CHAPTER 1

PROBLEM STATEMENT AND OUTLINE OF THE STUDY

1. INTRODUCTION

In August 2004, Johnson Controls South Africa (JCI SA) announced that it was to embark on a lean manufacturing implementation programme. The rationale behind this implementation was to remain a leader in the global automotive seating market. This programme must result in the improvement in the areas of manufacturing and service to the customer.

After monitoring the lean manufacturing programme that was implemented in the American Johnson Controls organisations, the South African group came to the conclusion that the JCI SA manufacturing model had to be changed to the Lean Model. This move to perpetual renewal as Hill (1997:24) states, is required to meet the increase in competition from foreign companies that are invading the markets that were predominately controlled by the domestic organisations. Todd (1994: 6) indicates that the pace of manufacturing has increased rapidly and that it is important for organisations to embark on continuous improvement implementations to become global leaders in the manufacturing
sector. Realising this, it is vital that JCI SA implement a lean manufacturing programme that will assist the organisation in reaching world class manufacturing standards.

2. MAIN PROBLEM

The western manufacturing managers are under pressure from their Japanese counterparts. The results have shown that the Japanese industry achieved a 100:1 quality advantage and a 2:1 productivity advantage over its British counterparts through the integration of the manufacturing systems with the need to satisfy the customer (Rich, 1999:3).

The Japanese manufacturing facilities have utilised the capabilities of Lean Manufacturing and implemented a Just-In-Time (J.I.T) philosophy. The goal is to reduce the time between payment on one end and receipt on the other, thus moving material through the manufacturing facility quickly, not allowing inventory to stand and become dead stock (Sandras, 1989:7).

The aim of this research is to identify those lean manufacturing capabilities that are required to enhance Johnson Controls South Africa (JCI SA) to be a world class-manufacturing site.
This leads to the following problem, which was addressed by this research:

**What lean manufacturing capabilities must middle managers incorporate in JCI SA?**

### 3. SUB-PROBLEMS

An analysis of the main problem allows identification of the following sub-problems.

**Sub-problem 1**

What lean manufacturing competencies does the literature reveal that JCI SA requires?

**Sub-problem 2**

What lean manufacturing competencies do current JCI SA senior managers believe are required?

**Sub-problem 3**

How can the results obtained from the resolution of the two sub-problems (1 and 2 above) be integrated into a model of how to reach
4. OBJECTIVES OF THE RESEARCH

The overall purpose of this research is to develop a Lean Manufacturing Model for JCI SA to remain a leader in the global automotive seating market. More specifically, the objectives of this research are to:

- Determine from the relevant literature, what are the lean principles that should be utilised by JCI SA to reach world class manufacturing standards;
- Identify specific principles that can be used to implement lean manufacturing in JCI SA;
- Establish the extent to which specific senior and middle managers of JCI SA agree that these lean principles can assist their organisation in the implementation of world class manufacturing; and
- Obtain recommendations from JCI SA’s senior and middle management staff on lean strategies that JCI SA can use to achieve world-class manufacturing.
5. DEMARCATION OF THE RESEARCH

Demarcation of the research makes the research topic manageable when researching. Certain topics have been omitted, but this does not imply that there is no need to research these topics.

5.1 MANAGEMENT LEVEL

The study was limited to middle and senior management. All other levels such as co-ordinator and team leader management levels are excluded.

5.2 SIZE OF ORGANISATION

JCI SA organisations employing more than 50 employees were used in the study. The motivation for this is that there is opportunity to implement lean concepts in a larger scale in larger organisations and there will be greater demands placed on management to become lean in these larger organisations.
5.3 GEOGRAPHICAL DEMARCATION

The empirical component of this study was limited to JCI SA organisations lying within the following geographical areas.

- Eastern Cape: the region is defined as statistical region 01 and includes the motor manufacturing area of Uitenhage and East London.
- Pretoria: this region is defined as statistical region 02 and includes two motor manufacturing plants in Pretoria.

The study was limited to these two regions, as JCI has divisions in these regions.

The empirical survey was conducted by means of an e-mail questionnaire. A personal visit to these organisations also took place.

5.4 LEAN MANUFACTURING

The research was limited to examining the lean manufacturing model that will allow JCI SA to reach world class manufacturing standards.
5.5 JCI SA REACHING WORLD CLASS MANUFACTURING STANDARDS

This research was limited to examining how JCI SA can reach world class manufacturing standards.

5.6 SUBJECT OF EVALUATION

The field of managing JCI SA as an organisation to reach world class manufacturing standards can be divided into the following:

- Efficiency management and constraints management;
- Value adding management controls; and
- Lean manufacturing tools.

5.7 BASIS FOR THE MODEL

The intention of this study was to develop a Lean Manufacturing Model from the current literature. The aim of the study was to develop a Lean Manufacturing Model of how to reach world class manufacturing standards within JCI SA. This model was based on relevant literature and competencies identified by practitioners.
6. DEFINITION OF SELECTED CONCEPTS

6.1 LEAN MANUFACTURING

Womack and Jones (1996:115) found from their studies of lean manufacturing that there are five elements managers must address to create a lean system approach. These five elements are as follows:

- Identifying practices which provide customer service and activities which yield no benefit to the customer and can result in a cost to the business;
- Identifying the value stream which supports the organisation and meets customer quality standards;
- Creating a flow of materials that links the supplier and the enterprise by avoiding delays of batching and queuing of products;
- Creating Pull systems within the manufacturing facility, allowing the customer in the next department to pull and not have goods pushed onto themselves; and
- Creating the ‘perfect’ production system, thus the company cannot remain static, but must continuously improve.
For purposes of this research, lean manufacturing will be defined in chapter 3 as the term used to describe Just-In-Time (JIT) and the Toyota production system (TPS). It can also be defined as an adaptation of mass production that prizes quality and flexibility.

6.2 WORLD CLASS MANUFACTURING

World-class manufacturing can be seen as when an organisation has total preoccupation with quality. The organisation would practice total quality management (TQM). Everyone, especially the chief executive officer, is committed to success and proven technology is applied where best suited. Planning within the organisation takes place and the supply chain is integrated within the organisations operation.

The organisation displays flexibility and is not limited to boundaries. Concepts such as computer integrated manufacturing, Just-In-Time systems and total quality management are used as the main pillar to achieve world-class manufacturing levels (Walley, 1992:80). World-class manufacturing can be defined as an organisation having equal or above normal efficiencies, quality and technology levels within that global manufacturing sector.
6.3 INTEGRATED MODEL OF LEAN MANUFACTURING

The Lean Manufacturing Model developed in this research has been defined as a model that incorporates the Just-In-Time principles that the Japanese industry embraced in the mid-1970s. The model therefore, consists of flexible resource systems, cellular layouts, pull production systems, Kanban production controls, small lot production, quick set-ups, quality at the source, Total Productive Maintenance (TPM) and supplier networks.

7. ASSUMPTIONS

It is assumed that there are certain universal Lean manufacturing tools in the motor manufacturing industry, which will allow JCI SA to reach world class manufacturing standards.

It is also assumed that the lean manufacturing tools are independent of the type of manufacturing facility and operate in the same way, irrespective of the type of motor manufacturing organisation.
8. THE SIGNIFICANCE OF THE RESEARCH

Before 1994 the global markets were closed to South Africa. Political barriers were the norm, getting in the way of finding new markets, which could be supplied. The barriers insulated South African motor manufacturers from global competitors other than local competitors. This is no longer the case, as the new world economy has opened the door for South African organisations to compete in the global market. The free trade economy has also opened the door to global competitors that can assault the South African motor manufacturing market. It is alarming for the SA motor manufacturers to know that the increase in the number of competitors has caused a hypercompetition (Schonberger, 2001: 1).

