute such a high percentage towards the country's GDP, it is vital to ensure that they perform consistently well. A key aspect to good performance is good communication channels between management and employees.

The researcher works as a consultant in an engineering firm in the Western Cape and deals with a variety of different SMEEs. Over the past years, the researcher noticed that when some companies introduce or implement new systems, they do not always inform their employees properly. The changes are received with mixed feelings: some employees welcome them and

others express their unhappiness. This often leads to conflicts and eventually results in employees boycotting or even embarking on strike action. Once the employees participate in such events, it leads to the company's poor manufacturing output and lowers their standing in the market place. The study focuses on the effective utilisation of lean thinking, employee response to lean thinking and the overall benefits of lean thinking to organisations.

### **1.3 Problem statement and research questions**

The utilisation of the lean thinking principles by South African SMEEs in their production processes should bear the desirable effects of competitiveness and sustainability. The low morale and negative attitude of workers will have a negative influence on the smooth process of lean thinking implementations. This will result if employees feel undermined or not important to the organisation, or that their contributions to the company or even their ideas are unimportant.

Lean principles and practices are not restricted in production and operations management, but they can be used as a mindset or a way of thinking, fostering relationships in an environment of trust, respect and full employees' involvement. A number of tools and techniques have been developed to support the team philosophy, enabling organisations to apply the ideas and implement change.

This research was driven by the following questions:

- How did the particular SMEE apply lean thinking principles to their organisation?
- What were the responses of employees and management towards the implementation of lean principles in their production processes?

### **1.4 Aim and objectives**

The aim of this research was to evaluate the effectiveness of the application of lean thinking on production process at SMEE level. It also aimed at evaluating the benefits of lean thinking which the organisation gained in general.

This study's objective is to investigate the effects of lean thinking on production process within an SMEE. The response of the employees, their acceptance of the implementation, and the effective utilisation of lean thinking in the whole manufacturing process will be reviewed.

## 1.5 Significance of the research

Should the results of this study prove that the contributions made by implementing lean principles through employee involvement in elimination of waste, better inventory control, improved product quality, and better overall financial and operational control, are positive, then the study may be used as a tool or reference to encourage other organisations at SMEE level within the manufacturing sector, to also implement lean principles in their processes.

## 1.6 Layout of research report

This research consists of six chapters. *Chapter one* presents the following: the background to the study, the motivation for the research, the problem statement, the research questions, the research aims and objectives, and the significance of the research.

*Chapter two* contains a literature review on the important aspects of lean product manufacturing. The various lean principles and concepts, as quoted from various authors, are corroborated and discussed in detail.

*Chapter three* deals with research design and methods, specifically, highlighting the research instrument, the sample of the study, procedure, and data analysis. The triangulation method associated with questionnaires, the survey method, and the case-based study approach, was used.

*Chapter four* presents an overview of ABZ's operation with specific reference to the lean implementation on their production processes. It presents the analysis as a case study using the Likert scale method based on lean principles as developed in the literature review.

*Chapter five* discusses the processes in chronological order in which ABZ implemented lean principles. Various achievements following the successful lean implementation are highlighted to prove that lean has made positive improvements to ABZ. The author presents a modified organisational lean production model with determinants as adopted by ABZ.

*Chapter six* highlights the findings of the search based on the literature review and the case study. The author made recommendations to ABZ to implement other lean tools in order to have continuous improvement.

## **CHAPTER TWO: LITERATURE REVIEW**

### **2.1 Introduction**

This chapter provides an overview of the main components of lean thinking in the manufacturing process, with particular focus on tools applied for the success of the organisation. The employee involvement on the lean implementation process is reviewed, based on past case studies.

### **2.2 Definition and concepts of lean production/manufacturing and lean principles**

The definition and concepts below forms the framework of this study as the terms lean production, lean manufacturing and lean principles are used interchangeable by various authors.

#### **2.2.1 Lean production**

Ever since the introduction of 'lean', the concept of lean production has gained widespread attention, both in the literature and in practice. It has become a dominant strategy in organising production systems (Karlsson and Ahlstrom, 1996). Lean production is not only confined to the activities that take place in the process associated with the manufacturing function of a company, but it also relates to activities ranging from product development, to procurement and distribution to customers. The ultimate goal of implementing lean production in an organisation is mainly to increase productivity, enhance quality, shorten lead times, and reduce costs. In order to achieve this desired performance, the lean production determinants involve some actions to implement the principles, and the changes to the organisation.

#### **2.2.2 Lean principles**

Lean principles originated from a book by Womack and Jones (1990) entitled, *The Machine that changed the World*. The book explains the movement of automobile manufacturing from craft production to mass production to lean production. It tells the story of how Henry Ford standardised automobile parts and assembly techniques, so that low skilled workers and specialised machines could make cheap cars for the masses (Poppendieck, 2002).



The ideas of lean manufacturing are based within the Toyota production system's (TPS) approach towards the elimination of waste in every aspect of a company's operation.

Womack and Jones (1996) refer to lean production as 'lean' because it:

.....'uses less of everything compared with mass production; half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. It requires keeping far less needed inventories on site, resulting in fewer defects, and producing greater variety of product.'

There are five basic principles of lean thinking highlighted by Womack and Jones (1990) and classified here:

- Value
- The value stream
- Flow
- Pull
- Perfection

The lean principles contend that the organisation must view itself as just one part of an extended supply chain that needs to think strategically beyond its own boundaries. It also contends that, because value streams flow across several departments and functions within an organisation, it needs to be organised around its key value streams. Stretching beyond the company, it needs to manage the whole value stream for a product family, setting common improvement targets, rules for sharing the gains and effort and for designing waste out of future product generations.

Womack and Jones (1996) argue that lean principles can be applied to any organisation in any sector. Although the origins are firmly in an automotive production environment, the principles and techniques are transferable, with little adaptation. Jones and Mitchell (2006) quote the director of a team at Flinders Medical Centre in South Australia that adopted lean principles for just two and half years as saying, 'We have found that we can do 15 to 20 percent more work, offer a safer service, on the same budget, using the same infrastructure, staff and technology. Everything has improved; cost quality, delivery, service and staff morale.'

This example relates to one of the key principles of the Toyota system, which is respect for people and society. Lean is not only about headcount reductions. It is about being able to do

more with less effort, and improve patient care with the existing resources. Lean means the same things could be achieved using fewer people without making staff redundant, but simply that people and resources could be redeployed to create even more value and deliver better service at lower overall cost.

Poppendieck (2002) indicates that it is instructive to explore the origins of the slogan ‘Do it right the first time’. In the 1980s it was very difficult to change a mass-production plant to lean production, because in mass production, workers were not expected to take responsibility for the quality of the product. In principle, workers respond only when they know that management actually values their skills and is willing to delegate responsibility to them. Thus, the slogan ‘Do it right the first time’, encourages workers to feel responsible for the products moving down the line, and encourages them to stop the line and troubleshoot problems when and where they occur.

Emiliani (2004) defines lean as a management system which is designed to be responsive to the needs of humans in business and to deliver better outcomes for key stakeholders such as associates, suppliers, customers and community. The system is rooted in key principles, supported by simple processes and tools that are designed to help people improve productivity and consistently deliver the value that customers seek in the products and services they buy. The overarching lean principles and two key objectives are presented in Table 2.1 below (Womack and Jones, 1996).

**Table 2.1: Key lean principles and objectives**

		<b>Explanation</b>
Lean principles (Toyota, 2001)	Continuous improvement	Day-to-day activities performed to improve business processes in response to changing market conditions. Called “kaizen” in Japanese, which literally means “change for the better”, and is often interpreted as “continuous improvement”. Utilizes specific processes and tools to achieve improvements
	Respect for people	People (i.e. stakeholders such as associates, customer, suppliers, investors, and the community) are valuable resources to which a business owes its existence. Disrespecting people creates waste
Objectives	Eliminate waste	Eliminate activities and behaviors that add cost but do not add value as perceived by end-use customers. The original seven wastes are (Ohno, 1988): overproduction, waiting, transportation, processing, inventories, movement, and defects. The eighth waste is behavior (Emiliani, 1998a). Waste is called “muda” in Japanese. Important related concepts are the elimination of unevenness (“mura” in

		Japanese), and unreasonableness (“muri” in Japanese)
	Create value for end-use customer	Focus on the value-creating activities that end-use customers desire

[Source: Emiliani, 2004]

According to Emiliani (2005), some of the key processes and tools that are used in the lean management system in an organisation, help employees to eliminate waste and create value for the customers. A number of tools and techniques such as the *kodak operating system*, *TP* and *Kaizen*, have been developed to support the lean philosophy and enable organisations to apply the ideas and implement change.

### 2.2.2.1 The kodak operating system

The kodak operating system (KOS) was first introduced in 1999 as a manufacturing related improvement system utilising the principles of lean manufacturing. KOS’s main philosophy seeks to increase productivity and profitability through the elimination of waste (Penner, 2005).

Since the KOS is adopted from lean manufacturing, it follows the same trend and has stretched beyond the traditional manufacturing focus to other areas such as legal and sales and marketing. According to Penner (2005), the KOS mandate is to eliminate waste, by mainly focusing on three key areas: the customers, the process, and the employees.

In order to deliver value to the company, KOS must enhance customer loyalty and satisfaction at all times. Processes must be effectively optimised to eliminate waste, and provide quality and value to the end-user/customer. Employees must also be motivated to continuously engage in problem-solving, to understand and embrace the KOS philosophy, and to ensure that good results are delivered. The basic KOS philosophy, referred to lean, is to do more with less. Improve customer service and satisfaction, and improved quality and improved working conditions (Penner, 2005).

### A. Lean manufacturing

The term ‘lean manufacturing’ (LM) was developed by Taiichi Ohno at Toyota motor company in the 1950s, as the result of:

'Toyota's innovation to take the minds and hands philosophy of the craftsmen era, merging it with the work standardisation and adding the glue of teamwork for good measure' (Motwani, 2003).

In the 1990s, it was reused by Womack et al, in their historic book *The Machine that changed the World*. Womack and Jones continued their research in lean production and studied the transfer of other companies into lean. In their second book, *Lean Thinking* (Womack and Jones, 1996), they explain that lean manufacturing is much more than a technique; it is a way of thinking, and a whole system approach that creates a culture in which everyone in the organisation continuously strives to improve operations (Taj and Bero, 2006).

Lean means manufacturing without waste. Waste is anything other than a minimum amount of equipment, materials, parts, and working time that is absolutely wasteful in the value stream. The waste concept includes all possible defective work and activities, not only defective products (Taj, 2008).

Lean manufacturing is a viable method for making products because it is an effective tool for producing the ultimate goal – profit. To achieve this purpose, the primary goal of lean manufacturing is cost reduction, or, improvement of productivity. Costs are defined very broadly to include not only manufacturing costs, but also sales, administration and capital costs as presented:  $\text{Cost} + \text{Profit} = \text{Price}$  (Motwani, 2003).

Reviewing this traditional-thinking model by Penner (2005), one could use it to determine a product's selling price based on the production costs plus a given profit margin.

Alternatively, one could have a different view by expressing it as follows:

$\text{Price (fixed)} - \text{Cost} = \text{Profit}$

This model clearly relates cost reduction to increased profits. Hence, lean philosophy is to reduce operational costs and embrace the culture of 'doing more, with less'. The lean tools in manufacturing such as: value stream mapping, kaizen, five Ss, good house keeping, total productive maintenance, pull system, etc. are used to produce change. These lean manufacturing tools are explained in detail in Table 2.2.

**Table 2.2: Lean processes or tools**

<b>Lean process or tool</b>	<b>Explanation</b>
Five Ss	Stands for. sort, sweep, straighten, shine, sustain. Important for establishing an organized workplace
Just-in-time	Subsequent operation acquires parts (or information) from the preceding operation when needed, in the quantity needed
Kaizen	Literally means “change for the better”, also interpreted as “continuous improvement”. Process used to identify and eliminate waste
Lean behaviors	Apply lean principles and tools to improve leadership behaviors and eliminate behavioral waste (Emiliani, 1998a, b)
Load smoothing	Called “heijunka” in Japanese. Used to smoothe fluctuations in customer demand
Percent loading chart	A one-page diagram depicting the cycle time between operations or workers compared to the rate of customer demand. Helps identify workload imbalances
Policy deployment	Called “hoshin kanri” in Japanese. A process used to connect corporate strategy to key objectives and resources, including daily activities across functions
Quality function deployment (“voice of the customer”)	A process used to incorporate the wants and desires of intermediate and end-use customer in the design of goods and services
Root cause analysis	Methods used to determine the root cause of a problem and identify countermeasures to avoid repeat occurrences. Key tools are “five Whys” (asking why five or more times until the root cause of the problem is discovered) and fishbone or cause-and effect diagram
Standard work chart	A one-page diagram showing the sequence in which work is performed
Talk time	The rate of customer demand. Used to establish a direct link between marketplace demand and workplace activities
Total productive maintenance	A program used to ensure equipment is in good operating condition and available for use when needed
Value stream maps	A one-page visual representation of material and information flows. Used to identify improvement opportunities and eliminates waste
Visual controls	Signs and other forms of visual information used to simplify the workplace and make it easy to recognize abnormalities

[Source: Emiliani, 2004]

Organizations that have successfully implemented lean thinking have realised that on the journey to lean, almost all the tools in the lean toolbox need to be used as they are all linked to one other (Penner, 2005).

Penner (2005) states that the Toyota motor corporation, through its successful application of LM principles known as the Toyota production system, became one of the world's major automobile manufacturers. The Toyota production system (TPS) is, perhaps, the most widely published collection of visual systems in the world. TPS provides for manufacturing the necessary quantity of the necessary item at the necessary time (Kasul and Motwani, 1997). The following section will begin by examining the success of the Toyota production system, the practical foundation of lean manufacturing (LM) in production process.

### **2.2.2.2 Toyota production system**

To survive amidst severe competition and economic conditions such as shortage of material, financial and human resources in Japan following the end of World War Two, the Toyota motor company introduced the concept of manufacturing best practices, in order to increase production and quality management that would later become known as 'Toyota production system' (TPS) or (LM). TPS is a hands-on approach to following a company's material and information flow. It uses a large amount of listening and observing in following the different stages in which a company's material and information are involved (Motwani, 2005).

According to Penner (2005), a better understanding of TPS can be obtained by considering what is known as the 'House of lean production'. Figure 2.1 is an illustration of the system with standardisation and stability as the foundation, while customer focus serves as its apex. The companies that implement TPS employ a highly integrated system that results in reduced lead times, just-in-time management, decreased costs, levelled production, continuous flow production, increased job satisfaction for employees, higher productivity, lower inventories and higher quality levels (Kasul and Motwani, 1997). This is achieved by eliminating waste and implementing process cost reduction.

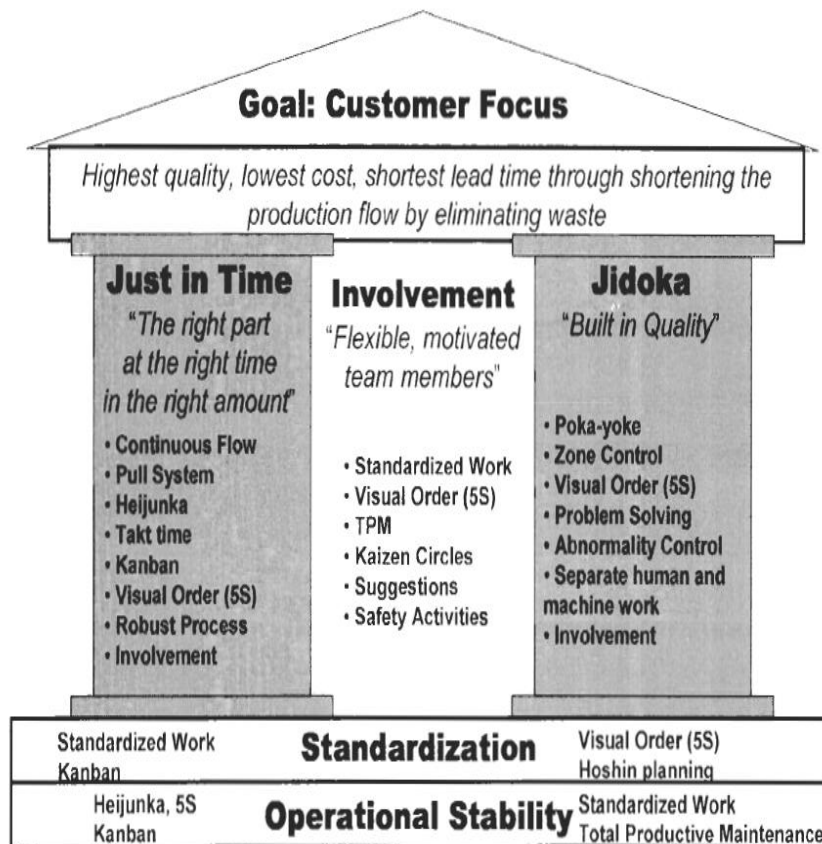


Figure 2.1 The Toyota production system – House of lean production

[Source: Penner, 2005]

### A. Just-in-time (JIT) system

JIT system is a key aspect in an organisation that needs to eliminate waste. It can be referred to as a management philosophy and not a technique. The system was originally referred to the production of goods to meet customer demand, in time, quality and quantity; whether the customer was the final purchaser of the product or simply another process further along the production line.

The principle of just-in time implies that each process should be provided with the right part, in the right quantity at exactly the right point in time (Karlsson and Ahlstrom, 1996). The ultimate goal is that every process should be provided with one part at a time, exactly when that part is needed. This process translates into the meaning of producing with minimum waste. Waste is taken in its most general sense and includes time and resources as well as materials.

The JIT system can be further developed in a method that is called continuous improvement or *kaizen* approach, (Rawabdeh, 2005). The *kaizen* approach is based on three specific ground

rules: house keeping, standardisation, and waste elimination. JIT works on the principle of small-lot production and delivery. In addition to reduction in product cycle time, JIT is effective in reducing storage areas, which eliminates the need for additional inappropriate space.

The JIT philosophy was developed and perfected within the Toyota manufacturing plants by Taiichi Ohno, as a means of meeting consumer demands on time. JIT manufacturing has the capacity, when properly adapted to an organisation, to substantially strengthen the company's competitiveness in the marketplace, by reducing wastes and improving product quality and efficiency of production. Ahlstrom (1996) indicates that the important determinants of JIT are: reducing lot sizes, reducing buffer sizes, and reducing order lead time.

### ***B. Elimination of waste***

The key aspect of LM is the elimination of waste, or *Muda*. Waste can be defined as anything other than the minimum amount of resources which are absolutely essential to add value to the product.