The Motor Industry Development Programme (MIDP) that has been implemented in SA has assisted the South African motor manufacturers to penetrate the global markets as late entrants. But this subsidy will be phased out, due to pressures being placed on South Africa by the World Trade Organisation. It is therefore important for the South African motor manufacturing industry to become efficient, improve their quality and produce their products at a lower cost. This can be achieved through using the Lean manufacturing tools. The Lean Manufacturing Model proposed by
this study could be used by South African organisations to achieve the world-class standards that are required to compete in the competitive global market.

9. RESEARCH DESIGN

The description of the broad methodology that was followed is as follows:

9.1 RESEARCH METHODOLOGY

To solve the main and sub-problems, the following procedure was utilised.

9.1.1 LITERATURE SURVEY

Lean manufacturing tools, which should improve JCI SA to become world class, were identified from the literature.

9.1.2 EMPIRICAL STUDY

The empirical study consisted of:
• **MAIL SURVEY**

A mail survey was conducted among manufacturing directors, plant managers and manufacturing managers. The use of a questionnaire that was drawn up by the researcher that would establish what lean manufacturing tools are required in the South African motor manufacturing industry to reach world class manufacturing standards. The reason for choosing senior and middle manufacturing management is because they have had first-hand experience of what competencies and tools that are needed to be a world-class manufacturer.

• **MEASURING INSTRUMENT**

The instrument used to measure what tools are required for lean manufacturing was a comprehensive questionnaire that was administered via e-mail.

• **SAMPLE**

JCI SA senior management and middle management were used for the empirical study. A statistical random sample of all those that employ more than 50 employees were used for the e-mail survey.
• STATISTICAL ANALYSIS OF DATA

A statistician from Nelson Mandela Metropolitan University was consulted at the time the questionnaire was being drawn up and later to assist in interpreting and analysing the data.

9.1.3 DEVELOPMENT OF AN INTEGRATED MODEL

The results of the literature survey and the empirical survey were integrated to develop a Lean Manufacturing Model that could assist JCI SA to reach world class manufacturing standards.

10 KEY ASSUMPTIONS

It was assumed that there are universal lean manufacturing strategies that can assist any organisation in effectively implementing the lean manufacturing processes to achieve world-class manufacturing.

11. OUTLINE OF THE STUDY

The study includes the following chapters.
• Chapter 1 contains the problem statement, definition of key terms and outline of the study;
• Chapter 2 describes the organisational lean manufacturing implementation and processes at JCI SA;
• Chapter 3 examines theories of reaching world class manufacturing through the use of lean manufacturing tools and presents a theoretical Lean Manufacturing Model;
• Chapter 4 describes the empirical study and analyses the biographical details of the respondents;
• Chapter 5 analyses and interprets the results of the survey; and
• Chapter 6 reaches conclusions and makes recommendations for JCI SA to achieve a lean manufacturing environment.

12. CONCLUDING REMARKS

In this chapter, the main problem and sub-problems of the study were stated. Selected concepts were defined and an outline of the study was presented. In the following chapter the implementation of lean manufacturing at JCI SA will be reviewed.
CHAPTER 2
LEAN MANUFACTURING IMPLEMENTATION AND PROCESSES AT JOHNSON CONTROLS SOUTH AFRICA (JCI SA)

2.1 INTRODUCTION

In this chapter the implementation of lean manufacturing at Johnson Control South Africa (JCI SA) will be described. It is necessary to firstly understand the corporate profile of Johnson Controls as seen by the employees and stated by the chairman and Chief Executive Officer. It is therefore important to state the mission of the company.

‘Committed to Exceeding Customer Expectations’

Johnson Controls has expanded remarkably since Professor Warren Johnson founded the company to manufacture his invention, the electric room thermostat. Since it’s start in 1885, Johnson Controls has grown into a multi-billion dollar corporation, with worldwide leadership in two businesses; automotive systems and building controls.

The fundamental reason for the success is the commitment to
Johnson Control’s mission to continually exceed customers’ increasing expectations. This commitment has thus driven a focus of innovation and commitment to continuous improvements in quality, service, productivity and time compression. The belief is that if the organisation goes beyond what the customer expects, then the customers will return again and again, wanting Johnson Controls to further contribute to their success.

The automakers have found that by outsourcing their interior system requirements to Johnson Controls, quality has been maximised and the cost of the product has been reduced.

Johnson Controls has not only concentrated on manufacturing the automotive interior systems, but have also incorporated the design phase that integrates the two phases that are delivered globally.

Being proactive to rising consumer expectations requires a strong commitment to innovation. Most of the innovation delivered by JCI to the customer is by integrating electronics into the vehicle interiors through systems such as the HomeLink garage door opener, AutoVision rear seat video entertainment system and the remote tyre pressure monitoring system. The organisation uses electronics to
create automotive seats that cool, pulse and even continuously adjust to the movements of the body (Barth, 2005).

The JCI SA divisions that will be analysed are the Trim and Just-In-Time (JIT) business units. ‘Trim’ refers to the seat covers for the automobile. This division cuts the seat cover material to size and sources parts for the seat covers from local suppliers and abroad. The main operation that takes place in this activity is the sewing of the cover and then supplying the seat cover (Trim) to the JIT facility that is based on the customers’ premises.

2.2 BENEFITS OF LEAN MANUFACTURING FOR JCI SA

On time delivery is vital for JCI SA’s success, as disruptions caused by JCI SA on the customer’s line will result in a financial penalty. JCI SA’s policy is not to carry high levels of inventory and therefore leaves little margin of error when dealing with on time delivery of the product.

The Logistics Department in JCI SA is directly responsible for the organisation’s efficiency results, as this department’s key objective is to reduce the inventory holding costs and to supply the correct assembly parts to the manufacturing facility at the correct time. The
Logistics Department thus enables the production department to fulfil the customer’s daily production requirements.

At present the main hurdle that the Logistics Department encounters is that a large quantity of the components are purchased from overseas suppliers. It is therefore necessary to incorporated into the material requirements plan (MRP), an adequate lead-time for the shipping and import delays.

Competing in a global market place, flexibility has become a competitive weapon for the Trim and JIT manufacturing industries. Flexibility allows the organisation to produce a wide variety of products, introduce new products when the market is saturated and allows the organisation to modify existing products rapidly. Customer satisfaction is one of JCI SA’s main values that the organisation continually strives to exceed.

These challenges that JCI SA encounter in the global market has thus warranted the implementation of lean manufacturing. Utilising lean manufacturing tools like the value stream map, will highlight excessive inventory levels in the warehouse and in the process. This will also indicate which are the bottleneck processes in the value stream. The value stream map will also highlight where the high
change over times are in the process and again the lean manufacturing team can concentrate on improving these set-up times. By reducing the change-over times, it allows for the process to be changed from one product type to the next frequently and flexibility is created within the process. A concrete example of flexibility would be the Toyota die change-over time that Ohno created for the Toyota organisation. Neither the capital nor the large batch order quantities were available at that time, to warrant the purchase of many presses. Instead the focus was placed on methods to reduce the die change-over time from a 24-hour period to a three-minute change over time. This was successfully achieved and it allowed Toyota to make smaller batches and improved the model mix per day. An added advantage was the negligible holding costs that resulted from the flexibility of the die changing process (Womack, Jones & Roos, 1990: 51).

2.3 IMPLEMENTATION PROCESS

JCI SA has embarked on implementing a lean manufacturing process in all their manufacturing plants. The first roll out of lean manufacturing was implemented in the JCI United States of America (USA) plants. The success that has been achieved in this division of JCI, has warranted the next roll out to be implemented in
the European plants. JCI SA’s head office is based in Germany and for this reason it is jointly rolling out the lean manufacturing principles with the European plants.

2.3.1 The roll out of lean manufacturing at JCI SA

The roll out of lean manufacturing in the JCI SA plants has taken place as follows.

Firstly, the lean managers and lean implementers have been appointed and their reporting structure is a direct route to the plant managers. This allows the lean implementers to successfully implement the lean projects. Liker (2004:304) indicates that the lean implementer must report to the highest level in the plant, as organisations must make it mandatory with consequences for individuals that resist the continuous improvement changes. This also allows the lean implementer to move to the value stream managers’ position once the initial lean implementation has taken place. The value stream managers’ position will replace the conventional department manufacturing managers’ position and will take care of the entire value stream of that specific product.
The individuals that obtained the lean implementer and the continuous improvement manager positions were sent to Germany to be trained in the lean manufacturing principles.

The Johnson Controls Lean Manufacturing Director for Europe also presented lean manufacturing training in South Africa. The reason for this training was to introduce lean manufacturing to all the JCI SA managers and to educate the employees that will promote the lean manufacturing roll out.

The next phase of the roll out plan was for the lean implementers to record the value stream map of their manufacturing areas and also to create lean manufacturing teams that can implement continuous improvement projects to reduce the non-value adding times of a specific product. The composition of the lean manufacturing team consisted of the following departments: Quality engineer, Process engineer, Logistics expediter, Production co-ordinator, Warehouse co-ordinator and the Lean implementer.

2.3.2 Integration between JIT facility and Trim facility.

Just-In-Time (JIT) has been a successful component of JCI SA’s business operating systems. JIT has created a delivery system that is
responsive to the customer’s needs. Customer satisfaction has been achieved by carrying low levels of inventory and achieving high levels of inventory turn over on the customer’s premises. JCI SA has based its JIT facilities on the customer’s premises, thus removing the travel time of the product once it has been assembled on the seating frame (Sabatini, 2000).

The Trim facility supplies its covers to the JIT facility to assemble the cover on the seating frame. This is triggered by an enterprise planning system from JIT. It is vital that the two facilities have a reliable method of communicating and the Trim facility must also have the ability to change its model mix, as JIT requires.

For the JIT system to be successful, an integrated production system must occur between these two facilities. It is important that the Trim manufacturing process is stable and has also been standardised so that the product is produced on time and the quality levels meet the customers expectations (Russell & Taylor, 2003: 533).

2.3.3 Ultimate objective

The ultimate objective of lean manufacturing is to remain ahead of the intense global competition that is present in all vehicle segments.
The result of this intense competition is the continual price pressures created by the original equipment manufacturers (OEM’s).

Lean manufacturing gives the organisation the flexibility to increase the quantity of models within each platform and thus allowing the organisation to present a niche product in each vehicle market.

Lean manufacturing creates a manufacturing system that customises consumers’ needs that can be met on a timely basis. JCI SA realises that lean manufacturing can facilitate order to delivery lead-time improvements that are demanded by customers on an annual basis. This is one of the objectives that lean manufacturing organisations use as a competitive weapon, as it solves the product time compression task that the customer requires.

The adoption of lean production will change everything in almost every industry - choices for consumers, the nature of work, the fortune of companies, and ultimately, the fate of nations. Lean thinking provides a way to do more and more with less and less - less human effort, less equipment, less time, and less space - while coming closer and closer to providing customers exactly what they require (Womack, Jones & Roos, 1990: 53). This is the ultimate objective that lean manufacturing must achieve for JCI SA.
The objective of a lean producer is to manufacture to the customers’ requirements and pull the demand through the value chain. The organisation must constantly reduce set-up times to increase the utilisation of the equipment and labour. Lean manufacturing focuses on maintaining small quantities of inventories at strategic buffer points to smooth the production flow. Lean manufacturing not only improves the on time delivery of the product but also focuses on increasing the capability of the product quality.

The lean philosophy views people as a resource and not a liability. JCI SA’s ultimate objective of lean manufacturing is to have a workforce that is committed to the lean principles. Stabilising the manufacturing system and supply chain will be created by utilising a current and future state value stream maps of the product lines. Installing level scheduling and variation buffering will be achieved through tools like line pitch, capability studies and safety stock determination. The process engineers and quality engineers will be assigned to line support and standardised work instruction tasks and this will create a standardised process that will assist the efficiency and quality when manufacturing the product. By achieving these results, it would enable JCI SA to reach an adequate level of lean manufacturing.
2.3.4 Value adding processes vs. Non-value adding processes

JCI SA needs to concentrate on eliminating the non-value adding processes and time. To achieve this, the organisation must first understand what value adding time is defined as. A value adding process can be defined as the work that takes place on a product line that the customer will remunerate. Non-value adding time is the time that it takes to complete processes that the customer does not remunerate. Liker (2004: 303) defines value stream mapping as the method for showing in diagram format the material and information flow of a specific product line. It is vital that JCI SA records all the non-value adding time through the use of a value stream map and searches for solutions that will compress these times that are spent on the product. If the non-value added time is necessary to achieve the quality levels that the customer requires, then the lean manufacturing team must determine the least timely method of executing that non-value adding process step. JCI SA’s Trim plant must realise that payment from the customer is received from the following process steps.

The fist value adding process step that would be identified as value adding is the cutting of the material, the next step in the process would be the sewing of the material together and the final process that the customer acknowledges as a value adding process would be
the packing process. Realizing that there are only a few value adding processes in the JCI SA manufacturing plant, there must be a large focus on reducing the through-put times by eliminating the non-value adding processes. This improvement will in turn improve the stock turn around time and thus improve the stock holding costs of the company.

JCI SA at present has established a lean manufacturing team that creates value stream maps of the existing processes. This has assisted in identifying the value adding and non-value adding process times. This tool also indicates how long the product takes to flow through from the supply chain to the customers’ premises. The lean manufacturing team also highlights the kaizan blitz’s on the value stream map and solves these problems through separate task teams. The end result is that the product flows through the value stream within a reduced period of time.

2.3.5 Identification of mass production principles within JCI SA

JCI SA has realised the need for lean manufacturing principles, as there is still push demand that takes place in the manufacturing processes. The lot sizes are larger than what JCI SA requires, as the
production facilities’ stock holding is higher than a lean manufacturing plant generally stores. Senior management has indicated that to achieve greater cash flow benefits, the organisation needs to hold less stock on site and to rotate the stock more frequently. Deployment of quality containment inspectors has been incorporated into the production system and this is to address the quality product defects that are found by the customer. JCI SA has adopted the one-piece flow concept, but must still utilise this manufacturing tool fully, as quality is inspected at the end of the production line and not at the ‘source’ where the product is manufactured. Liker (2004:95) explains that the one piece flow concept builds in quality, as every operator is an inspector and the operators work together to fix any problem in the station before passing the product on.

2.4 PRESENT LEAN ACHIEVEMENTS AT JCI

The global JCI Lean manufacturing improvements have had a major impact on the business. The present JCI lean plant pilots have resulted in inventory reductions of 40 - 60%, floor space reductions of 10% - 70%, labour reductions of 2% - 33%. The lean logistics and supply chain replenishment tools have contributed to an overall
inventory turnover improvement of 25% and a reduction in normal and premium inbound freight costs of 15%.

JCI SA has also gained financial benefits by implementing lean tools in their Trim plant. They have improved their efficiency on one product line by 14% and reduced down time of one product line in a supply department by 80%. Great results have been achieved by the JCI SA group using the lean principles and it is vital that the organisation continues to utilise all the lean tools to experience the full benefit of this philosophy.

2.5 CONCLUDING REMARKS.

In this chapter, the description of the lean manufacturing implementation at JCI SA was discussed. An introduction of JCI SA and its corporate profile was described and the benefits of lean manufacturing for JCI SA were also highlighted. This chapter also described how the implementation process must be rolled out and that it should be executed through the integration between the JIT facility and the Trim facility. The ultimate objective of lean manufacturing for JCI SA was also highlighted and this can be implemented through the use of a value stream map process. In the
following chapter, the lean manufacturing principles will be discussed in detail.
CHAPTER 3
THEORY OF LEAN MANUFACTURING PRINCIPLES

3.1 INTRODUCTION – What is Lean manufacturing?

Schonberger (2001: 1) recognizes that the interrelated concepts and techniques going by the words like ‘lean’ and ‘world class’ have been fused together. These two words have formed a cohesive system of assessment and application. They have been nourished, not replaced, by the best ideas from the new management movement. This being from reengineering to six sigma, and from activity based costing to balanced scorecards. World class manufacturing principles is about staying ahead of hypercompetitiveness.