Rawabdeh (2005) defines waste as anything other than the minimum amount of equipment, materials, parts, space, and workers' time, which are essential to add value to the product or service. The waste concept includes all possible defective work and activities, not only defective products, and can be classified in seven categories in the Toyota production system. However, Penner (2005) argues that the recent thinking includes the misappropriation of knowledge or resources as an eighth waste.

**Table 2.3: The eight wastes in lean manufacturing**

Motion	Movement of people that does not add value
Waiting	Idle time created when material, information, people or equipment are not ready
Correction	Work that contains defects, errors, re-work mistakes or lacks something necessary
Over-processing	Effort that adds no value from the customer's viewpoint
Over-production	Producing more than the customer needs right now
Transportation	Movement of product that does not add value
Inventories	More materials, parts or products on hand than the customer needs
Knowledge	People doing the work are not confident about the best way to perform tasks

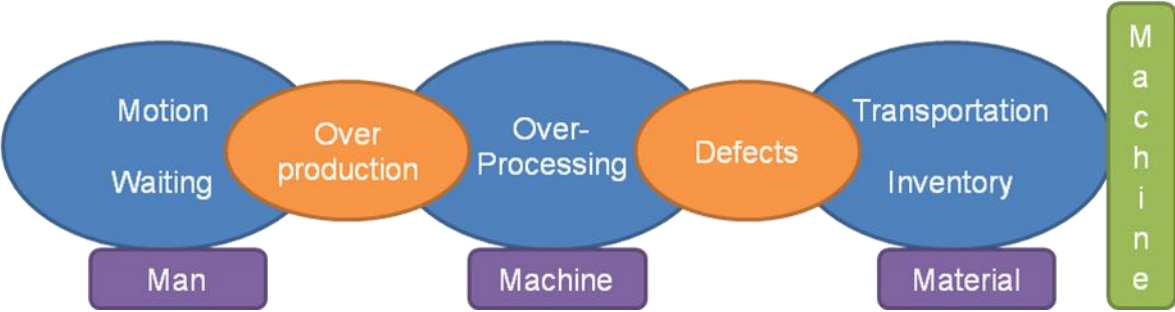
[Source: Taj and Berro, 2006]



It is acknowledged that the implementation of JIT is one of the major factors contributing to the success achieved in the international competitiveness of Japanese manufacturing firms in the last two decades (Rawabdeh, 2005). JIT has helped companies to improve their overall performance, by means of checking practices at all levels of the organisation, such as eliminating no-activities, and reducing inventories, motions, defects, waiting and overproduction. Thus, the JIT system is defined as the eliminator of waste in an organisation.

Rawabdeh (2005) emphasised that the eight wastes can also be categorised into three main groups related to: Man, Machine, and Material by means of activities as conditions that affect the fourth, namely, Money. The money-group contains the concepts of motion, waiting and overproduction; the machine-group contains over-processing waste; and the material-group contains transportation, inventory and defects waste.

The classification of these wastes and how they affect or overlap each other are demonstrated in Figure 2.2.



**Figure 2.2 The three categories of waste and their effect on money**

**C. Standardisation**

The idea of standardisation is part of waste elimination in manufacturing process. According to Penner (2005), the idea goes back to Henry Ford and the creation of the assembly line. The main goal is to create an efficient production sequence that emphasises human motion and eliminates waste. This should ensure a focus around human movements, standardised work lines, and efficient and safer work methods that help eliminate waste while maintaining quality.

Kasul and Motwani (1997) believes that if the standardisation method is implemented successfully, the expected results would include:

- Maintaining higher quality
- Providing safer and more efficient operations
- Ensuring proper use of equipment and machinery
- Facilitating problem solving
- Providing a tool for line balancing.

The system also establishes the work sequence, measures the cycle time for that work sequence, calculates the takt time (synchronised process speed), and compares the cycling time against the required takt time.

- ***Takt time***

Takt time is the time required to produce a single component or entire product based on sold product; it can also be referred to as the rate at which customers are buying products from the production line. Takt time is calculated by taking the total available production time divided by the total production requirement:

Takt time = operable time/ day (seconds)

Required number of pieces/day

Actual manning  $\leq \frac{\text{Total cycle time}}{\text{Takt time}}$

Takt times are usually indicated at each work centre and are understood to mean an hourly requirement of parts to meet the shipping schedule (Kasul and Motwani 1997).

#### ***D. Jikoda***

Jikoda is defined as a system that ensures that a defect-free product is passed from one operation to the next. Quality is designed into the operation beginning at the product/equipment design phase and utilising prevention techniques. The two common prevention techniques are *pokayoke* and *andon*.

*Pokayoke* is an element of the process that senses a defect or non-conformance and will not allow the process to proceed. Some examples of the *pokayoke* include fixture featuring that will not accept an out-of-spec part, sensing that checks for parts or features from previous

operations, or sensing/clamping in the process that will not release a part if it is not properly processed (Kasul and Motwani, 1997).

*Andons* are the visual displays such as lights and flags, which indicate the operating status of a work centre. For instance, a green light may indicate that a cell is on schedule and is meeting takt time, a yellow light may indicate a cell is behind schedule or that an operator is calling for help with a problem, and a red light may indicate a cell has been stopped.

### ***E. Continuous flow/ improvement***

This method of a production system is designed to increase constant improvement with a focus on the quality of product. The use of this idea will easily be able to address the fundamental problems in product manufacturing and has the ability to expose anything that does not add value to the product. The ultimate goal of the method, when engaged in an organisation, will likely strive for process simplicity. It is believed that when the system is simple, it can be more easily understood by all employees – the manager can undoubtedly have no difficulty in managing it, and production should be less likely to suffer.

Continuous improvement is reflected as quality control at source, meaning that each employee is responsible for the quality of his/her work out-put. It also implies that machinery and equipment are being checked and repaired timeously, resulting in smooth production flow at all times. If there are some areas within the system that are not functioning to the satisfaction of the production team, changes can be made without totally interrupting the production flow.

### ***F. Pull system***

'Pull' describes the philosophy of 'make' or 'move' an item only when needed, or more formally, the pull system which typically utilises the *kanban* system as a signaling device. In the manufacturing environment, each operation is considered to be the customer of the preceding operation. The 'pull' system can also be treated like a customer's order. In a pull system environment, items are not processed without a customer order, in other words, a pull signal. Thus items are made or moved 'just in time'. The system is closely related to the principle of JIT in the way in which materials are scheduled, through "pull" instead of "push", Karlsson and Ahlstrom (1996).

## **G. Kanban system**

*Kanban* is a scheduling system of production instructions. It is used to control inventories by keeping the level to a minimum and adjusting to changes according to demand. This system creates a balanced work load within the production line because, when the components are being used, it immediately sends an instruction to replenish used components and therefore the withdrawal of components triggers the feeding process to produce more, thus withdrawing components from other feeding operations.

The essence of the kanban concept is that the supplier or the warehouse should only deliver components to the production line as and when they are needed, so that there is no storage in the production area, thus inventories are minimised. Many authors have acknowledged that, when implementing this lean tool, their organisation has seen a significant reduction in material handling cost as fewer inventories are kept. Within this system, work stations located along production lines only produce or deliver desired components when they receive a signal indicating that more parts will be needed in production.

Since kanban is a chain process in which orders flow from one process to another, the production or delivery of components is pulled to the production line. This is in contrast to the traditional forecasting oriented method, where parts are pushed to the line. The rationale regarding kanban is that the concept takes form on the shop floor, in close interaction between the work force and management. Kanban will not work effectively without efficient logistics systems and process-oriented plant layouts. The system controlled production, and the kanban itself, must be able to flow smoothly between processes. The modular/cell manufacturing should be realised by U-shaped process lines, which integrate the manufacturing process into a continuous flow and increase supply accessibility to the lines.

The benefits of the kanban system are that it puts limits on inventory build up. When the system is full, no additional product can be made or removed into that location. Putting limits on inventory has some benefits such as; less cash is tied up, less space and less handling damage. Reduction of work-in-process (WIP) inventory has the additional benefits of reducing the products' lead time. Other kanban benefits are as follows:

- Kanban card indicates standard quantity of production
- Kanban maintains discipline of pull production

- Once implemented, the kanban system acts as a control system rather than a scheduling system
- It implements a repetitive schedule embedded in the system
- It can be generated by a scheduling algorithm
- Simulation can be used to determine the number of kanbans, queue size, and so on.

## H. 5S

The 5S system was implemented to provide a *de facto* standardised house keeping protocol amongst manufacturing operations. Standardisation and organisation through the 5S process also re-enforces the stability within the lean manufacturing methodology. The 5S activities are both continuous and sequential in their application and, in order to achieve a real value from the system, it is necessary to implement all five activities in the process. Table 2.4 provides a list of the 5S in both Japanese and English and their brief descriptions.

**Table 2.4: The 5S system in Japanese and English**

S1	Seiri	Sort	Separate and eliminate unneeded items
S2	Seiton	Straighten or Set-in-order	Compare 'what it is' with ' what it could be' Arrange layouts to minimize time and effort
S3	Seiso	Shine or Scrub	Keep the machine and workplace clean
S4	Seiketsu	Standardise	Use simple visual standards to highlight when things are amiss
S5	Shitsuke	Sustain	Through self-discipline, maintain and promote Five S

[Source: Penner, 2005]

The 5S process begins by *sorting*, which is mainly accompanied by activities in which unneeded items are marked for removal.

*Setting in order* helps improve the process flow, eliminate waste and move the system forward to a new improved state. A clean workplace helps promote a safe and positive environment, hence *shining* is a key of 5S. A clean workplace also makes it easier to identify abnormal conditions such as a leaky piece of machinery, unsafe work area and hazardous conditions. .

*Standardisation* is regarded as the best activity achieved through the use of clear, simple and visual standards (Penner, 2005). The standardised activity must be tied into the *sustain* aspect of 5S, which must be rooted within the corporate culture.

### ***I. Good house keeping***

In order to facilitate the logistic process of quickly moving material to numerous work stations on the production line, a clean and well organised environment is required. However, such a workplace increases safety, employee well-being and productivity. In addition to the duties directly related to working on the line, team members should be responsible for keeping their stations neat and clean and keeping tools in good condition. Production down time is often dedicated to house keeping activities.

More importantly, the factory layout should encourage and ease the house keeping process, which Toyota refers to as *siton*. All movable items, such as material boxes, should have dedicated positions on line indicated by symbols or lines on the ground.

### **2.2.2.3 Kaizen system**

Competitive market places require people at all levels in an organisation to think of ways to continuously improve the products or services that they deliver to the customer. Emiliani (2005) refers to this process used as *kaizen*, a Japanese word that means 'change for the better', and is also interpreted as 'continuous improvement'. The *kaizen* stands for *kai* (change) and *zen* (good).

Emiliani (2005) described the *kaizen* as often, incorrectly, solely associated with quality improvement, such as fewer defects or conformance to requirements, and is often poorly defined. The phrase 'change for the better' implies any change that results in improvement, which could be related to quality or other factors that customers judge to be of value. The *kaizen* process utilises various tools and methods to make the problem visible, and then uses formal root cause analysis and other means to identify and correct the problem at the source (Emiliani, 2005). This result in rapid improvement, lower cost, high quality and better product or service.

### **2.2.2.4 Material requirement planning system (MRP)**

Inventories are a significant portion of the current assets of any business enterprise. Inaccuracies in an inventory create a range of problems including: loss of productivity, the

manufacturing of unwanted items, reduction in the levels of customer commitment, the accumulation of costly physical inventories, and frustration (Rajeev, 2008)

The MRP modules take the guesswork out of purchasing, by automatically calculating material requirements and coordinating purchase orders and production orders for timely receipt. The system can also easily pinpoint the unrealistic manufacturing plans, which may arise when there is not enough time to manufacture an intermediate for a target production date, or if a supplier is unlikely to deliver materials by the time they are required. Petroni (2002) acknowledges that, despite the effectiveness and importance of having the MRP system in an organisation, there are still many problems involved in the effective running of MRP and there is a general lack of confidence in the system.

Petroni (2002) states that one of the principal reasons why MRP and other large technologically sophisticated systems fail, is that organisations simply underestimate the extent to which they have to change in order to accommodate their purchases. The effective management of technological change requires transformational leadership.

Successful MRP implementation in an organisation has many benefits. The benefits associated with the implementation of the system can be measured both in terms of enhanced performance and user satisfaction.

Petroni (2002) revealed a number of dimensional benefits of the MRP system, as follows:

- Better ability to meet volume/product change
- Better capacity planning
- Better cost estimates
- Better inventory control
- Better meeting of delivery promises
- Better production scheduling
- Higher inventory rotation
- Improved co-operation between managers and employees
- Improved co-ordination with finance
- Improved co-ordination with marketing and sales departments
- Improved employee job satisfactory
- Improved employee morale
- Improved personnel ability to perform own job
- Improved product quality

- Improved productivity
- Reduced expediting costs
- Reduced cost (material)
- Reduced delivery lead times
- Reduced inventory cost (supervising and controlling)
- Reduced manpower costs
- Reduced lead times
- Reduced overtime
- Reduced safety stock

The above benefits include both physical indicators (i.e. throughput), cost information (i.e. lead times), and organisation achievements (i.e. co-ordination).

#### **2.2.2.5 The supermarket**

A supermarket is a buffer or storage area located at the end of the production process, for products that are ready to be shipped. The reason for this is, if producing directly to shipping, only the units that are ready to be shipped are produced.

If the supermarket is nearing full level, it is switched to satisfy other products types until the time of the next order for transformer products is reached. In doing so, it prevents producing more than the capacity of the supermarket and also satisfies requirements for other product types.

The introduction of a supermarket that is controlled by a kanban system forces the entire production process to pace every work station to the speed of the bottlenecks.

### **2.3 The benefits of lean implementation**

In an organisation, the implementation of lean principles brings, among others, these benefits;

- Improved quality and safety – fewer mistakes, accidents and errors, resulting in better service
- Improved delivery – better work gets done soon
- Improved throughput – the same people, using the same equipment, find they are capable of achieving much more
- Accelerating momentum – a stable working environment with clear, standardised procedures creates the foundations for constant improvements



An article by National Research Council Canada (2004) added that lean production cuts cost and inventories and rapidly frees cash, which is crucial in a slow economy. It also supports growth by improving productivity and quality, reducing lead times and freeing huge amounts of resources.

In a manufacturing plant, lean production frees office and plant space, and can increase capacity, thereby enabling products without acquiring new facilities. Womack (1990) supported this by stating that lean thinking is a well-established, proven way to deliver sustainable improvements through an organisation. It can bring about quantifiable increases in productivity, efficiency and quality and help to make the company truly world class. Koenigsaecker (2005) stated that a lean company has a much higher inventory turnover, often lower receivables, and better fixed-capital efficiency. Capital efficiency rises because early work tends to double output per capital profits by using equipment better; and advanced lean work redesigns processes so that they fit lean requirements.

An article presented by Jacobs and Yan (2008) at the International Academy of African Business and Development (IAABD), conference supports the above statements by saying, 'if lean is implemented successfully; a company's productivity does improve. It also betters a customer focus, increases asset efficiency and increases profitability, including reduced scrap and rework, cutting down of costs and shorten period of 'lead times'.

## **2.4 Conclusion**

The literature review has revealed that lean is a fundamental transformation of an enterprise and needs to be approached as a total organisational and cultural transformation. The lean methods can potentially assist organisations to eliminated waste, reduce inventories, improve productivity, reduce cost, increase product quality, place a company in a competitive edge and increase workers' morale.

## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.1 Case study**

Yin (1994) defines a case study as an 'empirical inquiry that investigates a contemporary phenomenon within some real-life context'. The case study research methodology is described by Einshardt (1989) as 'particularly well suited to research area for which existing theory seems inadequate'.

Aamodt and Plaza (1994) advise that this type of research goes beyond testing the original model and actually leads to finding new variables and associations which can be subsequently used to build on or depart from the original model, thus by implication a case study research method is the most appropriate.

The Likert scale was applied as a research method because of its flexibility, ease of implementation, and its offer of a near limitless range of data with reliable results. The data gathered provided a detailed insight into this particular study as the information is directly from individuals who are affected by the lean programme. The Likert scale is often used to gather extensive data regarding the perceptions of participants and it can ensure the consistent collection of data because all respondents received exactly the same questions in exactly the same way (Likert, 1967).

### **3.2 Research setting**

The research design is employed in this study. The data were collected from a medium –sized engineering firm in the Western Cape, which has implemented lean principles in its manufacturing processes.

The term Small Medium Engineering Enterprise or 'SMEE' covers a variety of definitions and measures. SMEEs are usually defined as firms with fewer than 500 employees, although a number of countries use a lower cut-off point of 300, employees (Wu, 2003). It is important to define the SMEE economy in South Africa, which is segmented into three sectors. For the purpose of this research, the sector and class for our focus area have been highlighted.

**Table 3.1: The classification of sectors in South Africa**

<b>Sector</b>	<b>Size or classification</b>	<b>Total full-time employees</b>	<b>Total turnover</b>	<b>Total gross asset value</b>
Mining and quarrying	Medium	200	R39m	R23m
	Small	50	R10m	R6m
	Micro	5	R0.20m	R0.10m
<b>Manufacturing</b>	<b>Medium</b>	<b>200</b>	<b>R51m</b>	<b>R19m</b>
	<b>Small</b>	<b>50</b>	<b>R13m</b>	<b>R5m</b>
	Micro	5	R0.20m	R0.10m
Construction	Medium	200	R26m	R5m
	Small	50	R6m	R1m
	Very small	5	R0.20m	R0.10m

The manufacturing industry served as the prime industry for the analysis. The manufacturing sector was chosen for this study because of the variety of work activities that are lean implementable.

### **3.3 Survey approach (interviews)**

A preliminary survey instrument was designed to measure the variables of interest. Site visits were done by the researcher in order to provide an insight beyond the theoretical questionnaires. The preliminary questionnaire was sent to the plant personnel at least one week prior to the visits so that the respondents could have time for their response.

The interviews conducted at the Cape Town factory of ABZ were semi-structured. The people who were involved in the lean implementation, as well as those who were familiar with lean implementation, were interviewed.

The data required for this study were collected from people whose primary responsibility involved production scheduling and material management, and also from senior management and shop floor workers. The intention of this was to get a broader view of the reception of the change and its effect to the organisation. Below is a list of senior management and shop floor staff interviewed, who were part of the lean implementation change within the company.

**Table 3.2: A list of interviewees at ABZ**

<b>Interviewee</b>	<b>Position</b>
Mr A	Managing director
Mr B	General manager
Mr C	Planning manager
Mr D	Planning assistant
Mr E	Production manager
Mr F	Supply chain manager
Mr G	Supply chain assistant
Mr H	Supply chain assistant
Mr I	Production assistant
Mr J	Production assistant
Mr K	Shop floor staff
Mr L	Shop floor staff
Mr M	Shop floor staff

### **3.4 Measurements**

The measures investigated in this study were developed largely based on an extensive literature review and the researcher's visits to the plant. Some questions were borrowed from previous case studies, while most were designed by the researcher to meet the particular study objectives.