Schonberger (2001: 2) states that the Japanese success was out in the open by the early 1980s. This success was due to the Toyota get lean formula. The next thing that happened was that the Western industry learned and applied these Lean concepts. By the late 1980s the United States became the world’s generator of new ideas on how to manage a manufacturing enterprise.

Taiichi Ohno, the founder of Toyota Production System (TPS) states that when an organization wants to implement lean production, all the
company must concentrate on doing is to look at the time line from the moment the customer gives the order to the point when the cash is collected. To do this, the non-value-adding time must be removed (Ohno, 1988:57). The theory that will be discussed in this chapter shows that the value stream is a method of eliminating the non-value adding wastes that Taiichi Ohno highlights in his Toyota Production System.

Womack & Jones (1996:16) define lean manufacturing as a five-step approach. The first step is to define customer value, define the value stream, make it flow by pulling from the customer back and the fifth step in this approach is to strive for excellence. This five-step approach shows how the value adding and non-value adding processes is important to highlight and to action problems within a production line.

Kosiak (2005) advocates that lean manufacturing is a philosophy of production that emphasizes the minimization of the amount of all the resources and this includes time that is used in the various activities of the organization. It is important to identify the non-value adding activities in design, production, supply chain management and also in dealing with the customers. Kosiak (2005) says that the lean manufacturers must look at employing teams of
multiskilled workers at all levels of the organization and use highly flexible, increasingly automated machines to produce volumes of products with a large product variety.

Traditional manufacturing is characterised by production schedules that are based upon forecasts. These organisations also schedule large batch orders that are processed through multiple departments, based on their work functions.

Kosiak (2005) indicates that these traditional manufacturing methods create excessive inventories, and an overabundance of parts, and work in process (WIP) on the factory floor. The impact on the operation is wasted warehouse and factory floor space, excessive inventory, tracking costs, labour inefficiencies, and high cycle times.

A lean manufacturing initiative launched without careful consideration of the implications for upstream and downstream logistics is a recipe for supply chain delays. Kosiak (2005) shows the costs that a traditional functioning plant incurs due to its large inventory holding costs and the inflexibility of the plant, as it only schedules large batches through the production lines. But by incorporating the lean principles, it allows the plant to move the product through the process quicker due to the low inventory levels
and the flexibility of the machines that can produce a variety of products in a short period of time.

Penkala (2005) argues that lean manufacturing, often called agile manufacturing, is an operating strategy that seeks to maximize operational effectiveness by creating value in the eyes of the end customer. The focus is not isolated to an individual department, but the focus is on optimising the entire value stream. Penkala (2005) defines the value stream as a series of processes between receipt of customer order and delivery of finished product. Looking at the theoretical definitions of lean manufacturing, it is important to look at the entire process and to concentrate on eliminating the non-value adding time. Another point that has been raised is the flexibility of the lean plants to manufacture a variety of products and thus meeting or even exceeding the customers’ expectations.

3.2 WHY ARE ORGANISATIONS IMPLEMENTING LEAN MANUFACTURING PRINCIPLES?

Liker (2004: 28) lists the eight wastes that lean manufacturing can eliminate. These waste are as follows: over production, waiting time, unnecessary transport, over processing, excess inventory on hand, unnecessary movement, production of defects and the eighth
waste being unused employee creativity. By eliminating these wastes, the organisation will benefit financially. In the present global market, organisations need to achieve these financial gains to offer their customers better service, product prices and to even keep their customer from transferring their business to the opposition.

Schonberger (2001:11) says research shows that the majority of market leaders lose their top rankings within a two-decade period and it is therefore important to find out ways to renew and recover from regression, erosion, and complacency.

Lean manufacturing is a company philosophy that looks at continually improving and not being complacent. For this reason alone, it is important to implement the lean principles and not to become listed as one of those organisations which are dethroned once reaching the top position.

Penkala (2005) sees lean manufacturing improving the operating performance by focusing on the quick and uninterrupted flow of products and materials through the value stream. To achieve this, Penkala (2005) again states that the various forms of manufacturing wastes must be identified and eliminated. Waste can include any activity, step or process that does not add value for the customer.
Ohno (1988:57) also explains that by removing the non-value added waste it will reduce the product time line and thus reduce the costs to manufacture that specific product.

Under such a system, the plant is highly customer-focused, providing the highest quality, lowest cost products in the least amount of time.

Kosiak (2005) maintains that manufacturers get lean to trim waste. He indicates that those who advocate lean strategies tout the savings in labour, space, and time on the plant floor and beyond. It is for this reason that companies run on a very traditional 1970s lean business model that was developed by Toyota after World War II. This lean model offers companies a business strategy that eliminates waste while manufacturing the product. It is for these reasons mentioned above that organisations implement lean manufacturing as a competitive weapon in the global market place. It is important for an organisation to understand in detail, why lean manufacturing can be a competitive weapon.
3.2.1 Lean as a competitive weapon

Womack & Jones (1996: 13) indicate that lean manufacturing avoids high cost and rigidity in production, but strives to create teams that are multi-skilled at all levels in the organisation and uses machines that are highly flexible and automated to produce great product variety. In the ever-competitive global market lean can be used as a cost saving weapon, which is achieved through having better quality and efficiency rates.

Womack, Jones & Roos (1990: 103 ) note that lean production is fragile, but if the organisation totally believes in this manufacturing phylosophy, it will out perform the mass production organisations. The reason is that these mass production plants are designed to have costly buffers everywhere and this is in the form of extra inventory, extra space and extra workers to make it function properly.

3.2.2 Improves shareholder wealth

Lean impacts largely on the bottom line that the shareholders financially benefit from, as this lean philosophy strives for perfection in the work environment by continually reducing costs, striving for zero defects, striving for zero inventory and also looking
at creating a variety of products that will continuously exceed the customers expectations (Womack & Jones, 1996: 14).

Lean takes care of the financial aspects of a business to give the shareholders a continual increase in wealth. Lean does not measure on a quarterly basis the bottom line of the financial statement, as the Western world would do, but looks at improving the quality and efficiency of the processes. Doing this, the bottom line is taken care of continuously into the future, not like the Western world that focuses on short term (quarterly financial) improvements that are presented on the financial statement.

Lean manufacturing allows the financial department not to dictate to the production and quality departments, but directs cost savings through the use of process improvements and not through short term financial planning.

3.3 TYPES OF TOOLS USED TO CREATE A LEAN MANUFACTURING ENVIRONMENT.

Penkala (2005) focuses on nine key elements to implement a lean system and in these elements he discusses the tools that must be
used to achieve a lean manufacturing environment. These elements are now discussed.

The first element would be to capture the product value stream on paper with a cross-functional team and then to analyse the value stream to determine the factors that do and do not create value from the customer's point of view.

The second element is to streamline the manufacturing process by improving the flow of customer information to each department and determining the best flow of the materials and products through the value stream. In doing this, it will eliminate the waiting time and scrap.

The third element is to implement a quick changeover and set-up time that will reduce equipment downtime during production and between product changes. This additional time will improve the manufacturing flexibility to produce a wide variety of products.

Element four is important when one wants to hold a small amount of inventory, show up the bottleneck processes and improve the quality of the product. This element is to adopt a pull system and a one-piece flow methodology. This helps in synchronising the
manufacturing processes and also to produce to order rather than to stock.

The fifth element is to create a manufacturing cell system also known as a work cell or cross-functional team. These manufacturing cells will focus on the products rather than around process departments and the cells are responsible for quality at the operating source.

The is a fundamental point that Penkala (2005) raises, as lean manufacturing looks at engineering quality into the source where the product is manufactured and not like mass production that catches quality at the end of the manufacturing line. ‘Quality at the source’ is a phrase that is used in the Japanese plants and it means that the operator working on that specific product line is also responsible for checking the quality of that product before handing it over to their customer (next person in the manufacturing process).