The questionnaire consisted of two parts: part one comprised a personal profile of the respondent and general qualitative questions, and part two related to respondents' decision-making mechanisms. Regarding the personal profile, the respondents completed information about their gender, age, number of years at ABZ, and level of responsibility ABZ. General qualitative questions consisted of individual knowledge and experience of the lean implementation process, and the decision-making part consisted of several questions to which the respondents had to reply within a coding method.

The scoring code signified the following: SA - strongly agree, A - agree, DN - do not know, DA - disagree and SDA - strongly disagree. These abbreviations were in separate boxes and respondent indicated their choice by circling the box. There was a space for comments below the box.

The scoring code was used to allow the interviewees to use their judgment as to how they perceived the lean change in relation to the given statement. This was a subjective weighing done by the author in order to assess the responses received from the interviewees. The fact that the questionnaire was based on general lean factors lead to the assumption that all the subjects would receive 'strongly agree' as expressing favour towards the attitude statements, rather than 'agree' and 'strongly disagree'.

The survey questionnaires were given to managers, supervisors, and shop floor workers. All of them received the same questionnaire; a sample is shown in Appendix A.

### **3.5 Desk research**

Desk research involved the analysis of data provided by the organisation, for example memos, present and future state maps, as well as information on ownership structure, organisational structure and other information relating to lean implementation, that was sourced from management's PowerPoint presentations and the company website.

### **3.6 Data analysis**

In conducting the analysis, the multiple sources of data were used to collectively prepare a chronology of events leading to the lean implementation and the period during lean implementation. Once the data had been collected, the researcher applied the principle of Mouton (2001), which states that to satisfy the information needs of any study or research project, an appropriate methodology and suitable tools for data and data analysis should be selected.

The interviewees were requested to rank their responses to the questions according to the Likert scale format. This method enabled the author to measure the responses based on the attitude and preference to either the positive or negative given statement.

The quantitative data collected were coded into a format representation, such as gender, age, years of experience and level of responsibility. The responses from the participants' statements were used to test the presence of lean principles as identified in the literature review and also to identify the actual outcomes of the implementation. In analysing the responses, the author was able to test for the presence of lean in the organisation, as presented in the outcome of the questionnaire in chapter four.

### **3.7 Ethical appraisal**

The interviewees were initially informed of the purpose of the study and requested to only respond against the background of lean knowledge in the organisation.

The researcher signed a confidentiality agreement with the organisation prior to engagement with any of the employees. The questionnaire analysis and organisation data were kept confidential and anonymity of participants was maintained throughout the execution of this work. The information/data collected were used solely for the purpose of research and may not be shared with anyone without the authority of ABZ.

## **CHAPTER FOUR: CASE DESCRIPTION AND ANALYSIS – LEAN PRINCIPLES AT ABZ**

### **4.1 Introduction**

This chapter discusses the factors that led to the selection of the company ABZ as appropriate for this case study. It examines the history of ABZ and various developments pertaining to the implementation of lean principles within ABZ. The author also introduces a model by Karlsson and Ahlstrom (1996) that is being used to test the extent to which ABZ has applied lean principles in their processes. The research questionnaires used for data collection and their analysis are presented in this chapter.

### **4.2 Background to the case study at ABZ**

ABZ is a transformer supplier of electronic-mechanical components to various customers across South Africa. The ABZ group is comprised of three operating plants situated in [\*.....\*.....\*.....\*.....\*.....].

A case study was conducted by the author at ABZ's [\*.....\*.....] plant. This particular plant comprises the manufacturing division of the company, which is organized around customer groups based on the manufacturing process and supported from the main office in [\*.....].

### **4.3 Factors leading to the use of the organisation as a case study**

The organisation was chosen following a search for a suitable organisation for the purpose of the study. The criteria for the study were: an organisation that had implemented lean principles, or an organisation that was in the process of implementing lean principles in their production/manufacturing processes.

A number of organisations were contacted requesting their permission to conduct a study. The organisations approached were as follows:

*\* The location blanked for confidentiality purposes.*

Organisation A accepted the request, but near to the time of the author's visit, the manager responsible for lean requested a postponement. The visit to the organisation was never materialised.

Organisation B indicated that they had implemented lean principles in the company's various sections but could not help as they did not have sufficient staff to allocate their time for this research.

Organisation C accepted the request for a case study. The author investigated the factory and in the process of reviewing the lean principles that the organisation had implemented, it was noted that the management did not have sufficient knowledge of lean principles and therefore their information would not be beneficial for the intended research.

Organisation D promised that they would contact the author to arrange a suitable date and time but they did not. Numerous follow-up calls and emails were unanswered.

Organisation E (ABZ) was initially reluctant to assist, but eventually agreed on condition that the outcome of this study would benefit their organisation by pointing out areas that need improvement and recommending applicable tools to do so.

#### **4.4 ABZ background, products, culture and objectives**

The background information on ABZ was extracted from the company's website and is summarised as follows:

ABZ originated in 1953 when [\*.....] was founded. The organisation is co-owned by the Holding Group No2 and Holding Group No1 through its subsidiary No1 as indicated on the matrix structure in Figure 4.1. Holding Group No2 is a global company in power and automation technologies, while Holding Group No1 is a group of high-technology organisations operating in the telecommunications, information technology, power electronics and multi-media industries.

In 1999, ABZ became the first Black economic empowered (BEE) transformers manufacturer through the partnership with Parent No1, Parent No2 and its subsidiary No2. The company was subsequently renamed ABZ.

In 2001, ABZ purchased [\*.....\*.....\*.....] division, based in plant No2.



ABZ regards itself as the country's largest and most experienced manufacturer of power distribution products. Its products were designed, tried and tested under the harshest of African conditions, and have proven to be robust and reliable for more than fifty years. The products are manufactured under national and international standards to meet the needs of local conditions. In the beginning of 2003, ABZ's management made a decision to transform the organisation from the traditional approach of manufacturing transformers to the lean manufacturing approach. The move was made in order to enhance the performance in some specific areas of the business, such as quality, inventory management and on-time delivery to the customers.

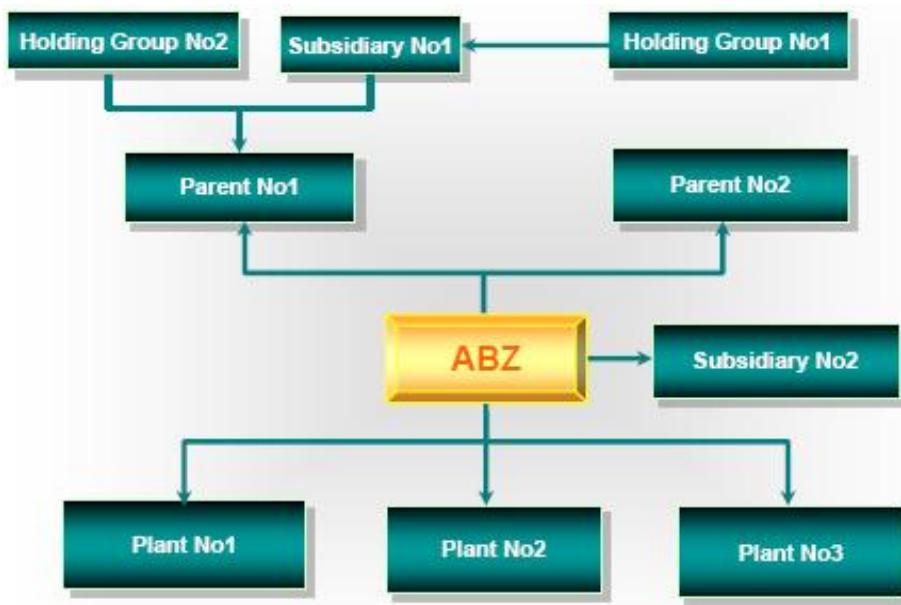
ABZ, as one of the leading BEE transformer manufacturers in the country, had to attend to these areas, aiming to enhance the organisation's reputation to its customers. Being co-owned by two respected corporate organisations (the Holding Group No2 and Holding Group No1), ABZ needed to take this leading step in the industry.

#### **4.5 Company structure**

ABZ continues to innovate and keep up with technology trends. With the backing of the major Southern African Subsidiary No1, a wholly owned subsidiary of the JSE listed Holding Group No1, ABZ has continued access to leading technology developments and expertise.

The empowerment arm of ABZ is through Parent No2 a 100% black owned organisation.

- Subsidiary No1, a wholly owned subsidiary of Holding Group No1, owns 50% of Parent No1
- Holding Group No2 owns 50% of parent No1
- Parent No1 holds 74.95% share in ABZ
- Parent No2 holds 25.05% share in ABZ
- ABZ holds 37.5% share in subsidiary No2



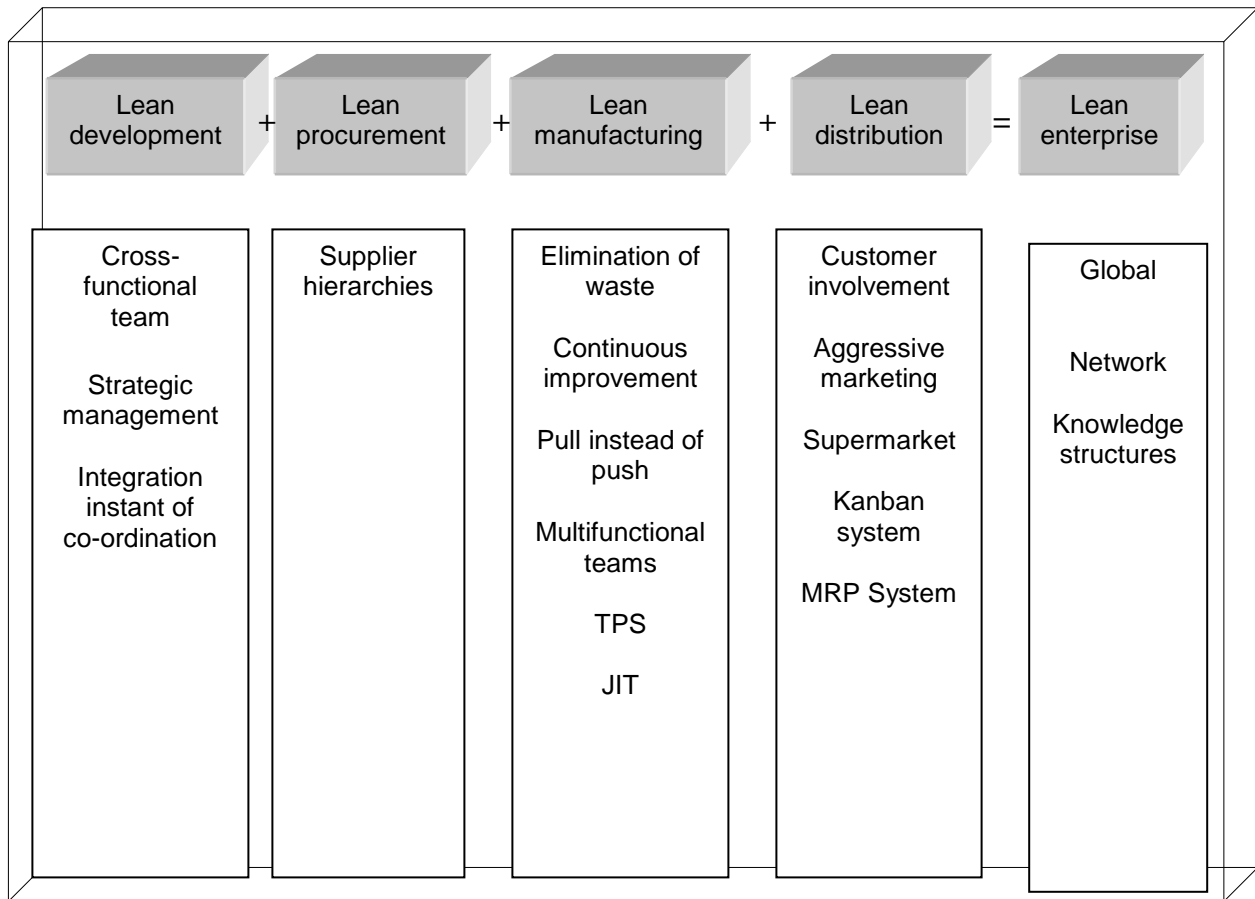
**Figure 4.1 Matrix structure of ABZ**

[Source: Khomo & Maharaj, 2004]

#### **4.6 The review of ABZ operations**

During this study it became apparent that the measurements of ABZ’s manufacturing processes had to be benchmarked against a known or recommended standard.

Figure 4.2 represents the organisational lean production model chosen by the author as the benchmark against which ABZ was to be measured. This model spans different functional areas, however the focus in this study was on the manufacturing function of the organisation.



**Figure 4.2 Overview of lean principles model**

*The organizational lean production model (Karlsson, 1996)*

The model by Karlsson represents the operational determinants of a lean production system. The study at ABZ aims at identifying how many of the principles shown in Karlsson's model have been implemented and the consequences of their implementation.

#### **4.7 Factors that led ABZ to implement lean principles in their processes**

ABZ was experiencing numerous production challenges such as, not adhering to its lead time delivery schedules, a high rate of product returns related to quality, and increasing inventory levels within the factory (Khomu & Maharaj, 2004).

The lead times for some products were overdue by up to three months, which had implications for the organisation, such as:

- The company's market share in the industry was dropping.

- The quality returns from customers was up to thirty percent.
- The inventory levels were high and waste was on an increase.
- The factory's profitability was low.
- Stress levels amongst the staff were high and a blame culture had surfaced.
- The transformer market was becoming more competitive with new players having entered the market.

#### **4.8 Introduction of lean at ABZ**

ABZ adopted lean in their organisation, because it is one of the routes which an organisation may take towards achieving a world class manufacturing level. In the modern manufacturing arenas, low cost and high quality are taken for granted as being essential to the competitive success of an organisation.

The new managing director (MD) joined ABZ in 2003. The MD came from a project environment to a manufacturing environment. The mandate given to the MD on his arrival by the holding group No2, was that all operations within his management should 'go the world class manufacturing route'. This was in line with the group's strategy of reducing cost by manufacturing differently (Khomu & Maharaj, 2004).

The MD introduced the lean manufacturing concept to the organisation's board of directors. It was agreed that he would champion this concept as part of his management role. The MD emphasised that the introduction of lean principles was the only way to achieve the desired goals. This move proved to be very fruitful during and after the implementation stage. The management, employees and the union were brought on board at the early stages of transformation, and briefed on the company's intentions.

The changes were made clear to all the personnel, as what was going to happen and how it would affect each of them. This included everyone working at the factory, from cleaners to drivers and managers. The reason for the change was explained them, and everyone was reassured that their jobs were not under threat.

Prior to the transformation, all employees from senior management to the shop floor staff were trained on lean concepts. During this time, the MD recognised that the previous managing director had managed the factory in an autocratic manner, where employees were merely given instructions on what to do and had no say. This prompted the new MD to create an environment for innovation and idea generation from all stakeholders, in order to improve the factory operations. The detailed information on the lean training programmes is explained in 5.1.2.

#### **4.8.1 The product matrix at ABZ**

The organisation's products are divided into three categories based on their size and level of specific design. Most of the small transformers up to 100kVA (SDT) are of standard design and can be manufactured at high speed. The middle range transformers up to 1000kVA (MDT) require some detailed design and customisation. The larger transformers up to 40MVA (LDT) all have unique designs as they are specific to the customer's needs. These products also require a longer manufacturing time due to an extra process of drying that utilises a larger drier; this is a different manufacturing process from other products' processes.

As part of the plan of going lean, it was decided to divide the manufacturing plant into three product lines. This was to determine which product would be included in the high speed standardised line (SDT type products). The standardised products were of similar design and did not require much input from the engineering design team.

Management saw the opportunity to start the lean concept on the standard product line (SDT), as this would make it easy to see the impact of change and the targets could be achieved quickly.

#### **4.9 Meeting with management during interviews**

The author had several meetings with the managing director (MD) during visits to the ABZ plant. On the second visit, the MD introduced the author to the general manager (GM) who took the author throughout the plant and explained various processes; this occasion gave the author a better understanding of ABZ's operations.

On follow-up visits, the author was introduced to other senior managers and respective supervisors. The author conducted personal interviews with each senior manager regarding lean implementation at ABZ. The visits to ABZ helped the author to develop some of the items in the questionnaire, based on observations in the plant and information received during interviews.

#### **4.10 Collection of data from employees and analysis of responses**

*In trying to answer the author's research question 'what are the responses of employees and management towards the implementation of lean principles in their production processes?'*

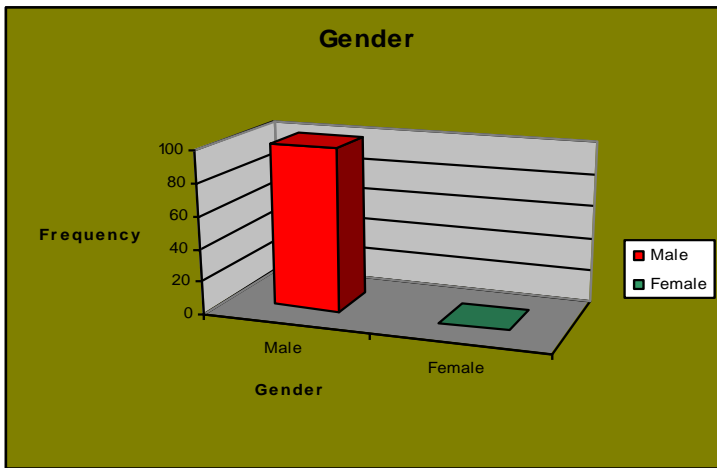
The author took the questionnaire to ABZ and distributed it to senior managers, who in turn helped to distribute same to relevant shop floor workers. The outcome of the questionnaire was as follows:

#### 4.10.1 Part one: Descriptive statistics of the sample

The biographical characteristics of the respondents are presented in graphical format in Table 4.1 below.