Liker (2004:139) realised that in the Toyota plants, the workers all believed that they are responsible for quality and not that it is the Quality Department’s responsibility. This re-affirms that quality at the source best represents Toyota’s workers commitment to quality and if an organization wants to achieve lean manufacturing
standards then quality at the source needs to be instilled in the workforce.

Element six is vital for the organisation to satisfy the customers’ needs, as the organisation will be blindfolded to the customers’ needs if they do not respond to this element. The sixth element is to make operating performance and customer information visible on the shop floor to increase customer focus. This is important as the production operators are directly involved in making the product for the customer and is generally the only department that really adds direct value to the product.

The seventh element is to create lead-time metrics throughout the plant and in doing this it is important to continually identify ways to reduce these lead times.

Element eight is a method to get the entire company to buy into lean manufacturing and this is done through involving every employee in continuous improvement (kaizen) efforts, which in turn will improve the operating performance and accelerate the achievement of the organisational goals.
The ninth element institutes total productive maintenance (TPM) and this tool is incorporated into the manufacturing sector to increase equipment efficiency and reliability and to enhance ownership of the machinery.

Penkala (2005) summarises that the successful implementation of lean manufacturing starts by analysing the value stream of each product line. Doing this it will identify non-value added activities in the process flow. The key flow of a product and the way a product is manufactured should take place by adopting pull production and one-piece flow. This synchronises the manufacturing process. It also creates a small work in process (WIP) and finished goods inventories, minimal waiting time occurs on the shop floor and reduces the manufacturing lead times of the product. Such a strategy aims to produce only what the customer requires for immediate sale and the production process is only triggered by customer demand. A push strategy in a mass production environment, on the other hand, seeks to maximise the machine utilisation at each area in the plant. This allows for building piles of inventory between work processes. This disconnects the production processes from each other and extends the lead times in the value stream.
Liker (2004:130) notes that Toyota’s success has been due to solving quality problems at the source. This saves time and money downstream, as problems are fixed as they occur. For this reason, the Toyota management says that it is acceptable to run less than 100% of the time, even when the line is capable to run. The reason for this is, solve the quality at the source and the operating utilisation time will also increase.

Penkala (2005) discusses TPM and set-up time reduction as a lead-time reduction technique. In lean manufacturing it has been named as single-minute exchange of dies (SMED). This seeks to improve the product changeover proficiency on machines that in turn will enable shorter production runs and greater manufacturing flexibility. Quick changeover capability is vital in an environment of changing customer needs. SMED allows schedule changes not to throw the production department into a chaos situation. Manufacturing effectiveness in a lean manufacturing environment is not measured by maintaining high efficiency during long production runs, but by reacting quickly to customer changes and being able to consistently meet the daily production scheduled mix.

The lean approach is a transformation from a departmental-based organisation to one that is centred on products and product families.
Manufacturing cells are created on the shop floor to keep focus on an entire product within the plant. This allows the factory operators to take ownership of the product and it is easy to monitor, control and improved at the operating level, as the people who actually make the product are involved and held accountable by the use of hourly measurement systems.

By studying the lean manufacturing concept that Toyota coined as the Toyota Production System (TPS), there are specific continuous improvement tools that must be mentioned in detail that compliment the implementation of lean manufacturing in organisations (Womack & Jones, 1996:67). These tools are discussed below.

3.3.1 One-piece flow – Pull vs Push

Penkala (2005) explains that the traditional manufacturing plants use a ‘push’ production strategy. A push production strategy creates schedules for each area in production based on the sales forecast. In doing this, each area will run at maximum capacity, pushing material to the next manufacturing process. If the upstream process is more efficient than the downstream process, then this will create a large WIP deposit at the downstream process. Mass production/push system maximises the utilisation of each process
and therefore creates mountains of inventory between workstations throughout the plant. This interrupts the material flow, disconnects the workstations and lengthens the value stream processing time.

A pull system on the other hand allows the material flow to be triggered only when a customer orders material from the finished goods stock. Production is always triggered by demand from the next work centre. Ohno (1988: 13) defines the disadvantage of a push system, as having more inventory, but likely having inventory one does not need at that specific time.

Penkala (2005) states that the objective of a pull manufacturing system is to simplify scheduling of production. By creating a pull system, it benefits the organisation by minimising the lead times and inventories. Due to the ever-changing global markets, the pull system is designed to respond with minimal cost and waste and enables the manufacturing process to be flexible to customer product changes in both volume and mix.

Kanban, which is a card signal system, is the tool used to control the process in a pull production environment. The kanban system triggers the upstream operation whether additional product is needed at the downstream operation. Permission to produce is given not by
upstream to downstream processes as in the mass production environment but vice versa. The mechanism that is used to trigger the supplier to produce more of that specific part the customer requires is the parts’ container. The empty container is the automatic signal to make more of those parts (Womack, Jones & Roos, 1990: 62).

A pull manufacturing system requires that production stoppages are minimal. For this reason a pull system requires that the implementation of a Total Productive Maintenance (TPM) programme and a quality improvement system are present on the production floor. In a push manufacturing environment, manufacturing problems are hidden in WIP inventory. A pull system exposes the problems and deals with these problems making the organisation more profitable for the shareholders. It is vital that the organisation lowers the WIP inventory incrementally, to create an environment of solving the most detrimental problems first. It also shields the organisation from being inundated with problems all at once, but sorts the problems out in a methodical manner (Liker, 2004:101).

Ohno (1988:59) says that by running a one-piece flow process (manufacturing one part at a station and then moving it to the next...
station before manufacturing another part) and not batch producing, will stop operators from producing quantities that they would like to produce at a station. This will frustrate the operator, but will also make that operator think how to get the quantity that is required by the customer.

A tool that can be used to aid the creation of a one-piece flow process, as mentioned previously, is the cellular manufacturing layout.

### 3.3.1.1 Cellular manufacturing

An integral part that creates a one piece flow manufacturing system is the cellular manufacturing layout, also known as flexible manufacturing cells (FMC). This machine layout lends itself to the lean manufacturing philosophy, as it seeks to reduce manufacturing lead times, improves product cost through reduction in inventory, builds in quality, creates real flexibility, frees up floor space and creates an atmosphere of employee involvement and continuous improvement (Liker, 2004:96).

Penkala (2005) highlights that Cellular manufacturing is a series of product-focused work groups or cells, which contain all the
operations that manufacture a family of products. The cellular manufacturing system is dedicated to manufacturing those products that require similar operations. While the mass manufacturing environment is laid out functionally with similar machines in one area, cellular manufacturing operates by starting with the raw material process and ending with the finished product that will be sent to the external customer. All the operations are performed in the manufacturing cell.

The machines in the manufacturing cells are located within close proximity to minimize the manufacturing waste of over transportation and the cell assists in maintaining a continuous flow with zero inventory between operations. The manufacturing cell must contain operators that are multi-skilled and who will take complete responsibility for quality and delivery performance within the cell. Cellular manufacturing will highlight the unskilled operators in the cell through the inventory build up in front of their workstation.

Penkala (2005) says that it is important to start a cellular manufacturing system with the right people and success will be carried throughout the rest of the organization with this pilot group. The process engineers must ascertain what machines and equipment
are needed in the cells and also allocate an area with enough space to create the cellular manufacturing process. The cell's products should be located together and this will minimise the cell's dependence on resources or the operations that are external to the cell. It is important to focus on the common set of operations that is needed to manufacture the products in the cell.

For cellular manufacturing to be a success, the cell must contain multi-skilled operators who can move freely as needed between work centres within a cell, as to balance the cells’ workload between the operators. The idea is teamwork - it is important not to consider the individual performance, but to consider the team’s performance (Ohno, 1988: 24).