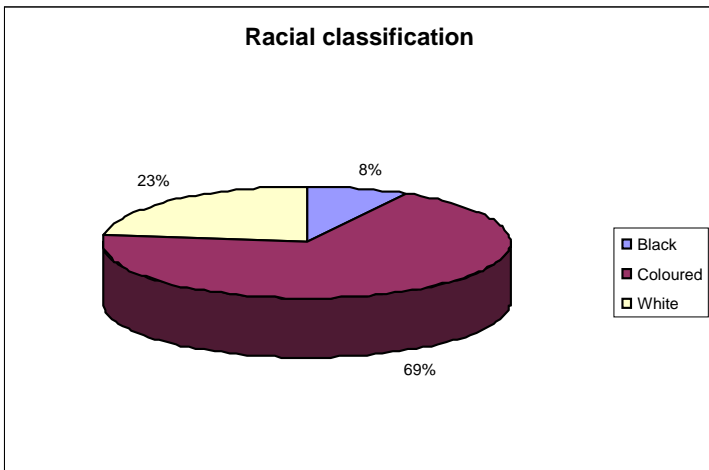
**Table 4.1 Personal profile of respondents**

Interviewee	Gender	Age	Years of experience at ABZ	Level of responsibility
Mr A	M	41~50	5~7	Managing director
Mr B	M	41~50	+10	General manager
Mr C	M	41~50	+10	Planning manager
Mr D	M	41~50	8~10	Planning assistant
Mr E	M	21~30	2~4	Production manager
Mr F	M	51~60	8~10	Supply chain
Mr G	M	41~50	+10	Supply chain assistant
Mr H	M	41~50	5~7	Supply chain assistant
Mr I	M	41~50	+10	Production assistant
Mr J	M	51~60	+10	Production assistant
Mr K	M	31~40	8~10	Labourer
Mr L	M	31~40	+10	Labourer
Mr M	M	21~30	5~7	Labourer



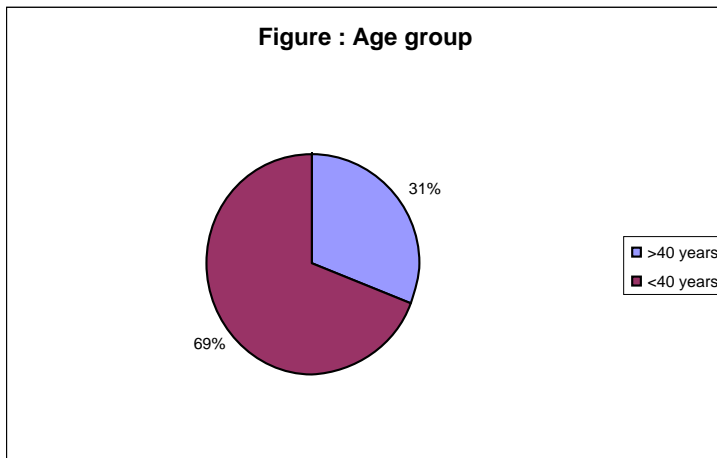
**Figure 4.3 Gender of employee participants of the questionnaire at ABZ**

In Figure 4.3 it is shown that 100 percent of the samples were male participants (no females participated). In essence, it proves that the engineering industry is dominated by males.



**Figure 4.4 Racial classification of the questionnaire's participants at ABZ**

Figure 4.4 gives an overview of race classification in the sample. The chart shows that the majority of the respondents, (69 percent) were coloured, while (23 percent) were white and (8 percent) were black.



**Figure 4.5 Age group of participants of the questionnaire at ABZ**

Figure 4.5 indicates that the majority of respondents (69 percent) were older than 40 years of age and 31 percent were younger than 40 years of age.

The author chose to use the age of 40 years as a benchmark, because during his visits to the plant, he noticed that the participants of the questionnaire were approximately 40 years old, and experienced personnel, who had been working at this company for more than eight years. Furthermore, a person of this age is assumed to have knowledge and a matured level of expressing his judgment when answering a question.

#### **4.10.2 Descriptive statistics for the questionnaire**

The author has analysed the employees' and management's comments of the questionnaire regarding lean implementation at ABZ. The respondents' answers are divided into two parts.

Part one deals with general qualitative responses of employees, and part two deals with quantitative responses pertaining to broader improvements through lean principles in specific areas of interest.

The part two questionnaire had a section for comments for the reviewer; this was an attempt to ensure that answers given were understood. In many of the answers, the respondents did not make comments as requested, hence the author did not present such comments as they did not have sufficient substance to warrant inclusion in the analysis.



*It is important to note that when presenting the responses from the participants, their identities and views were protected. The only name mentioned in the study is that of the managing director (MD). Below are the responses received from the interviewees at ABZ.*

The responses in review are based on individual knowledge, observation, understanding, and experience of the whole lean implementation process within various sections at ABZ. When analysing each response given, the author used a coding method of yes (y) or no (n) as a means of proving whether the given answers had positive meaning in relation to the questions.

### **Part one: Qualitative responses: general open-ended questions regarding lean implementation**

#### **Mr A**

1. What has motivated the management to implement lean in your organisation?  
*(A). Refer to our presentation 'reason for change' [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
*(A). Refer to our presentation 'reason for change' [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
*(A). Previously they were not happy with performance, not meeting deadlines and quality. Now they are happy. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
*(A). Lead time improved, reliability on delivery, cost management better. [Y]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
*(A). Changes made to the better. Process improved. [Y]*
6. Do employees understand and accept lean in your organisation?  
*(A). It was communicated with employees and unions. [Y]*
7. Does the management encourage lean practices in your organisation?  
*(A). Yes, encourage and drive the process. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
*(A). No exiting kaizen events. [Y] (see chapter two, page 17)*  
*(A). Intend to do Kaikako.*

#### **Mr B**

1. What has motivated the management to implement lean in your organisation?  
*(A). The company was experiencing numerous production challenges. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?

*(A). Yes, the product's quality improved. [Y]*

3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.

*(A). Yes, prior to lean implementation the customers were not satisfied with performance of the company. [Y]*

4. Has lean implementation placed your organisation in a competitive edge? Give an example.

*(A). Yes, the lead times has improved. [Y]*

5. Does lean encourage and guide you to achieve better in your work? If yes, how?

*(A). Yes, due to the changes, the production process has improved. [Y]*

6. Do employees understand and accept lean in you organisation?

*(A). Yes, during lean implementation, the process was communicated to all employees and they were involved. [Y]*

7. Does the management encourage lean practices in your organisation?

*(A). Yes, the management encourages the practices and are the main driver of the lean process. [Y]*

8. What do you think still need to be improved through lean within your organisation?

*(A). The management needs to continuously enforce and encourage lean practices at all times. [Y]*

### **Mr C**

1. What has motivated the management to implement lean in your organisation?

*(A). To become more competitive and to reduce material stock levels. [Y]*

2. Did lean implementation bring improvements to your organisation? If yes, how?

*(A). Through people who have done lean in the past (at other companies). [Y]*

3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.

*(A). Do not know. [N]*

4. Has lean implementation placed your organisation in a competitive edge? Give an example.

*(A). Hope it did. [N]*

5. Does lean encourage and guide you to achieve better in your work? If yes, how?

*(A). Yes. [Y]*

6. Do employees understand and accept lean in you organisation?

*(A). At first no, but after a while yes. [Y]*

7. Does the management encourage lean practices in your organisation?

*(A). At first when it started. [N]*

8. What do you think still need to be improved through lean within your organisation?

*(A). When you start something continue with it. [Y]*

## Mr D

1. What has motivated the management to implement lean in your organisation?  
(A). *To improve the company's business for the better. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Yes, supermarket was introduced to keep finished products. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *Turn around is shorter and single orders are always available in our supermarket. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *I think customers are happy but it is management's responsibility. [Y]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *The changes made our work simpler and easier. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *Yes, we work according to new system and in co-operation. [Y]*
7. Does the management encourage lean practices in your organisation?  
(A). *They make us take responsibility for our work and to work as a team. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *To have a better linkage on MRP system and lean systems. [Y]*

## Mr E

1. What has motivated the management to implement lean in your organisation?  
(A). *To reduce costs by eliminating wasteful activities. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Yes, by appointing an industrial engineer to implement projects. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *Not sure, never my responsibility. [N]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *Yes. [Y]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Yes. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *No. [N]*
7. Does the management encourage lean practices in your organisation?  
(A). *Yes. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *No comment. [N]*

## Mr F

1. What has motivated the management to implement lean in your organisation?  
(A). *Lean works. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Top down leadership. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *Yes, it was poor. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *It could have. [N]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Yes. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *No. [N]*
7. Does the management encourage lean practices in your organisation?  
(A). *Yes. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *Convince production management that it can work. [Y]*  
(A). *Take MRP out and eliminate silo mentality.*

## Mr G

1. What has motivated the management to implement lean in your organisation?  
(A). *To increase work output. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Factory layout was changed and material purchase was according to factory loading. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *Yes, they were happy with our service. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *No, cost too high. [N]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Yes, material stock less. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *Yes, given training session. [Y]*
7. Does the management encourage lean practices in your organisation?  
(A). *Yes, but system not effective due to economic condition. [N]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *The flow is not smooth, there are bottlenecks in the process. [Y]*

## Mr H

1. What has motivated the management to implement lean in your organisation?  
(A). *To reduce raw material/stock level at holding area. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Yes, supplier delivery directly to shop floor. No huge stock on hold. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *The orders are now quicker now. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *Hope so. [N]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *The material flow is now better controlled. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *We work according to schedules. [Y]*
7. Does the management encourage lean practices in your organisation?  
(A). *All changes were made and we work according to them. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *To help other suppliers to understand our new operation. [Y]*

## Mr I

1. What has motivated the management to implement lean in your organisation?  
(A). *To eliminate waste (time, material) and to improve turn-around time, and reduce stock holding. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Educate workers, management and the complete supply chain. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *We were losing market share due to long lead times and higher pricing. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *Would like to think so. [N]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Yes, through time was quicker, smaller batches, less material on the shop floor. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *Almost all employees received training. [Y]*
7. Does the management encourage lean practices in your organisation?  
(A). *Yes, but to a point 'customer is king'. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *Eliminate small bottlenecks. [Y]*

**Mr J**

1. What has motivated the management to implement lean in your organisation?  
(A). *Not commented. [Nil]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Not commented. [Nil]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *Not commented. [Nil]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *Not commented. [Nil]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Not commented. [Nil]*
6. Do employees understand and accept lean in you organisation?  
(A). *Not commented. [Nil]*
7. Does the management encourage lean practices in your organisation?  
(A). *Not commented. [Nil]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *Not commented. [Nil]*

**Mr K**

1. What has motivated the management to implement lean in your organisation?  
(A). *To stream line production flow. Better system control. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *By educating suppliers on lean system. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *The stock is always available as they want it. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *I think so. [Y]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Yes, processes flow better. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *Yes, we have morning session for 15 minutes on feedback. [Y]*
7. Does the management encourage lean practices in your organisation?  
(A). *Yes, work is done in creative ways. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *Get everybody to understand the system. [Y]*

## Mr L

1. What has motivated the management to implement lean in your organisation?  
(A). *To improve working systems and teach workers. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *Many changes were made and workers now work together. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *Most probably. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *Most probably. [N]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Yes, when a problem happens it does not affect the whole production. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *Yes, they were informed and they now work differently. [Y]*
7. Does the management encourage lean practices in your organisation?  
(A). *We have a morning meeting ever yday to discuss problems that happened yesterday. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *Not sure. [N]*

## Mr M

1. What has motivated the management to implement lean in your organisation?  
(A). *To have a better way of doing things and it is working good. [Y]*
2. Did lean implementation bring improvements to your organisation? If yes, how?  
(A). *The product quality is better now and less mistakes. [Y]*
3. Do you think the improvement in your organisation increased customer satisfaction? Give an example.  
(A). *The quality of our products is now improved. [Y]*
4. Has lean implementation placed your organisation in a competitive edge? Give an example.  
(A). *Hope so, we are very busy now. [N]*
5. Does lean encourage and guide you to achieve better in your work? If yes, how?  
(A). *Yes, we were given all the tools we need for work. [Y]*
6. Do employees understand and accept lean in you organisation?  
(A). *The experienced ones understand but new ones I'm not sure. [N]*
7. Does the management encourage lean practices in your organisation?  
(A). *Yes, we are still working on new system. [Y]*
8. What do you think still need to be improved through lean within your organisation?  
(A). *Sort out finished products accordingly when storing them. [Y]*

**Table 4.2 Summary of part one questionnaire**

<b>Interviewee</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Q5</b>	<b>Q6</b>	<b>Q7</b>	<b>Q8</b>
Mr A	Y	Y	Y	Y	Y	Y	Y	Y
Mr B	Y	Y	Y	Y	Y	Y	Y	Y
Mr C	Y	Y	N	N	Y	Y	N	Y
Mr D	Y	Y	Y	Y	Y	Y	Y	Y
Mr E	Y	Y	N	Y	Y	N	Y	N
Mr F	Y	Y	Y	N	Y	N	Y	Y
Mr G	Y	Y	Y	N	Y	Y	N	Y
Mr H	Y	Y	Y	N	Y	Y	Y	Y
Mr I	Y	Y	Y	N	Y	Y	Y	Y
Mr K	Y	Y	Y	Y	Y	Y	Y	Y
Mr L	Y	Y	Y	N	Y	Y	Y	N
Mr M	Y	Y	Y	N	Y	N	Y	Y
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>83%</b>	<b>42%</b>	<b>100%</b>	<b>75%</b>	<b>83%</b>	<b>83%</b>

Table 4.2 summarises the outcome of the qualitative responses received in open-ended questions regarding lean implementation. One interviewee (Mr J), who is a production assistant, did not respond to any of the questions given, therefore the author did not have information to review and thus his part is not included in the summary.

It became evident when analysing the responses of the questions that the interviewees had played a role during the lean implementation phases. The majority of the summarised answers (6 in total) received were positive and had an above eighty percent rating, showing that respondents do acknowledge the contribution made by implementing lean in their organisation.

When analysing the summary of the part one questionnaire (Table 4.2) as based on the coding method for each answer, questions 1, 2 and 5 have the highest score (100%), questions 3, 7 and 8 score 83%, question 6 scores 75% and question 4 scores 42%.

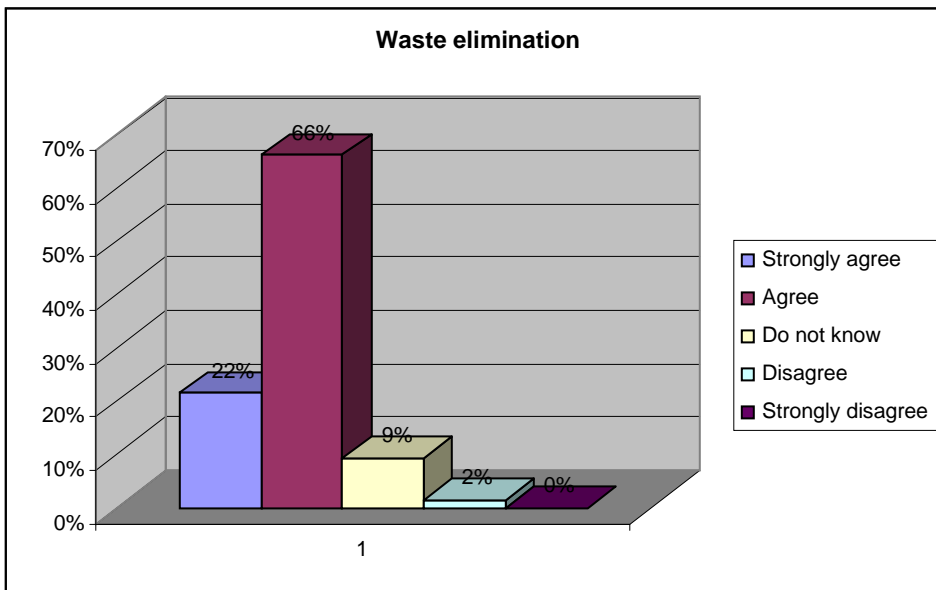
These scores may be interpreted as that the employees and management are satisfied with the changes and improvements lean has brought to their organisation. This is in the form of improved product quality, better inventory control, better process flow, etc. as indicated by the answers obtained from the respondents. The author concludes that even though there is criticism about the lack of management's fostering of continuous practice of lean principles and that lean has not placed the company in a competitive edge, the overall employees' feelings are positive about the benefits that the lean principle has brought to the organisation.



**Table 4.3 Part two: General quantitative response regarding lean**

**Table 4.3.1 Elimination of waste**

<b>1. Lean has helped your organisation to eliminate waste of:</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Do not know</b>	<b>Disagree</b>	<b>Strongly disagree</b>
1.1 Excessive lead and storage time.	0	13	0	0	0
1.2 Waiting while material, information, people or equipment are not ready	0	9	3	1	0
1.3 Unnecessary transportation of non-value adding products	1	9	3	0	0
1.4 Over-producing materials that customer needs	12	1	0	0	0
1.5 Rework and excessive defects items	1	11	0	0	0
<i>Total count</i>	<i>14/65</i>	<i>43/65</i>	<i>6/65</i>	<i>1/65</i>	<i>0</i>
<i>Percentage</i>	<i>21.5%</i>	<i>66.1%</i>	<i>9.2%</i>	<i>1.5%</i>	<i>0</i>

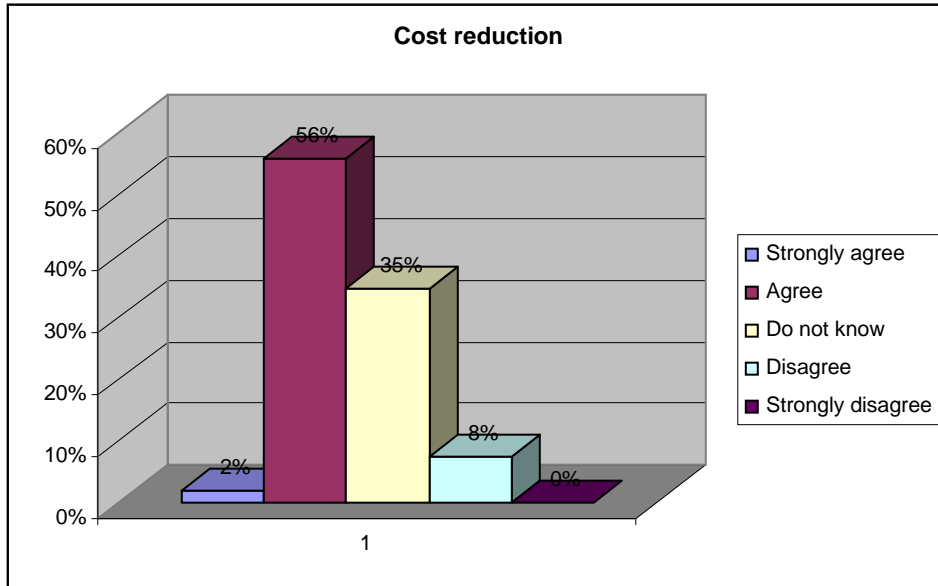


**Figure 4.6: Total count of personal responses**

Figure 4.6 shows that most respondents agree that lean has eliminated waste in their workplace. Questions 1.1 to 1.3 and 1.5 show high percentages on agree, and of these, 22% strongly agree.

**Table 4.3.2 Cost reduction**

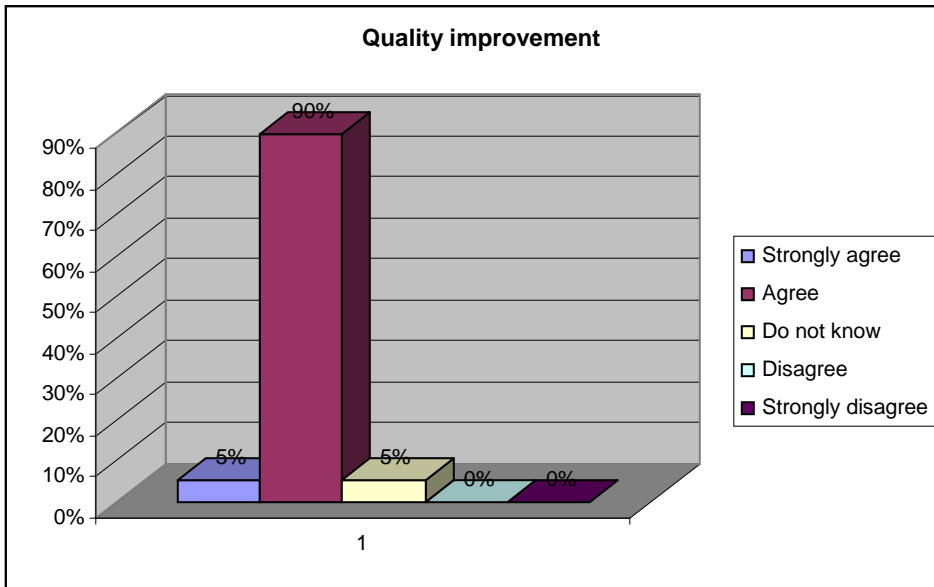
<b>2. Lean helped your organisation to reduce cost of:</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Do not know</b>	<b>Disagree</b>	<b>Strongly disagree</b>
2.1 Producing unnecessary products	1	12	0	0	0
2.2 Unnecessary training of employees	0	1	9	3	0
2.3 Over staffing	0	4	8	1	0
2.4 Unnecessary rework and reducing defect.	0	12	1	0	0
<i>Total count</i>	<i>1/52</i>	<i>29/52</i>	<i>18/52</i>	<i>4/52</i>	<i>0</i>
<i>Percentage</i>	<i>1.9%</i>	<i>55.7%</i>	<i>34.6%</i>	<i>7.6%</i>	



**Figure 4.7: Total count of personal responses**

**Table 4.3.3 Quality improvement**

<b>3. Lean has helped your organisation to improve the quality of:</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Do not know</b>	<b>Disagree</b>	<b>Strongly disagree</b>
3.1 Produced products	0	13	0	0	0
3.2 Workmanship amongst employees	1	11	1	0	0
3.3 Its products on competitive standing	1	11	1	0	0
<i>Total count</i>	<i>2/39</i>	<i>35/39</i>	<i>2/39</i>	<i>0/39</i>	<i>0</i>
<i>Percentage</i>	<i>5.1%</i>	<i>89.7%</i>	<i>5.1%</i>	<i>0</i>	<i>0</i>



**Figure 4.8: Total count of personal responses**

In Figure 4.8, the respondents agree that the quality of products has improved as a result of lean implementation. This is evident as 'Agree' scores high percentages in all questions. Due to this quality improvement, the cost of producing unnecessary products was also reduced. This statement is supported by respondents in item 2.1 in Table 4.3.2.

**Table 4.3.4 Production improvement**

4. Lean has helped your organisation to improve production through:	Strongly agree	Agree	Do not know	Disagree	Strongly disagree
4.1 Clearer working schedule	11	1	1	0	0
4.2 Better performance during manufacturing process	3	10	0	0	0
4.3 Less defect rate on products	4	9	0	0	0
4.4 Reduced lot size		9	4	0	0
4.5 Better organised house-keeping.	12	1	0	0	0
4.6 The introduction and use of <i>kanban</i> system	13	0	0	0	0
4.7 Standard setup during production	9	4	0	0	0
4.8 Standard work methods	9	4	0	0	0
<i>Total count</i>	<i>61/104</i>	<i>38/104</i>	<i>5/104</i>	<i>0/104</i>	<i>0</i>
<i>Percentage</i>	<i>58.6%</i>	<i>36.5%</i>	<i>4.8%</i>	<i>0</i>	<i>0</i>

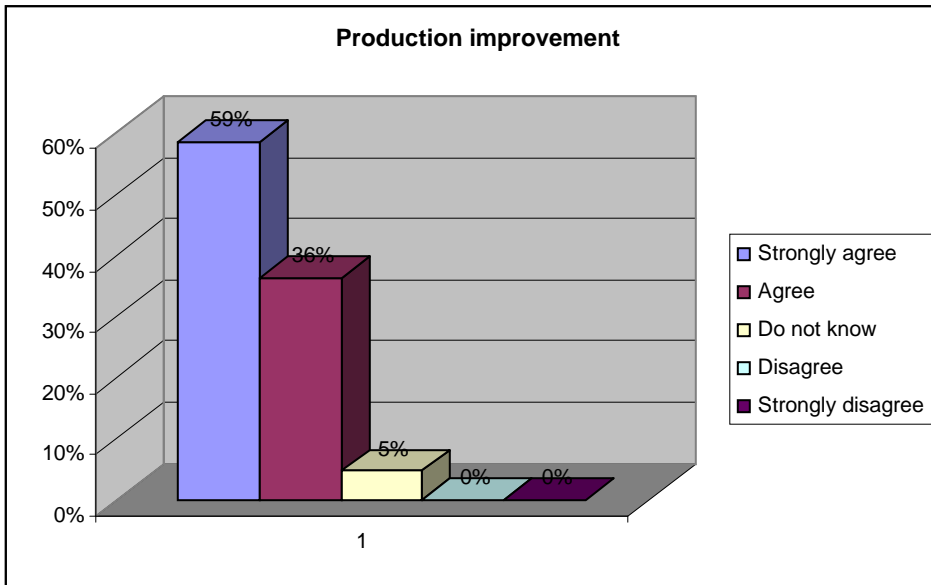
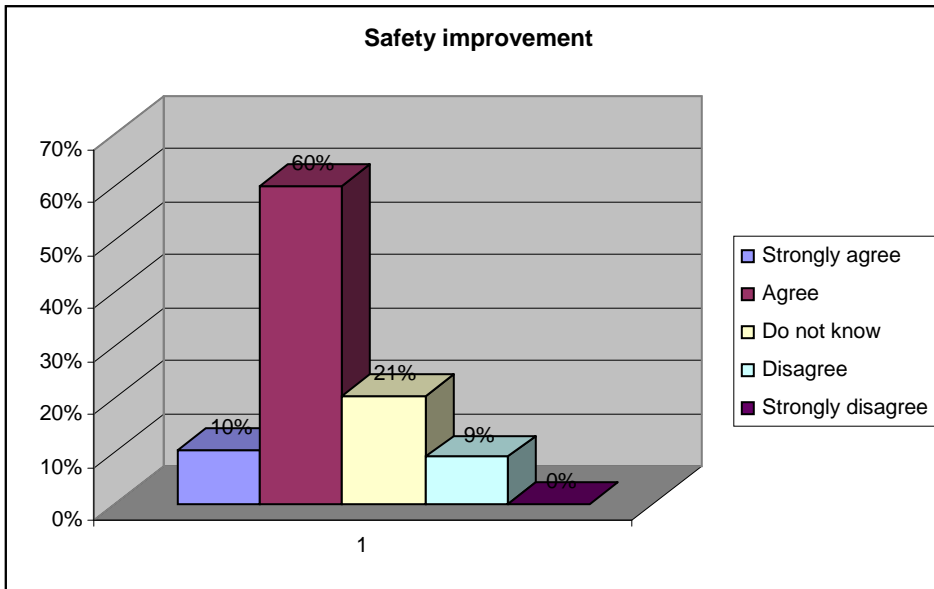


Figure 4.9: Total count of personal responses

Table 4.3.5 Safety improvement

5. Lean has helped your organisation to improve safety through:	Strongly agree	Agree	Do not know	Disagree	Strongly disagree
5.1 One-piece material flow during production	3	7	3	0	0
5.2 Accidents awareness and displays in workshop	4	8	1	0	0
5.3 Identification of plant processes and their sequences	0	11	1	1	0
5.4 Introduction of preventative maintenance on equipment	0	5	5	3	0
5.5 Establishment of stable working condition during production process	0	5	5	3	0
5.6 Demarcating of floor layout	1	11	1	0	0
<i>Total count</i>	<i>8/78</i>	<i>47/78</i>	<i>16/78</i>	<i>7/78</i>	<i>0</i>
<i>Percentage</i>	<i>10.2%</i>	<i>60.2%</i>	<i>20.5%</i>	<i>8.9%</i>	<i>0</i>



**Figure 4.10: Total count of personal responses**

Table 4.3.4 revealed that some respondents 'Strongly agree' and 'Agree' with the fact that production has improved. This was due to the introduction of lean standard working methods, which resulted in improved safety amongst employees, as acknowledged by respondents in Table 4.3.5.

**Table 4.3.6 Facilitate problem solving**

<b>6. Lean has helped to facilitate problem solving through:</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Do not know</b>	<b>Disagree</b>	<b>Strongly disagree</b>
6.1 Simplifying root cause analysis	0	5	5	3	0
6.2 Improving employee logical thinking during production	1	8	4	0	0
6.3 Enhancing staff knowledge and skills	4	8	1	0	0
6.4 Training and self empowerment	6	7	0	0	0
6.5 Fostering individual accountability on work ethic	8	5	0	0	0
6.6 Improving work culture	10	3	0	0	0
<i>Total count</i>	<i>29/78</i>	<i>36/78</i>	<i>10/78</i>	<i>3/78</i>	<i>0</i>
<i>Percentage</i>	<i>37.1%</i>	<i>46.1%</i>	<i>12.8%</i>	<i>3.8%</i>	<i>0</i>

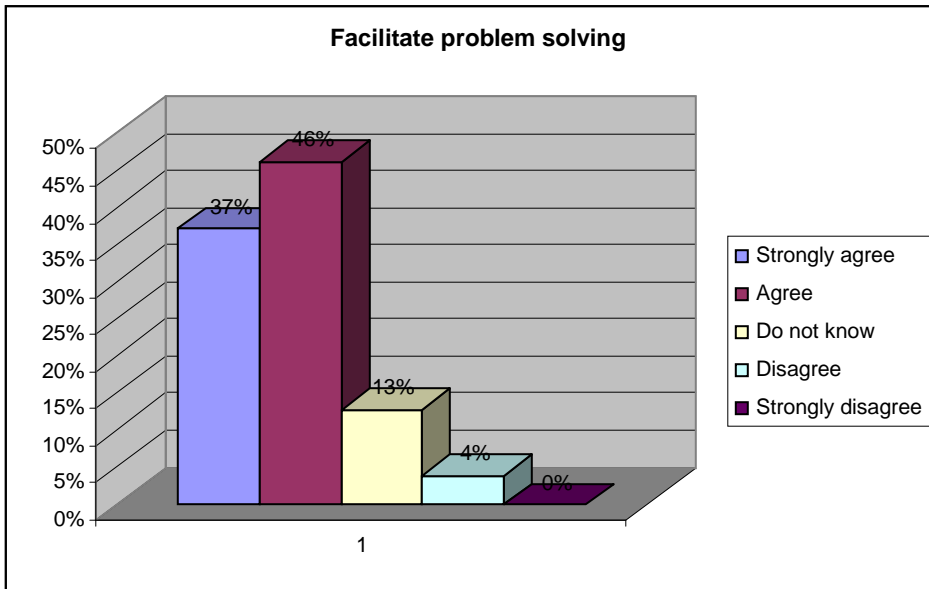
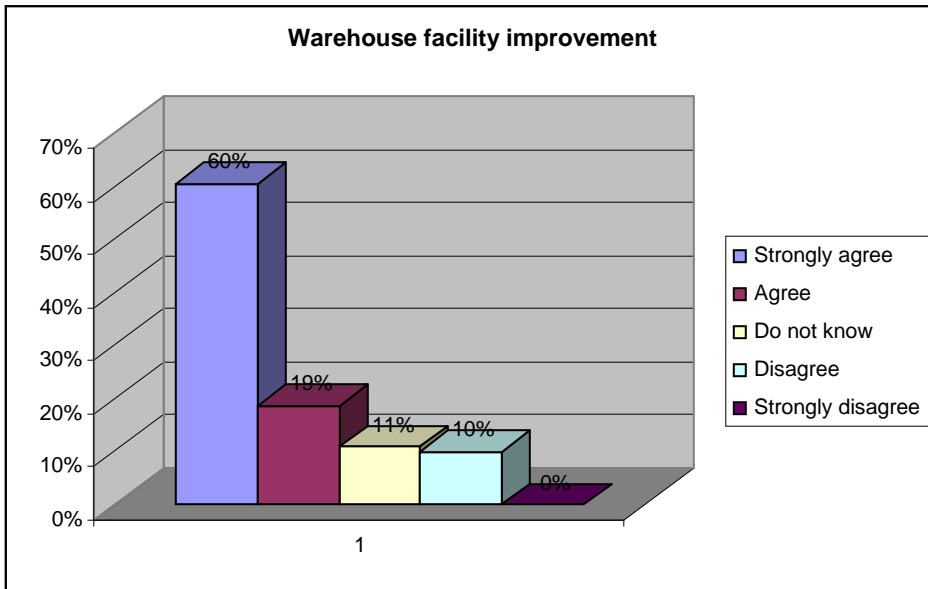


Figure 4.11: Total count of personal responses

Table 4.3.7 Warehouse facility improvement

7. Lean has helped to improve warehouse facility through:	Strongly agree	Agree	Do not know	Disagree	Strongly disagree
7.1 Better cooperative culture within the organisation	6	4	0	3	0
7.2 On-time delivery of products	13	0	0	0	0
7.3 Reduction of stored inventories, parts etc.	10	0	0	3	0
7.4 Better storage arrangement	13	0	0	0	0
7.5 Placing material visible and clearly marked	12	1	0	0	0
7.6 The use of MRP technology	0	3	7	3	0
7.7 Control of continuous flowing of material	1	9	3	0	0
<i>Total count</i>	<i>55/91</i>	<i>17/91</i>	<i>10/91</i>	<i>9/91</i>	<i>0</i>
<i>Percentage</i>	<i>60.4%</i>	<i>18.6%</i>	<i>10.9%</i>	<i>9.9%</i>	<i>0</i>



**Figure 4.12 Total count of personal responses**

The results in Table 4.3.6 proved that the majority of respondents strongly agree that lean has helped them to be able to facilitate in problem solving. In Table 4.3.7, some respondents disagree that lean has helped to improve their warehouse facility. This was evident in some of their responses in stream one where they stated that ....'MRP system must be taken out'.... and the MRP system is used to control the warehouse inventories.

Table 4.4.1 represents a combined count on personal responses based on given statements in order to measure how individuals responded on the seven key subjects of the questionnaire compare.

**Table 4.4 Part two: Personal responses regarding lean**

**Table 4.4.1 Total count per statement (percentage)**

	Strongly agree	Agree	Do not know	Disagree	Strongly disagree
1. Elimination of waste	21.5	66.1	9.2	1.5	0
2. Cost reduction	1.9	55.7	34.6	7.6	0
3. Quality improvement	5.1	89.7	5.1	0	0
4. Production improvement	58.6	36.5	4.8	0	0
5. Safety improvement	10.2	60.2	20.5	8.9	0
6. Facilitate problem solving	37.1	46.1	12.8	3.8	0
7. Warehouse facility improvement	60.4	18.6	10.9	9.9	0
<b>Total count</b>	<b>194.8</b>	<b>372.9</b>	<b>97.9</b>	<b>31.7</b>	<b>0</b>