3.3.2 Total Productive Maintenance (TPM)

Schonberger (2001: 109) explains that TPM does not imply “We did our TPMs”, but that it is a philosophy of continuous improvement, as it seeks to achieve zero breakdowns and zero defects. This TPM philosophy is achieved through equipment maintenance and sustained operator involvement. The benefit of TPM is the elimination of losses due to breakdowns on the shop floor.
The overall equipment effectiveness (OEE) as Schonberger (2001: 111) states has only two uses, the first to raise an alarm after a number of months and the second reason is to benchmark against other companies. Utilisation of machines has no merit as a measure of performance. TPM on the other hand can eradicate production losses and should therefore be the philosophy that an organisation should concentrate on. The losses that TPM can eradicate are as follows.

The first loss would be through machine breakdowns and this is due to unexpected equipment repairs. Costs that can be associated with machine breakdowns are output losses and higher labour dependant costs.

The second loss that can be eliminated is the set-up and adjustment time losses that occur during product changeovers, shift change and changes in operating environmental conditions.

Speed losses occur when equipment is slowed down to prevent quality defect stoppages. The speed losses have a negative effect on productivity and asset utilisation.
The fourth loss would be quality defect losses and this is caused by the manufacture of defective or sub-standard products, which must be reworked or scrapped. These losses include the labour costs to rework the defective part and material costs associated with the material that must be scrapped.

Yield losses are the fifth type of loss that occurs and is reflected through wasted raw materials associated with the quantity of rejects and scrap that result from start-ups, changeovers, equipment limitations and poor product design.

The overall equipment utilisation is affected by these losses stated and TPM is a lean manufacturing tool that seeks to reduce these losses. TPM can be used as a tool to solve the route cause of machine downtime and OEE measurement can be a tool for the plant manager to see how TPM is progressing in the plant.

Penkala (2005) explains that TPM involves small group activities with participation from maintenance and the manufacturing personnel on the shop floor. The objective of a TPM system is to teach the operators how to maintain their equipment and to perform minor repairs on their machines before a breakdown or loss occurs. In doing this, the operator does not need to wait for a maintenance
technician to fix the minor breakdowns that occur on their production line.

3.3.3 Total Quality Management

When transferring from a mass production operation to a lean operation that has just enough inventory, and is delivered just in time, the quality must be observed at the source and not at the end of the production line. TQM also affects the organisation's political system, as the decision-making processes will be placed at the lower levels in the organisation and not only at management level. The decision-making base is incorporated in the TQM process to assist the employees that are adding the value to the product. It is an important step for South African organisations to implement these cultural changes, as this will set the company atmosphere where TQM can be implemented successfully. The Japanese organisations have shown that the cultural atmosphere is vital for continuous improvement. Senge (1992: 274) affirms that organisations striving to achieve successful management cultures like TQM, will not be a success, unless the cultural and political part of an organisation is attended to.
A personal programme of leadership development for South African managers that will create a participative management style in their leadership skills is important. It will assist the managers to function as an internal TQM change agent. Instead of telling the employees what to do and punishing the employees when they deviate from the correct method, the leader should rather help individuals to do a better job and the result will be an objective learning environment for all in the organisation (Walton, 1986: 35).

For the TQM culture to be present in a South African organisation, all the organisational systems must be aligned. So it is important for the human resource systems, such as job design, selection processes, compensation & rewards, performance appraisal and training & development to be aligned to the TQM system. TQM integrates fundamental management methods, existing improvements and tools under one disciplined approach (Besterfield, 1995: 2). The information systems will need to be redesigned to measure and track the correct information that can be acted upon, to assist the company to achieve TQM.

Senge (1992: 299) explains that the learning organisation is important for an organisation to achieve TQM and this involves staff always learning how to do better and management learning how to
be more responsive to staff. The leaders will facilitate this process, by helping the staff develop their own visions and aligning these visions with that of the organisation's quality vision.

Jablonski (1992: 60) recommends that management must implement process action teams, who are, interested in the TQM organisational change and who will evaluate, improve and implement change. Less energy will be needed to get greater results through this core team and this will start a positive wave for TQM. Leaders need to be persistent, using constant reinforcement, through continuous training.

The leaders must make sure that the organisation sees TQM as a process and not a programme that could be phased out. It should be integrated into ongoing operations and the focus should be on how an organisation can continuously improve their goals and objectives. It is important not to overemphasize techniques such as statistical process control and the use of charts. The employees should rather focus on the systems, the analysis and the improvement of processes.
The implementation should be gradual, so that meaningful culture change is ensured and frequent feedback must be given to the leaders.

It can never be overstated that involving the employees in the decision making process at each stage and every level is vital for the success of TQM.

Besterfield (1995: 68) believes that union representatives must be involved in programmes that involve employees and it is therefore important for the organisation to have discussions with the unions about the TQM roll out. Leaders must create an atmosphere that allows the workers and managers to feel free to share improvement ideas. Emphasis on client feedback must be made known to the relevant employees and quantitative and qualitative performance tracking must take place in the self-directed work team forums.

The concept of ‘management by walking around’ is a useful way to stay in contact with the plant operations and to be accessible to the employees on the floor when they highlight improvements. This again eliminates the organisational levels, as the manager is accessible to all employees and there is no need to go through the long red tape system to get an improvement implemented. The
leaders must meet weekly with middle managers regarding their personal efforts to use TQM in the plant. It is important that the employees are trained in horizontal and vertical communication, as this will get the groups to communicate with each other.

Liker (2004: 38) believes that the company culture must be one of: "stop and fix the problem, to get quality right the first time”. It is important that the organisation first learns to see the problems before learning to fix problems. The managers must continuously check with the employees, their comfort with the process. If people are feeling threatened, the process pace should be reduced to address this issue.

The suppliers and the employees must feel like partners and there should be a mutual commitment from every one. As mentioned previously, it is important for the top management to lead in this roll out. Quality needs to be built in at the source. A dynamic tool that the Japanese use is the ‘poka –yoke’ system and this means to error proof the operation so that the operator can only produce that part the correct way every time (Liker, 2004:132).
3.3.4 Create uniform production – Kanban & Just In Time

Sandras (1989:1) describes how just-in-time works, the principles that hold it together, the motor that propels it and what the operator must do to drive it. It is also stated that lean manufacturing is a constant series of small steps, which is a safe, economical and rapid way to drive continuous improvements into the manufacturing organisation. Sandras (1989: 2) identifies four factors, which play a role in promoting a Lean manufacturing organisation. For the organization to implement a uniform production process, it needs to take the following four factors into account.

The first factor to consider when creating a pull system from the customer would be the kanban (card signal) system, which works the same way, as a signal to replace what has been used. If the kanban authorization is present, one can act. If it is not, one does not act. In lean manufacturing it is important to control inventory and the kanban system does just that. It again promotes one-piece flow rather than large batch production. The customer will signal to the supplier when to manufacture the next parts. It will allow for fewer inventories on the line and this will help the reduction of scrap parts (Likert, 2004:23).
Ohno (1988: 95) shows how reducing and avoiding set-ups gives an organisation the flexibility of running smaller batches. In lean manufacturing, it is important to reduce unnecessary and non-value adding production time. Reducing and avoiding set-up times can assist in achieving these results. The objective is to make sure that the set-up time is an external process time that can occur while the machine is operational or the set-up time can be reduced by using the single minute exchange of die philosophy (SMED) (Womack, Jones & Roos, 1990: 52). This system gives the organisation flexibility, but also allows the organisation to hold fewer inventories on the factory floor. So this is a key tool to achieve a Lean manufacturing plant and it aids in developing a production line that is uniform.

The third factor to consider is the importance of linking the supplier and customer together. This reduces the value chain time by linking the supplier to the operation and linking the manufacturing operation to the customer. A proven method is to supply just-in-time and even have the supplier on the customers manufacturing sight. This close relationship sets the perfect scene for communication and to create the ‘customer-in’ relationship rather than the fatal ‘product out’ policy. It is important for the organization to be based close to the customer. If the supplier cannot be based close, then a well set-up
communication system must be implemented to alert the supplier when to manufacture the next good parts (Liker, 2004: 24).

The fourth factor is to measure performance, as it is important to see where the organisation is at present. The best way of doing this is to measure the performance of the operation by first looking at quality and then looking at the efficiency.

Schonberger (1982:103) states that it is important to standardise and simplify the operation. By simplifying the process, mistakes are not easy to make. The process can then be stabilised and goods will flow like water.

3.4 APPROACHES OF LEAN MANUFACTURING

Russell and Taylor (2003: 534) state that the lean pull system is the basis for the just-in-time production system. This basic concept of just-in-time began in the supermarket. The Japanese factories used this concept to replenish their inventory instead of using huge inventory build-ups and complex scheduling algorithms.

It is reasonable to assume that there are certain universal lean manufacturing approaches, which will result in a positive
consequence to reach world class manufacturing standards. Part of this proposed research would be to find these universal lean manufacturing approaches, which will lead to the world class manufacturing standards that are required to be global manufacturing leaders in a certain manufacturing sector.

Four views of effective lean manufacturing approaches are presented below. These are:

- Schonbergers’ theory of nine hidden Japanese manufacturing lessons;
- Shingos’ study of the Toyota production system and this is from an industrial engineering viewpoint;
- Richs’ lean approach of total productive maintenance; and
- Likers’ utilisation of value stream mapping.

3.4.1 SCHONBERGER’S THEORY OF NINE HIDDEN JAPANESE MANUFACTURING LESSONS.

Schonberger (1982:8) notes nine Japanese manufacturing lessons that the western world can learn from and these are as follows:

lesson 1: Management technology is a transferable commodity;
lesson 2: Just-in-time can expose excess inventory;
lesson 3: Quality must be a habit;
lesson 4: Culture is not an obstacle;
lesson 5: Simplify the process;
lesson 6: Process flexibility is vital;
lesson 7: Just-in-time inventory purchasing;
lesson 8: Form quality circles; and
lesson 9: Maintain simplicity.

Schonberger (1982: 2) states that total quality control is vital for production to reach world-class standards. Total quality control is a tool used by lean implementers to improve the efficiency of the plant and drive down customer quality concerns. Quality must be engineered in at the source and it begins with production. It should become a habit of improvement for the organisation.

3.4.2 SHINGOS’ STUDY OF THE TOYOTA PRODUCTION SYSTEM

Shingo’s (1989: 67) view of lean is directly in line with the Toyota production system. The Toyota system is a system for the absolute elimination of waste. It states that an organisation must eliminate waste and make fundamental improvements in the production system before implementing techniques like kanban.
The Toyota production system is a means of achieving just-in-time production. So the Toyota production system can be used as a lean implementing tool to achieve world class manufacturing standards (Shingo, 1989: 68).

3.4.3 RICH’S LEAN APPROACH OF TOTAL PRODUCTIVE MAINTENANCE.

Rich (1999: 25) maintains that an organisation cannot transform to lean without Total Productive Maintenance (TPM). As stated previously about the Toyota system that looks at reducing waste, it is also important for the lean implementer to achieve levels of machine availability and flexibility that is needed to link processes into a continuous flow. For lean to be a success, it is important to pay as much attention to the organisations’ machines and not only look at the production processes and people to eliminate waste.

3.4.4 LIKERS’ UTILISATION OF VALUE STREAM MAPPING

Liker (2004:275) states that the value stream map is a proven tool to implement lean manufacturing successfully, as it captures existing
processes, material flows and information flows. It also helps to identify waste in the system (Liker 2004:279).

The environment that this tool should be utilised in is through a kaizen workshop. The following steps will take place in this workshop.

The customer is defined, the current state map is drawn up, the future state map is designed, action plan is recorded, implementation takes place and lastly the improvements are evaluated.

Liker (2004:303) explains that the value stream map (current state map) allows the lean manufacturing team to see the waste and also assists (future state map) in applying the lean tools and philosophies on the production line.

3.5 INTERGRATED MODEL OF LEAN MANUFACTURING

Liker (2004:303) believes that at least 80% doing and 20% of training and informing should take place when implementing a lean manufacturing environment in an organization. A good example of this is the ‘Toyota way’, which concentrates on learning by doing.
The literature discussed in this chapter indicates that a successful lean manufacturing model is one that incorporates just-in-time. Another important aspect of this model as Schonberger (1982:48) states, is total quality control. This is vital for production to reach world-class standards in quality. To achieve high levels of quality and productivity, the process must be simplified. In doing this, mistakes are not easily made. The process can then be stabilised and goods will flow properly, improving the value stream.

Shingo’s (1989: 67) view, which must be incorporated in the lean manufacturing model, is directly in line with the Toyota production system. This system concentrates on eliminating waste. The method to identify the wastes is through the creation of a value stream map, as it highlights the value adding time and non-value adding time process.

Rich ‘s (1999: 48) approach, which is also important in creating this model, is to focus on eliminating waste, but this is implemented through a Total Productive Maintenance (TPM) system.

For the lean manufacturing model to be successfully implemented in an organisation, the following tools must be implemented
simultaneously: One-Piece flow, cellular manufacturing, TPM, TQM and kanban creating a JIT production system. When companies fail at lean, it’s usually because they start by trying to master individual lean tools. Instead, organisations should begin their lean journey by developing an overall strategy that utilises all the lean tools, as this will direct the organisation to world class manufacturing levels (Kosiak, 2005).

The theory of lean manufacturing as explained by the authors in this chapter have shown that JCI SA as a manufacturing seating plant, should follow the lean manufacturing model as shown in figure 3.1

An organisation should firstly stabilise, then standardise and finally simplify their manufacturing process before embarking on the lean manufacturing journey. Once this step has taken place, the lean manufacturing team must decide on which production line the lean manufacturing improvements should be applied. Once the pilot line has been chosen, then the capturing of the current process must occur. The tool that must be utilised for this step in the lean model is the value stream map. The current state map is used to identify the non-value adding and value adding processes. The lean manufacturing team will concentrate on eradicating the non-value adding processes and also improve the value adding processes, as
there may be non-value added steps within the value added process. Once this has been completed, the future state map must be drawn up to visually analyse how the pilot line’s non-value added time has been reduced. It is at this step in the lean manufacturing model that the lean manufacturing tools are decided upon for that specific pilot line and also implemented simultaneously. Once the improvements have been successfully implemented, the lean manufacturing team will then evaluate the success that has been achieved. If the project has reached an adequate level of success (as per the goals set out for the lean manufacturing team), the team will hand the improved pilot line over to the process owner. If the lean implementation process has not reached the levels that the team set out to achieve, then an assessment of the cause of the problem will be analysed through the use of a kaizen workshop.
The purpose of this chapter was to discuss the theory of lean manufacturing principles that contemporary literature reveals. Various types and models of lean manufacturing were discussed. The various approaches and strategies that an organization can use to effectively execute lean manufacturing change were also highlighted.
From the theory discussed in this chapter a lean manufacturing model was developed. This model formed the basis for the development of the research questionnaire which is discussed in section 4.3.2.

The following chapter outlines the research methodology and analyses the biographical details of the respondents.
CHAPTER 4

RESEARCH METHODOLOGY AND ANALYSIS OF THE BIOGRAPHICAL DETAILS OF RESPONDENTS

4.1 INTRODUCTION

In chapter 3 the theory of lean manufacturing principles were established and an effective lean manufacturing model was developed for JCI SA. The literature study was used to establish the answer to sub-problem 1: What lean manufacturing competencies does the literature reveal that JCI SA requires?

The purpose of this chapter is to describe the research methodology pursued for this study. An analysis of the biographical details of the respondents will also be presented.