**Table 4.4.2: Total count per statement in percentage**

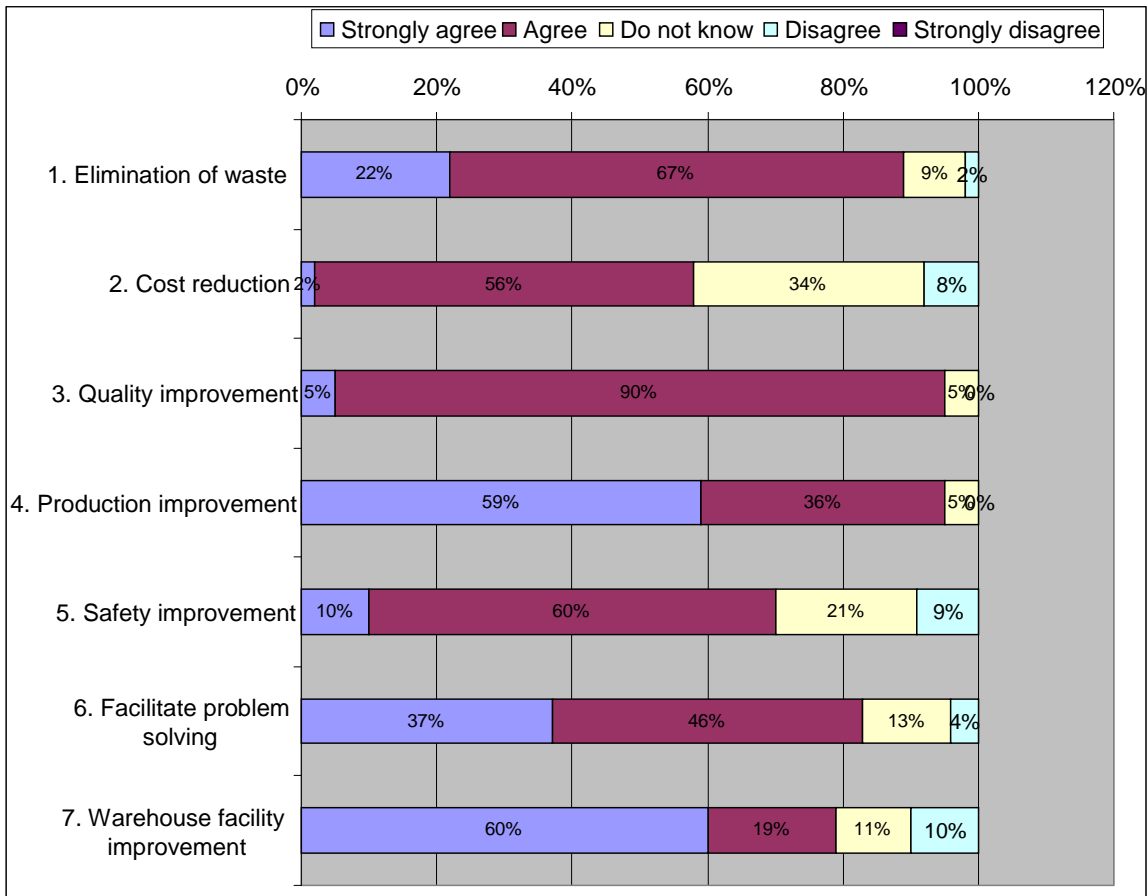
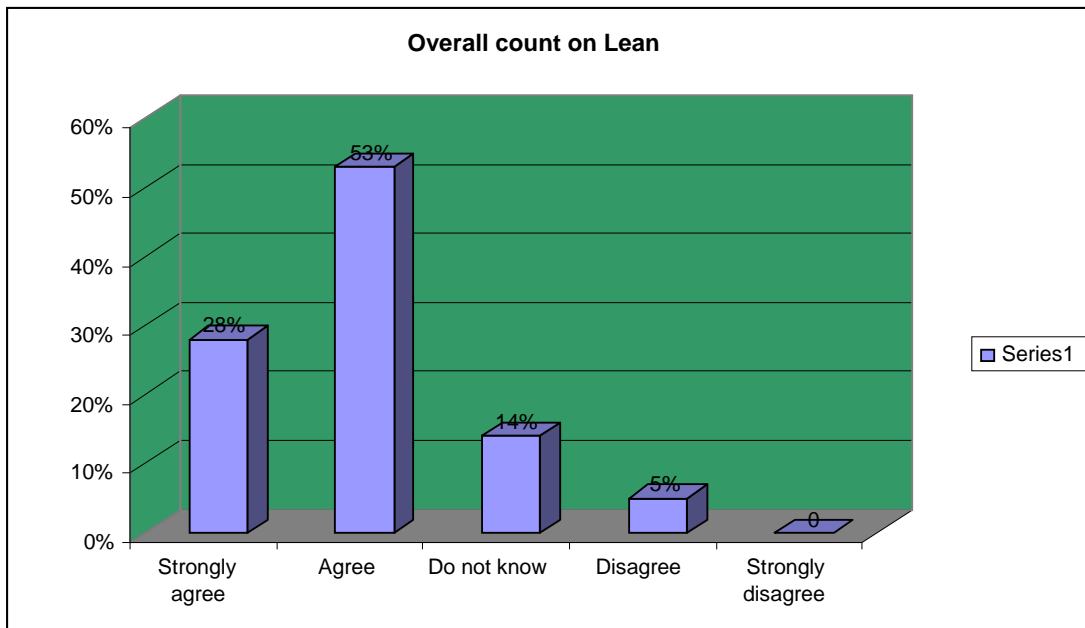


Table 4.4.2 proves that the majority of employees and management acknowledge the contribution made through the adoption of lean principles in their organisation. This further highlights that lean has positively impacted on areas such as safety, quality, production, cost control, warehouse facility improvement, wastage and so on.

**Table 4.5 Part two: The overall count of lean in the Likert scale method (percentage)**

	Strongly agree	Agree	Do not know	Disagree	Strongly disagree
Total count	194.8	372.9	97.9	31.7	0
Percentage	28	53	14	5	0





**Figure 4.13: The overall count of lean in percentage**

The counting of respondents in Table 4.5, as ranked by the Likert style format, shows positive responses were given regarding lean implementation at ABZ. These outcomes are presented in Figure 4.13 with 53 percent (agree), 28 percent (strongly agree), 14 percent (do not know) and 5 percent (disagree). No answers were noted for employees who strongly disagree with any of the questionnaires.

#### **4.11 Summary**

The author has described the history of ABZ and various developments within the organisation. Factors that led to the adoption of lean principles and how the implementation process took place were discussed. This also led to the development of the questionnaire which was used to collect data from employees at ABZ. The data collected from employees and management were analysed to determine the impact made through lean implementation. Karlsson's model was presented in the chapter, with all the key lean principles as a form of benchmarking the measure at ABZ.

## CHAPTER FIVE: DISCUSSION AND RESULTS

### 5.1 The lean journey at ABZ – Discussion

*In trying to answer the author's research question 'how did the particular SMEE apply lean thinking principles to their organization?'*

The author had several desk interviews with the MD and other participants in order to obtain their viewpoints and understanding of how the organization has applied its lean principles. During this time the author was also provided with company material, containing information in chronological order, on how lean implementation was achieved. These data were analysed and the results are discussed below.

#### 5.1.1 Management

The MD assembled a lean team from management which would promote lean in the organization. The team included;

- the factory manager
- an industrial engineer
- a production manager
- two quality officers.

The management team scheduled meetings for Monday mornings prior to the first working shift. The lean team, together with the rest of management, were given literature on lean thinking, with specific reading schedules to focus on and understand prior to the next scheduled meeting. During these meetings, everyone would have the opportunity to share their understanding of the specific lean concept that they had studied. In addition, this created an opportunity for various sectional supervisors to have a better understanding of the whole organisation's value chain.

This plan of action was aimed at first ensuring a cultural change at management level, before it subsequently filtered to the shop floor. In this instance, the organisation was applying part of the 'lean development' in Karlsson's model.

### **5.1.2 Lean training**

Management initiated training programmes over a period of four months with the lean team involved in training the workers. All the concerned parties from manufacturing and management were involved. The lean team was tasked to serve as the 'think-tank' that would carry the intellectual capacity forward.

During the training period management spent time on the shop floor, explaining to workers how the plans of going lean would be achieved. They discussed the real cases to show employees the value-add activities and non value-add activities during the production process. The majority of these workers have subsequently left the company and only few that were part of lean implementation are currently working at ABZ.

### **5.1.3 Workers**

The workforce was involved in seminars where lean terminologies and principles were explained, and evidence of its success in other industries was demonstrated.

As part of the change to lean, the MD had set up the 'green teams' with the intention of improving communication, helping workers to know what they were doing, and encouraging them to speak out about things that were wrong, knowing that they would be given support. Each section had a lean leader whose role was intervention rather than direct supervision and all leaders together were called the 'green team'. This team was designed to encourage team work, tolerance, communication and gate-keeping.

Workers were encouraged to work in cell formation with four people in each cell, which created a closed loop communication. Workers would discuss the past day's production and what needed to be done to improve it. In the end, workers started running their own meetings and being responsible for their own work.

Figures 5.1 and 5.2 show how the organisation's manufacturing facility was prior to lean implementation and the challenges which ABZ was facing at the time.



**Figure 5.1: Poor house keeping before lean change**

Due to the high inventory levels that the company had created, the products were placed improperly and different products placed together. As shown above, there is clear evidence that the area was not well organized, for example empty boxes were placed on walkways and there were loose wires on the floor. The situation regarding the shop floor employees' well-being and safety was of great concern to the MD. The situation also created problems relating to the late delivery of products to customers, due to poor house keeping. All moveable items, such as materials and boxes, should have dedicated positions indicated by symbols or lines on the ground.



**Figure 5.2: Winding and stacking cell before lean change**

The floor layout was not properly designed to allow for a smooth flow of production from one section to the next. Figure 5.2 shows employees lined up along the winding cell working on a single product. If employee E had difficulty in completing his work on time, the next employee F had to waste time waiting for the product in order to complete his part. These working conditions caused a built up (bottleneck) of products or inventory and in turn affected other employees' productivity.



Figure 5.3: Winding cells after lean change



Figure 5.4: New U-shaped roller conveyors after lean change

Figures 5.3 and 5.4 show the changes made to the general house keeping and winding cell layout. Safety conditions and lighting conditions were improved as an early indication of a positive change to the plant. This was followed by the physical changing of the floor layout, the removal of unnecessary excess material from the floor, the removal of two material storerooms in the production area, and the installation of proper shelving. The organisation was applying part of the 'lean manufacturing' in Karlsson's model.

When all the changes were done, machines were placed back into new designated positions and roller conveyors were re-laid to create flow and to reduce space to discourage accumulation of excess inventory.



**Figure 5.5: Good house keeping after lean change**

Figure 5.5 shows an employee being equipped with all the tools needed for the job, such as a brush for cleaning his work area, and a whiteboard and pen for recording his own production output and work related problems.

According to the presentation by Sidinile (2007), the lean changes to this organisation had a positive impact and some of the improvements were: inventory levels in the section dropped, the quality of products improved, the on-time delivery of products to customers improved, and utilized space was reduced.

## **5.2 The principles adopted by ABZ during lean transformation**

The organisation employed formal techniques and process metrics successfully for process measurement. The lean manufacturing principle in Karlsson's model was adopted which included: one piece flow, standard work, standard set-up, kanban, jidoka and the MRP system. These are described below

*One piece flow:* The implementation strategy involved completing a line balance based on observed times and modifying work stations so that only one part could be kept between them.

The system is defined as moving/making only what is needed, when it is needed, thus minimizing the work in progress (WIP) inventory. Minimizing the WIP inventory would enhance efficiency, enable quick response time, eliminate build-up of defects and facilitate standardised work. The system was implemented at the factory layout as a 'U' shape, with the operators within the configuration as indicated in Figure 5.4. The new ABZ factory featured the machines as demarcated to smooth the flow of material and movement of shop floor workers. The difference between the old layout and the new U-shaped layout is shown in appendices B and C respectively.

*Standard set-up:* To shorten the set-up time, a decentralized die and tool storage area was created that allowed the operator visual access to the next set of dies and quality fixtures needed. Standard set-up applies the principles of standardised work to the process of converting an operation currently producing one part number so that it produces a different part number. It is considered a series of steps that are the most efficient way to change over from one product to another.

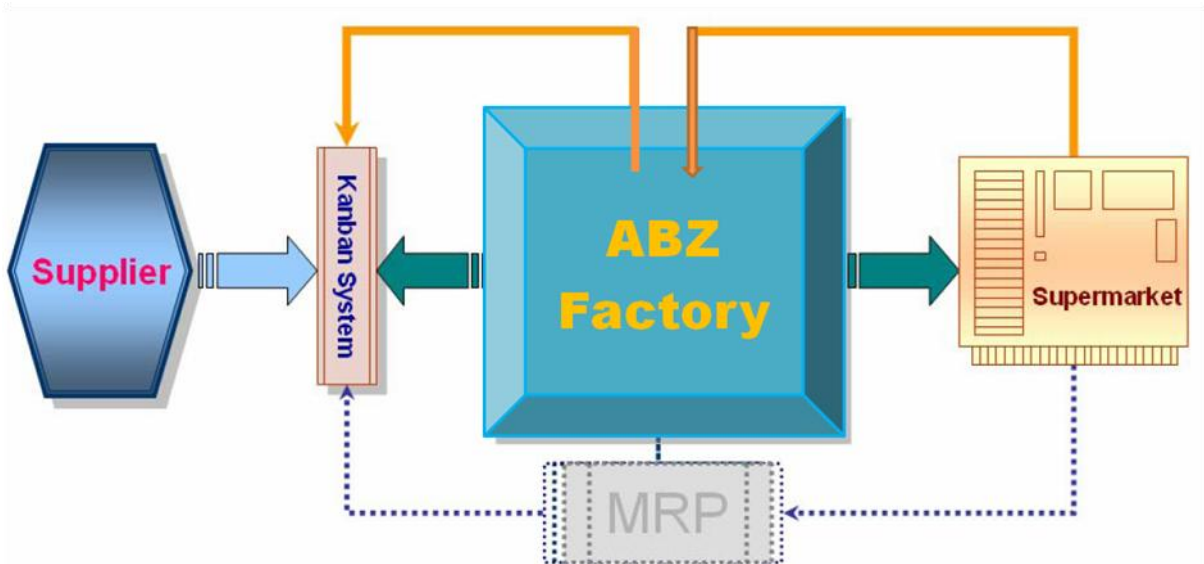
The standard work principle was also implemented whereby the system would establish work sequence, measure cycle time for such work sequence and ensure proper utilisation of machinery and equipment.

ABZ adopted the material requirement planning (MRP) system in their operation merely to improve material flow between various sections of the shop floor, with the goal of reducing



inventory and shortening lead times to customers. The system helps manufacturers determine precisely when and how much material to purchase, based on a time-phased analysis of sales orders, production orders, current inventory and forecasts. The system also ensures that firms will always have sufficient inventory to meet production demands, but not more than necessary at any given time.

The linkage between the two tools (MRP and kanban) and how they interlink with each other is demonstrated in Figure 5.6.



**Figure 5.6: The MRP and kanban linkages at ABZ operations**

Currently ABZ produces a variety of transformer products and stores them in a holding area (supermarket) where they are housed with other products waiting to be shipped. However, this is done based on a pull system where product movement is based on the kanban system. Whenever the supermarket's inventory is below a certain level, this triggers the last production stage to schedule completed products to replenish the supermarket accordingly. This model is based on lean manufacturing and lean distribution on Karlsson's model.

The kanban system was implemented at ABZ. It starts in the supply of material: when materials in the manufacturing location are withdrawn the system creates a need for replacement. As containers or pallets of material are emptied at the supermarket, instructions are sent to the area that produces the components and the consumed components are replenished. Figure 5.7 illustrates the kanban system as applied at ABZ.



**Figure 5.7: A transformer on a kanban unit**

Figure 5.7 shows a completed transformer being placed on a kanban unit and taken to the holding area in a supermarket. The organisation's lean distribution principle implementation included applying fixture design to prevent parts with defects or wrong components from being used, and to ensure that the state of production in the work centre was clear and visible.

### **5.3 The initial benefits of lean principles adoption at ABZ**

The MD confirmed that the successful adoption of lean principles and the changes made to the organisation had brought about many developments within the ABZ operations. For example, on a daily basis at the start of each shift, employees have the opportunity to discuss the production output of the previous day, the problems encountered and to develop a strategy to alleviate the repeat of same problems. In a period of six months from 2003, inventory levels in the section had dropped by 75%, quality improved by 99%, on-time delivery surged to 99%, throughput time

was reduced by 86% and there was a 25% reduction in utilised space. These results on ABZ's performance are shown in Table 5.1.

#### 5.4 ABZ overall performance - Results

**Table 5.1: ABZ performance indicator (2003 to 2008)**

	<b>Before (2003)</b>	<b>After 3 months</b>	<b>Target</b>	<b>2006</b>	<b>2008</b>
<b>Productivity index</b>	1	1.5	1.6	2.1	2
<b># ration failures</b>	10.8%	0.1%	0%	0.1%	0.1%
<b># test failures</b>	3%	1%	0%	0.6%	0.2%
<b>Throughput time</b>	33.5 days	4.5 days	4 days	4 days	4 days
<b>On time del</b>	59.95%	99%	100%	100%	100%
<b>Fin goods inv</b>	375 units	75	80	100	45
<b>WIP</b>	212	71	55	68	70

*[Source: Based on V Sidinile presentation, 2007]*

##### 5.4.1 Products failure ratio

The organisation's product failure rate prior to lean implementation was 10.8% percent. This rate improved within three months following the lean implementation to 0.1%. The organisation had a base target of zero percent failure rate but this rate stood still at 0.1% over a five year period.

##### 5.4.2 Product test failures

During the final production process, every manufactured product has to be tested for compliance to its design intent and declared safe for usage. Before lean implementation, up to 3% of products of did not passing the test due to various factors, such as poor product quality and poor workmanship. These shortcomings were reduced following lean implementation and the failure rate reduced to 1% within three months. In three years, the failure rate improved further to 0.6% and 0.2% in 2008.

##### 5.4.3 Production time

The time to produce a product from customer order to shipment to the customer was at least 33.5 days. This delay gave other suppliers that had shorter lead time a competitive advantage. Due to the introduction of lean principles such as, good house keeping, the kanban system, and

the establishment of a supermarket section with MRP system, the production lead time was reduced to four days.

#### **5.4.4 On-time delivery to customers**

The delivery of finished goods to customers was initially poor as the organisation was not adhering to its promises and commitments. This process was improved significantly and the author suggests that this has placed the organisation at a good competitive standing over its competitors and it has also gained trust from its customers.

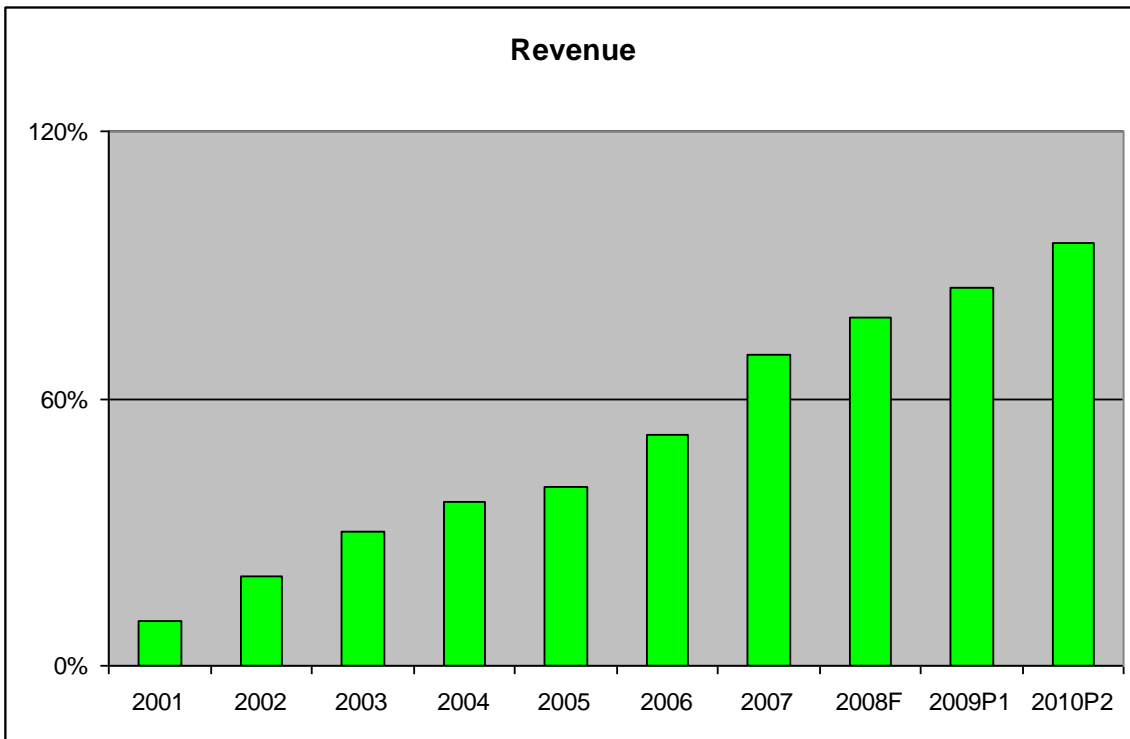
#### **5.4.5 Finished goods inventory**

In Figure 5.1, the huge amount of finished inventory on the factory floor can be clearly noted. This implies that products of valuable assets were being kept on the premises. In 2006, the improvement reduced the number of stored products from 375 units to 100 units at any given time, and freed cash for the organisation. In 2008, the inventory levels improved further to an average of 45 units, as referred to in Table 5.1.

#### **5.4.6 Work in progress (WIP)**

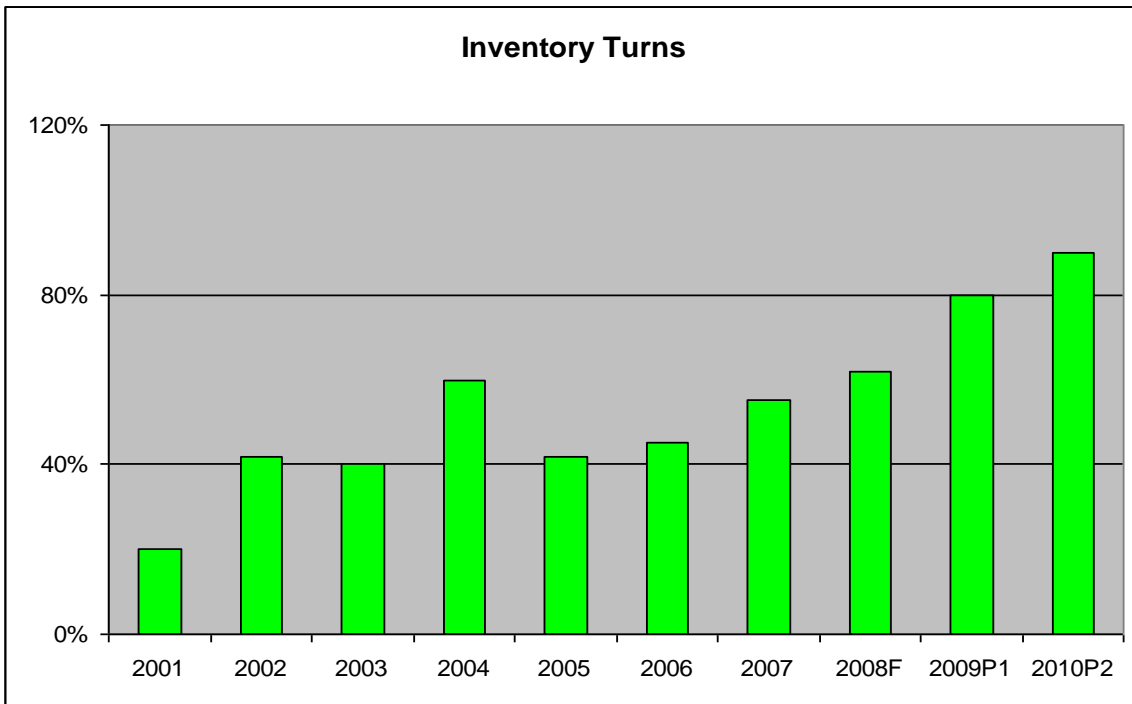
The products in the production process amounted to 212 units. The cause of this high amount of products was due to the original cell layout design, whereby employees would work on one product at a time, each employee doing his/her part on the unit and then passing it on to the next employee. When one employee had difficulty completing his task on time, this delayed the entire process and increased products in waiting. After the changes to the cell layout and introduction of lean principles, the product output increased drastically over a measured five year period, as presented in Table 5.1.

The information presented in Figures 5.8 to 5.11 was obtained from ABZ's management. The organisation would not disclose their actual figures in real terms but were kind enough to provide the author with comparative figures.



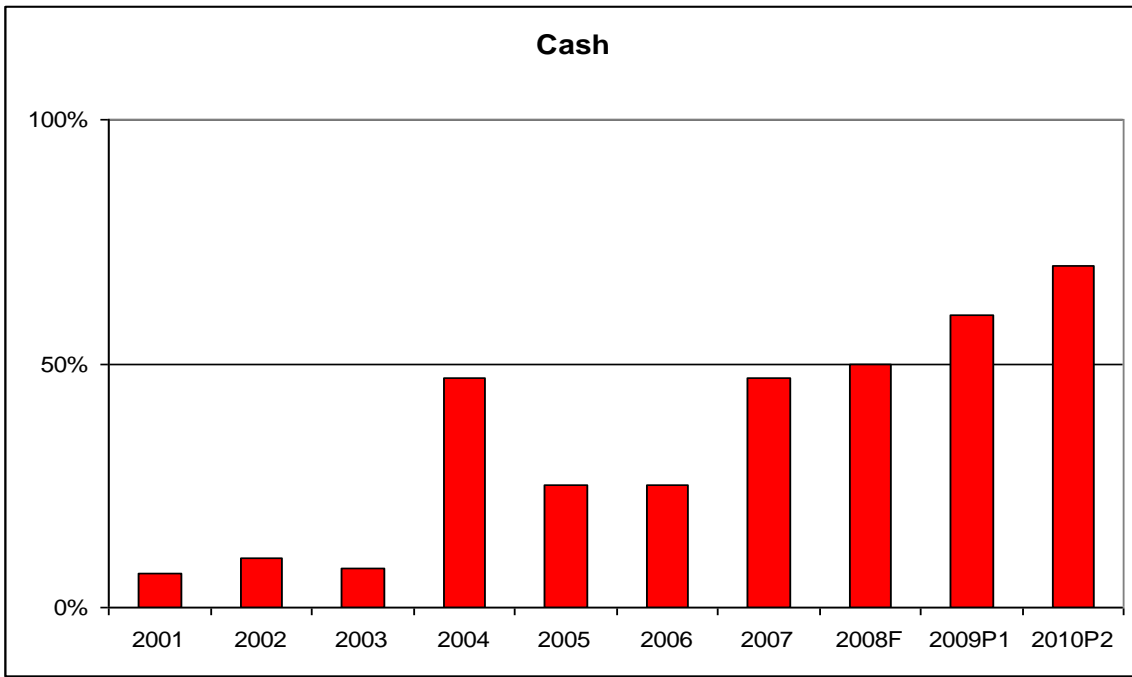
**Figure 5.8: Performance in revenue improvement**

The successful implementation of some lean principles improved the company's overall financial performance. The revenue improved significantly for the years 2003 to 2008 as shown in Figure 5.8. Due to the steady improvement, projections were made for the next two years (2009 and 2010).

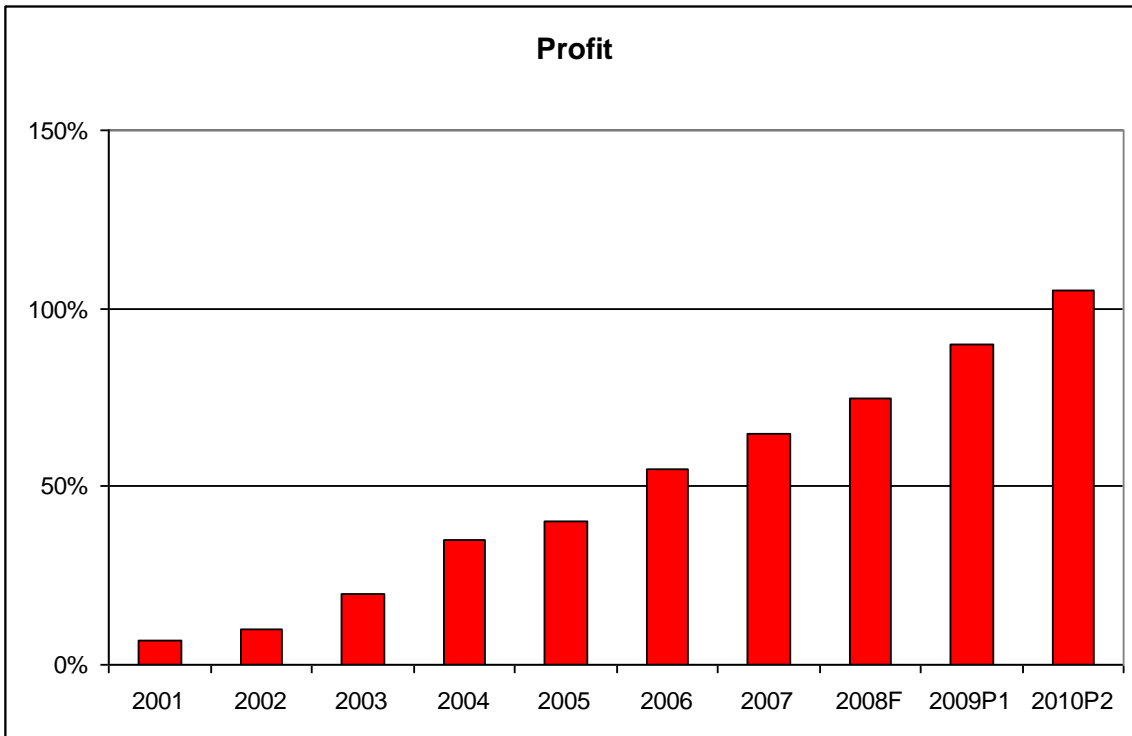


**Figure 5.9: Performance in inventory improvement**

The turnover on product inventory increased as fewer finished products were kept within the company's premises. The above graph (Figure 5.9) represents this improvement from 2003 to 2008, with 2009 and 2010 as forecasted performances.



**Figure 5.10: Performance in cash improvement**



**Figure 5.11: Performance in profit improvement**

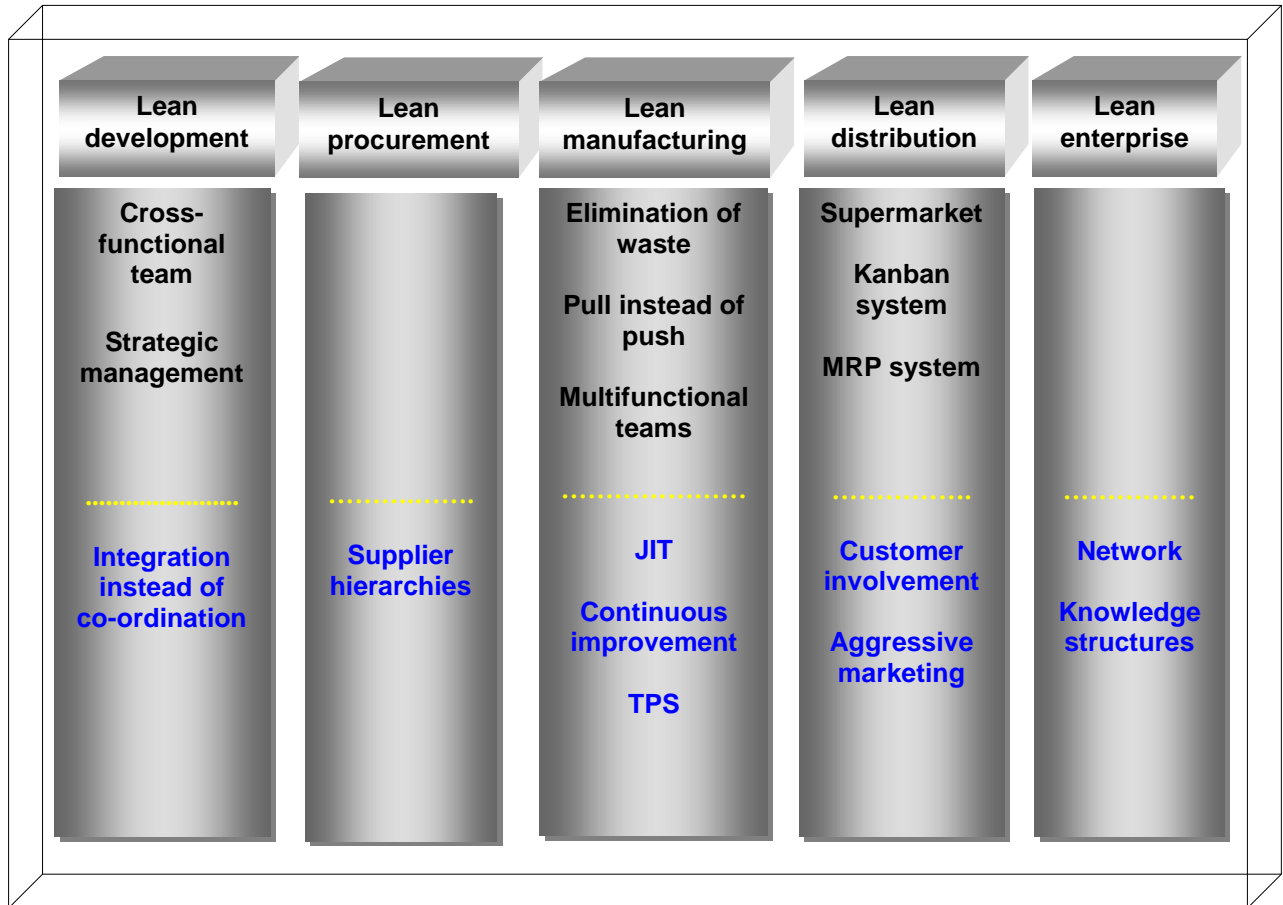
The author assumes that the continued increase in the organisation's cash and profit is as a result of clients beginning to trust the company and being satisfied with the quality of its products. According to the company's MD, the reduced lead time contributed to the betterment of the organisation's competitive standing and the increase in customer loyalty. The graphs in Figures 5.10 and 5.11 represent the financial muscle of the organisation since the implementation of lean principles.

## **5.5 Summary**

In this chapter, the author answered the research question through a review of various milestones that ABZ undertook to achieve the desired competitiveness in their market following lean principles implementation.

It is noted that only some of the determinants of the lean production system, as presented on Karlsson's model, were adopted by ABZ. This proved that if some of the model's determinants are applied correctly in an organisation, it could bring about benefits to the organisation. Figure 5.12 represents an organisational lean production model with determinants as adopted by ABZ in their lean implementation process. The overall benefits to ABZ through lean implementation are: reduction in inventory, a shorter lead time, improved product quality, reduction in costs, elimination of defects and rework, improved financial standing and enhanced company competitiveness.





**Figure 5.12: Overview of the lean principles applied at ABZ**

*[Source: based on model by Karlsson]*

In Figure 5.12 above, the dotted lines that separate the determinants in each principle give an indication of the extent of usage of Karlsson’s model by ABZ. Only parts of the three principles were implemented.

## CHAPTER SIX: CONCLUSION AND RECOMMENDATION

### 6.1 Conclusion

The case study, as a research method employed here, sought to obtain the views of employees that are part of the lean transformation team in an organisation. The main objective of the study was to investigate the effect of lean thinking on production processes in a SMEE.

While the author was reviewing the literature, he came across a developed model by Karlsson (1996) with lean principles determinants. The author considered this model suitable to be used as a benchmark in the study while observing the effect or the consequences of the implementation by the organisation, of some of the model's determinants. The study also aimed at establishing if lean determinants, when applied to an organisation with the full participation of employees, would bring about improvements to the organisation.

With reference to the responses from the questionnaire, it was noted that the organisation has reaped notable benefits from the implementation of lean determinants. The responses from employees and management to the questions were positive even though there were few areas where some employees showed uncertainty or disapproval of the changes. Theory usually predicts that employees will resist change in their work environment (Yan, 2007). This was evident as some employees with more working experience in the company were not supportive of the changes (for example see on part one, question 8 (Mr F, G and I), and their answers).

Some senior employees criticised and questioned the effectiveness of the lean system (for example on part one, question 7 (Mr G) and question 4 (Mr I), and their answers)

The findings of the study reveal that after some lean principles were applied at ABZ, their implementation brought significant benefits. Many of the benefits gained by ABZ have been discussed in Chapter five.

The author is of the view that even though some workers lost their employment in similar industries, the success of lean implementation observed at ABZ facilitated the company to remain vigilant and be able to respond faster to the changing market conditions. The author

concludes that the company's higher asset efficiency and positive financial muscle should allow ABZ to retain their workers during a changing economic climate.

## **6.2 Recommendations**

ABZ has shown to have a strong corporate culture and a leading industry position upon which to build. This represents an opportunity in which to implement other key elements of lean with a view to further enhance or strengthen the competitive standing of the organisation.

A focus on customer needs, linkages with the suppliers, and continuous improvement during manufacturing aided by a meaningful network with lean principles stake holders, would be desirable, as no organisation will claim to lack supplier/customer focus or be disinterested in the quality of their products. The specific recommendations are presented as follows:

### **6.2.1 Continuous improvement**

While the approach to continuous improvement is desirable, on some occasions changes attributed only to customer's wants may not be the correct response.

The basis for a culture of continuous improvement should be in the organisation's knowledge structures. The very least requirement here would be to ensure an organisational infrastructure providing education and continuous improvement of the employees, particularly new entrant employees.

ABZ should seriously look at implementing the *kaizen* system which envelops the principle of continuous improvement (refer to chapter two, page 17).

### **6.2.2 Extended training of suppliers**

The external linkage and education by ABZ for its suppliers on best lean practice is important and should be established. The organisation should invite their top suppliers and take them through ABZ's operations with the view of helping them understand the lean operations ABZ has adopted.

Such a process would give the suppliers an opportunity to have a better understanding of ABZ's operations and the service that is expected from them in order for ABZ to maintain its level of

service to its customers. The suppliers should also be provided with lean literature for further in-depth knowledge of lean principles, and they could be invited by ABZ to lean related seminars on a regular basis.

### **6.2.3 Linkage between internal bodies and external bodies**

ABZ has established their in-house lean body, the green team, which should be used to network with other external bodies (Lean Institute Africa, Lean Enterprise Academy, etc.) in order to be updated about new developments regarding lean best practice.

The organisation should subscribe to these institutes' databases on behalf of their in-house bodies and obtain membership, which would give the green team the opportunity to attend the regular workshops and receive regular circular lean notes from these institutions.

### **6.2.4 Regular communication and feedback with customers**

ABZ should establish regular communication and feedback sessions with its customers with respect to the level of service they offer. A dedicated person, preferably the technical sales manager, should be assigned to carry out this process of engagement with customers on a regular basis and this should form part of his duties at ABZ. This would ensure that customers are kept informed of any changes to the company's operations and would easily alarm the organisation if there is any dissatisfaction about their service. It would also provide ABZ with the opportunity to receive direct feedback on matters of quality of their products.

### **6.2.5 The significance of the research outcomes**

The author is convinced that the recommendations presented in this study would be beneficial to ABZ. Specific areas that need improvement have been pointed out with the specific recommended applicable lean principles.

During the period that the author was searching for a company to conduct this study, it was noted that most SMEEs in the Western Cape Province have not implemented lean principles in their production/manufacturing processes. Figure 5.12 indicates that only some of the determinants from Karlsson's model were used by ABZ, however they did result in benefits such as reduction of costs and inventory, improved product quality, etc.

It can be argued that Figure 5.12 can be used as an incentive when approaching SMEEs with a view to convince them to embark on the lean principles journey. Thus, the author hopes to use Figure 5.12 as a reference to convince other SMEEs that even if only a few of the lean determinants can be adopted by an organisation, notable benefits will be forthcoming.

## BIBLIOGRAPHY

Aamodt, A. and Plaza, E. (1994). Case Based Reasoning: Foundations issues, methodological Variations, and Systems Approaches, *AICom-Artificial Intelligence Communications*, 7 (1), 39-5

Antil, J. (1988) New product or service adoption: when does it happen? *The Journal of Consumer Marketing*, 5, Spring, 5-18.

Crawford, C.M. (1988) How product innovators can foreclose the options of adaptive followers. *The Journal of Consumer Marketing*, 5, Fall, 17-24.

Emiliani, M. L. (2004) Improving business school courses by applying lean principles and practices. *Quality Assurance in Education*, 12 (4), 175-187.

Emiliani, M. L. (2005) Using kaizen to improve graduate business school degree programs. *Quality Assurance in Education*, 13 (1), 37-52.

Haque, B. & James-Moore, M. (2004) Applying Lean Thinking to new product introduction. *Journal of Engineering Design*, 15 (1), 1-31.

Hines, P. & Rich, N. (1997) The seven value stream mapping tools. *International Journal of Operations & Production Management*, 17 (1), 46-64.

Jacobs, K. & Yan, B. W. (2008) Applying a “Lean Enterprise” System to Increase Productivity at an SMEE in South Africa: Track 7, *CPUT*.

Jones, D. & Mitchell, A. (2006) Lean Thinking for the NHS. Lean Academy, UK: *NHS Confederation*.

Karlsson, C. and Ahlstrom, P. (1996) Assessing changes towards lean production. *International Journal of Operations & Production Management*, 16 (2), 24-41.

Kasul, R. A. and Motwani, J. G. (1997) Successful implementation of TPS in a manufacturing setting. Michigan, USA: *Industrial Management & Data Systems*, p274-279.

Khomo, J. & Maharaj, R. (2004) A Case Based Study in Operational Strategy. Cape Town: *The Graduate School of Business, UCT*.

Koenigsaecker, G. (2005) Leadership and the Lean Transformation. Lean Investments, USA: *LLC Muscatine*.

Kumar, S & Meade, D (2002) Has MRP run its course? A review of contemporary developments in planning systems. *Industrial management & Data Systems*, 102 (8), 453-462.

Likert, R. (1967) The method of construction an attitude scale. In: Fishbein, M (ed) *Reading in attitude theory and measurement*. New York: Wiley.

Massey, L. (2002) An Introduction to Lean Thinking. Lean Enterprise Research Centre, UK: *Cardiff Business School*.

Motwani, J. G. (2003) A business process change framework for examining lean manufacturing. Michigan, USA: *Industrial Management & Data Systems*, p339-346.

Mouton, J. (2001) How to succeed in your Master's and Doctoral studies. *A South African guide and resource book*. Pretoria: Van Schaik

National Research Council Canada. (2004) Principles of Lean Thinking, "Tools & Techniques for Advanced Manufacturing". Industrial Research Assistance Programme, *ITC*.

Penner, R. S (2005) An application of lean principles to product development. Business Administration and Management of Technology, Simon Fraser University.

Petroni, A. (2002) Critical factors of MRP implementation in small and medium-sized firms. *International Journal of Operational & Production Management*, 22 (3), 329-348.

Poppendieck, M. (2002) Principles of Lean Thinking. USA: LLC

Rajeev, N. (2008) Inventory management in small and medium enterprises. *Management Research News*, 31 (9), 659-669.

Rawabdeh, I. A. (2005) A model for the assessment of waste in job shop environments. *International Journal of Operations & Production Management*, 25 (8), 800-822.

Sidinile, V. (2007) The ongoing Lean Transition at Desta Power Matla. Presented at the Lean Summit, Africa. Cape Town.

Taj, S, and Berro, L. (2006) Application of constrained management and lean manufacturing in developing best practices for productivity improvement in an auto-assembly plant. *International Journal of Productivity & Performance Management*, 55 (3/4), 332-345.

Taj, S (2008) Lean manufacturing performance in China: assessment of 65 manufacturing plants. *Journal of Manufacturing Technology management*, 19 (2), 217-234.

Von Stamm, B. (2003). Managing Innovation, Design and Creativity. West Sussex, England. Wiley and Sons Ltd.

Voss, C., Tsikriktsis, N. and Frohlich, N. (2002) Case Research in Operations Management. *International Journal of Operations & Production Management*, 22 (2), 195-219.

Womack, J., Jones, T., & Roos, D. (1990), The Machine that Changed the World. New York, NY: Rawson Associates.



Womack, J. P. & Jones, D. T. (1996), *Lean thinking. Banish waste and create wealth in your corporation*. New York, NY: Simon & Schuster.

Yin, R. K. (1994) *Case study research: Design and methods*. Newbury Park, CA: Sage.

Zhang, Q. & Doll, W. J. (2001) The fuzzy front end and success of new product development. *European Journal of Innovation Management*, 3 (3), 125-136.

## APPENDICES

### Appendix A: The Questionnaire

#### Part One

<b>PERSONAL PROFILE</b>
-------------------------

Please make a cross "X" next to the appropriate item.

#### 1. Gender

1.	Male	
2.	Female	

#### 2. Age

1.	21~30	
2.	31~40	
3.	41~50	
4.	51~60	
5.	60+	

#### 3. Years of experience at your organization

1.	Less than 1 year	
2.	2~4	
3.	5~7	
4.	8~10	
5.	Over 10 years	

#### 4. Level of responsibility

1.	Manager Labour	
2.	Planning manager	
3.	Production manager	
4.	Labour	
5.		

Part Two

**COMPANY PROFILE**

**1. Population of the company**

1.	Less than 20 employees	
2.	21~40	
3.	41~70	
4.	71~100	
5.	Over 100 employees	

**2. Size of company R (m) (Turnover for 2008)**

1.	Less than 0.50	
2.	0.5~1.0	
3.	1.0~2.0	
4.	2.0~5.0	
5.	Over 5.0	

**3. Years of Lean Implemented**

1.	Less than 1 year	
2.	2~4	
3.	5~7	
4.	8~10	
5.	Over 10 years	

**4. Area of Lean application**

1.	Administration section	
2.	Design section	
3.	Manufacturing section	
4.	Maintenance section	
5.	Warehousing	

Part One

**OPEN – ENDED QUESTIONS**

1. **What has motivated the management to implement lean in your organization?**
2. **Did lean implementation bring improvements to your organization? If yes, how?**
3. **Do you think the improvement in your organization increased customer satisfaction? Give an example.**
4. **Has lean implementation placed your organization in a competitive edge? Give an example.**
5. **Does lean encourage or guide you to achieve better in all your work? If yes, how?**
6. **Do employees understand and accept lean in your organization?**
7. **Does the management encourage lean practices in your organization?**
8. **What do you think is still need to be improved through lean within your organization?**

## DECISION-MAKING

Please circle your answer in the box and give brief comments under each of the questions in order to support your response.

Code	Decisions
SA	Strongly Agree
A	Agree
DNK	Do not know
DA	Disagree
SDA	Strongly Disagree

For example, if you agree with the first question, you can make a circle on “A” as it is indicated in the table below:

The Lean implementation has helped the organization and employees to reduce waste in production process.	<b>SA</b>	<input checked="" type="radio"/> <b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
Comments:					

**Questions: Part Two**

1. Lean has helped your organization to eliminate waste of;					
Excessive lead and storage times.	SA	A	DNK	DA	SDA
<i>Comments:</i>					
<i>Waiting</i> while; material, information, people or equipment is not ready.	SA	A	DNK	DA	SDA
<i>Comments:</i>					
Unnecessary transportation of non-value adding products.	SA	A	DNK	DA	SDA
<i>Comments:</i>					
Over producing materials than customer needs	SA	A	DNK	DA	SDA
<i>Comments:</i>					
Rework and excessive defects items	SA	A	DNK	DA	SDA
<i>Comments:</i>					

<b>2. Lean helped your organization to reduce cost of;</b>					
Producing unnecessary products	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Unnecessary training of employees.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Over staffing	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Unnecessary rework and reducing defects.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
<b>3. Lean has helped your organization to improved quality of;</b>					
Produced products.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Workmanship amongst employees	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					

Its products on competitive standing.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
<b>4. Lean has helped your organization to improve production through;</b>					
Clearer working schedule.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Better performance during manufacturing process.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Less defects rate on products.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Reduced lot size.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Better organized house keeping.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					



The introduction and use of <i>kanban</i> system	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Standard setup during production	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Standard work methods	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
<b>5. Lean has helped your organization to improved safety through;</b>					
One-piece material flow during production	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Accidents awareness and displays in workshop	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Identification of plant processes and their sequences	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					

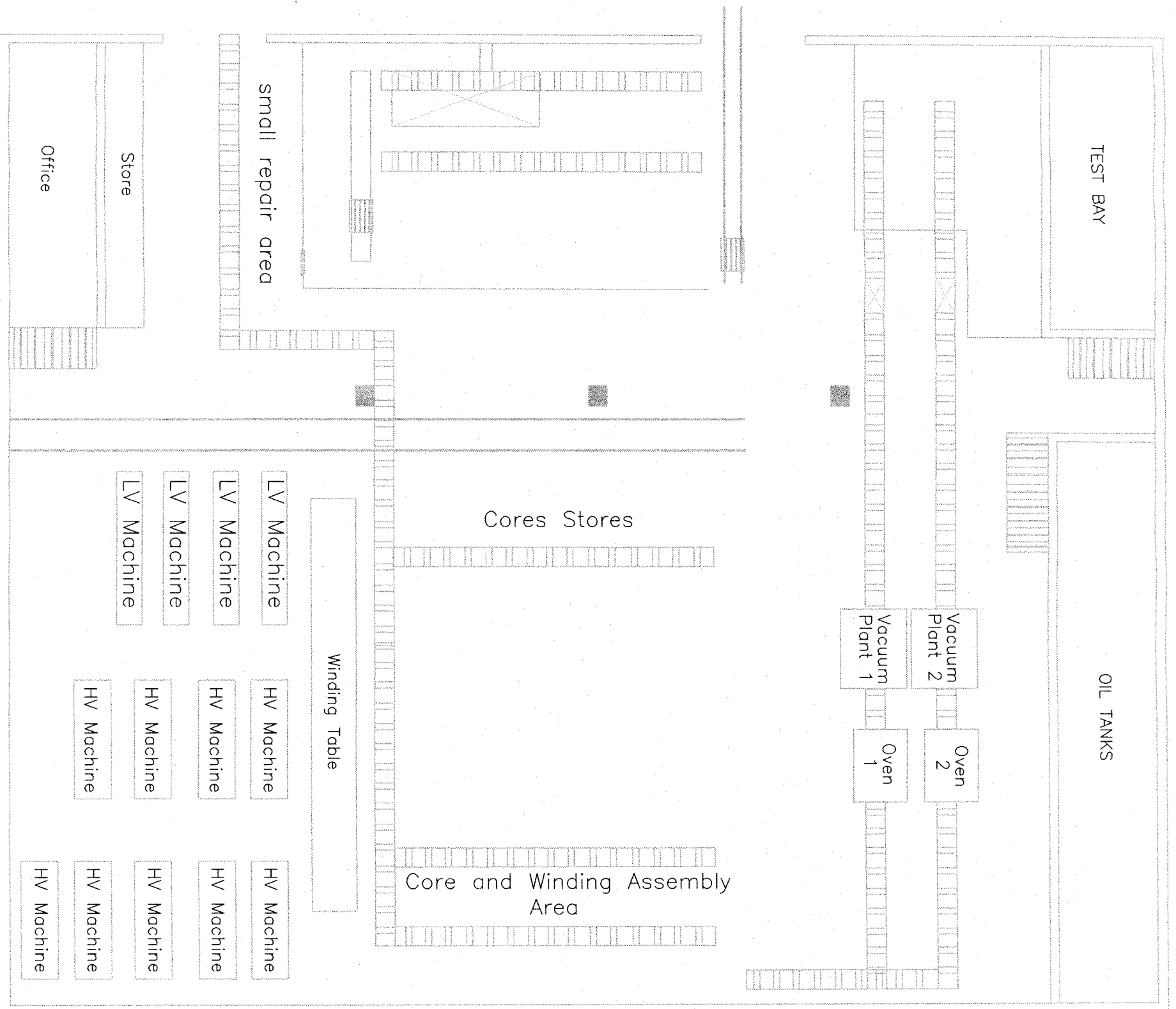
Introduction of preventative maintenance on equipment.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Establishment of stable working condition during production process.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Demarcating of floor layout.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
<b>6. Lean has helped to facilitate problem solving through;</b>					
Simplifying root cause analysis.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Improving employee logical thinking during production.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Enhancing staff knowledge and skills.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					

Training and self empowerment	SA	A	DNK	DA	SDA
<i>Comments:</i>					
Fostering individual accountability on work ethic.	SA	A	DNK	DA	SDA
<i>Comments:</i>					
Improving work culture	SA	A	DNK	DA	SDA
<i>Comments:</i>					
<b>7. Lean has helped to improve warehouse facility through;</b>					
Better cooperative culture within the organization	SA	A	DNK	DA	SDA
<i>Comments:</i>					
On-time delivery of products.	SA	A	DNK	DA	SDA
<i>Comments:</i>					
Reduction of stored inventories, parts etc.	SA	A	DNK	DA	SDA
<i>Comments:</i>					
Better storage arrangement.	SA	A	DNK	DA	SDA
<i>Comments:</i>					

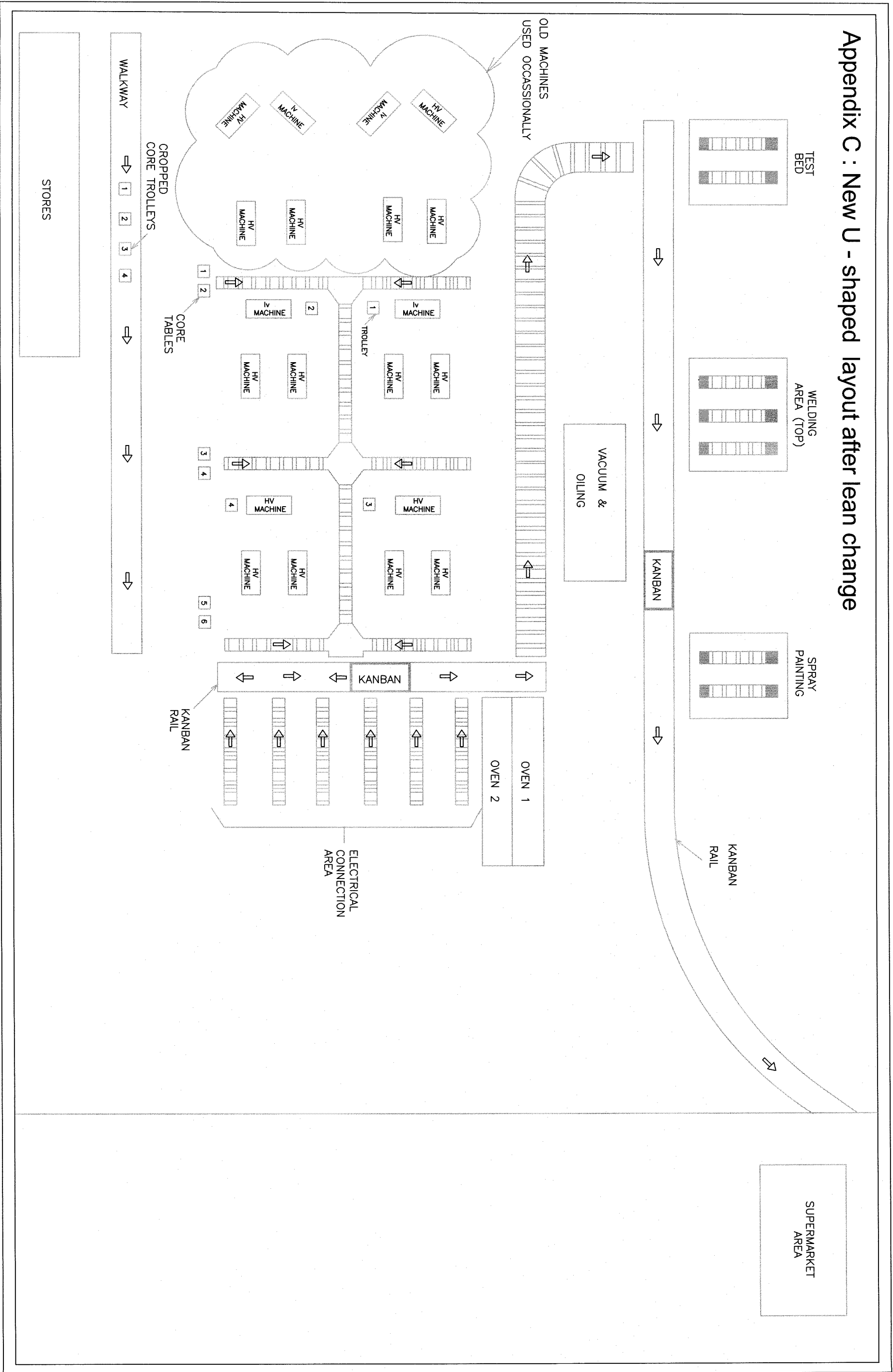
Placing material visible and clearly marked.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
The use of MRP technology.	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					
Control of continuous flowing material	<b>SA</b>	<b>A</b>	<b>DNK</b>	<b>DA</b>	<b>SDA</b>
<i>Comments:</i>					

**THANK YOU VERY MUCH FOR YOUR PARTICIPATION!  
YOUR FEEDBACK IS VALUABLE.**

# Appendix B : Old Layout prior to lean implementation



# Appendix C : New U - shaped layout after lean change



TEST BED

WELDING AREA (TOP)

SPRAY PAINTING

SUPERMARKET AREA

VACUUM & OILING

OLD MACHINES USED OCCASSIONALLY

ELECTRICAL CONNECTION AREA

CORE TABLES

CROPPED CORE TROLLEYS

WALKWAY

STORES

KANBAN RAIL

KANBAN

KANBAN

KANBAN RAIL

OVEN 1  
OVEN 2

1 2

3 4

5 6

1 2 3 4

1 2

3 4

5 6

1 2 3 4

5 6

7 8

9 10

11 12

13 14

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17 18

19 20

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