4.2 RESEARCH DESIGN

Research, as defined by Welman & Kruger (1999:2), is the process by which scientific methods are used to expand knowledge of a particular field of study. In this case it would be lean manufacturing. Leedy (2001:91) defines research design as the complete strategy to solve the main research problem. It is a structural means of
establishing ways that must be followed when conducting research. It is therefore vital that the design of the research must be carefully planned. The research design for this study was broken down into a main problem, with three sub-problems. The main problem is as follows: What lean manufacturing capabilities must middle managers incorporate in JCI SA?

The three sub-problems that follow on from the main problem were identified to assist with the resolution of the main problem. The three sub-problems are:

- What lean manufacturing competencies does the literature study reveal that JCI SA requires?
- What lean manufacturing competencies do current JCI SA senior managers believe are required?
- How can the results obtained from the resolution of the two sub-problems above be integrated into a model of how to reach lean manufacturing standards within the JCI manufacturing industry in South Africa?

4.3 CONDUCTING THE EMPIRICAL STUDY

The empirical study was conducted by means of a mail survey and the questionnaire was the tool used as the measuring instrument.
Greenfield (1996:121) explains that the questionnaire should be short and easy to understand. The reason for this is that it will ensure that the correct answers to the questions will be elicited from the respondents. A statistical analysis of the questionnaire was undertaken.

4.3.1 Sample

When conducting a research project, the entire population that is being researched is not always possible to cover. The researcher will then use subsections of the population and the findings will therefore represent the entire population. Leedy & Ormrod (2001:211) state that the sample of the population must be carefully chosen, as the researcher must be able to extrapolate all the characteristics of the total population. The size of the sample must also be able to see the total populations characteristic (Birley & Moreland, 1998:44).

For this research project, probability sampling was chosen because every element in the population has a known probability of being selected in the sample. Cluster sampling was the probability sampling technique followed. The reason for choosing clustering is that the population is divided geographically and by occupation. This allows the sample to represent the total population.
The representative sample for this study consisted of middle managers, senior managers and continues improvement experts at JCI SA who have a direct impact on the manufacturing sector. The sample population was also geographically selected, as JCI SA has different types of manufacturing sites and in different regions of South Africa namely Uitenhage JIT plant, Uitenhage Trim plant, East London Cock Pit plant, Pretoria JIT plant and Pretoria Trim plant.

4.3.2 The Questionnaire

Leedy & Ormrod (2001:202) suggest that clear instructions must be provided and this should be achieved by communicating exactly how the researcher wants the respondents to respond. To make sure that this is achieved, a pilot study must take place, as this will highlight items that are difficult to understand.

The questionnaire developed for this research was simple and easy to understand by the respondents. Close-ended questions with a four-point scale were utilised. The most appropriate box was ticked by the research respondent and a theoretical lean manufacturing model was attached to the questionnaire as a visual aid to eliminate any
confusion when answering the questionnaire (Annexure 1 shows the complete questionnaire).

4.3.2.1 Pilot Study

A pilot study helps to refine the questionnaire so that the respondents have no issue in answering the questions that are presented to them (Saunders, Lewis & Thornhill, 2000:305).

Saunders, Lewis & Thornhill (2000:307) explain that the pilot study will also show if visual aids are required for clarity and if the pilot respondents are experiencing problems following the questionnaire. It is for this reason that a lean manufacturing model was attached to the questionnaire to assist in the clarity of the questions asked.

The pilot study was given to six of the researcher’s work colleagues to establish if they had difficulty in understanding any of the items in the lean manufacturing questionnaire. These colleagues also checked for spelling and grammatical errors. Suggestions from these colleagues were incorporated in the questionnaire.

The names and respective divisions of the middle managers, senior managers and continuous improvement experts required for the
sample were obtained from the Head Office Human Resources department. For the Port Elizabeth respondents, the questionnaire was personally distributed to these individuals. E-mail was the medium chosen for distributing the questionnaire to the East London and Pretoria respondents.

4.4 RESPONSE RATE

Questionnaires were mailed to 26 JCI SA employees on the 5th of October 2005 and of the total representative sample sent out, 22 responses were received on the 16th of October 2005. This represented a response rate of 85 per cent. The overall response rate is illustrated in table 4.1 and Chart 4.1.

| TABLE 4.1 |

| OVERALL RESPONSE RATE FROM JCI SA EMPLOYEES |

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attained Responses</td>
<td>22</td>
<td>85%</td>
</tr>
<tr>
<td>Outstanding Responses</td>
<td>4</td>
<td>15%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>26</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire
A fair spread of responses was received from the different JCI divisions in South Africa. The responses obtained from the J.I.T seating plants were 18%, the J.I.T cockpit plant was 9%, Head office was 18%, Trim cut and sew & J.I.T was 9% and the majority of the responses were received from the Trim cut and sew plant which translated into 45% of all the responses received. The responses according to the JCI SA divisions are depicted in table 4.2 and chart 4.2.
TABLE 4.2
RESPONSES ACCORDING TO JCI SA DIVISIONS

<table>
<thead>
<tr>
<th>DIVISION</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trim cut and sew</td>
<td>10</td>
<td>45%</td>
</tr>
<tr>
<td>J.I.T seating</td>
<td>4</td>
<td>18%</td>
</tr>
<tr>
<td>J.I.T cockpit</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td>Head office</td>
<td>4</td>
<td>18%</td>
</tr>
<tr>
<td>Trim cut and sew &amp; J.I.T</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section A1

CHART 4.2
RESPONSE ACCORDING TO JCI SA DIVISIONS

Source: Table 4.2 converted to a Pie Chart

The response rate levels were compared among the regions where each JCI SA plant resides. The Port Elizabeth office recorded a 94
per cent response rate and this translated into 73 per cent of the total response rates among all the regions. The reason for the high response rate in Port Elizabeth is that the respondents were given the questionnaire personally and were reminded on a daily basis to return the completed questionnaire on time. Port Elizabeth’s overall response rate was very high compared to the other regions due to this region having the largest plant based in this region and Head office also resides in Port Elizabeth. East London and the Pretoria region respondents were e-mailed the questionnaire to complete. Both had a 67 per cent response rate, but due to the plant sizes in these regions, they had a 9 per cent and 18 per cent overall response rate respectively. Table 4.3 and Chart 4.3 reflects the high response rate from the Port Elizabeth region.

### TABLE 4.3
RESPONSES ACCORDING TO REGION

<table>
<thead>
<tr>
<th>REGION</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Elizabeth</td>
<td>16</td>
<td>73%</td>
</tr>
<tr>
<td>East London</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td>Pretoria</td>
<td>4</td>
<td>18%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section A.2
4.5 ANALYSIS OF BIOGRAPHICAL QUESTIONS ASKED

Question A.3 in the questionnaire asked the respondents to indicate the position they hold in JCI SA. The distribution can be seen in Table 4.4 and Chart 4.4. Top management represented 32 per cent of the respondents, middle management also known as senior management represented 41 per cent of the respondents, there was no junior management that took part in this questionnaire and the continuous improvement experts represented 27 per cent of the respondents. Overall there was a large component of senior and top management that took part in this empirical study.
### TABLE 4.4

RESPONSES ACCORDING TO RESPONDENTS POSITIONS

<table>
<thead>
<tr>
<th>REGION</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top management</td>
<td>7</td>
<td>32%</td>
</tr>
<tr>
<td>Middle management</td>
<td>9</td>
<td>41%</td>
</tr>
<tr>
<td>Junior management</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Continuous improvement expert</td>
<td>6</td>
<td>27%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section A.3

### CHART 4.4

RESPONSES ACCORDING TO RESPONDENTS POSITIONS

[Pie chart showing percentages for Top management (32%), Middle management (41%), Junior management (0%), and Continuous improvement expert (27%).]

Source: Table 4.4 converted to a Pie Chart
Table 4.5 and Chart 4.5 depict the composition of the JCI SA response rate by gender. It can be seen that 86 per cent of the respondents that took part in the empirical study were males and 14 per cent were females.

**TABLE 4.5**

**RESPONSE RATE BY GENDER FROM JCI SA EMPLOYEES**

<table>
<thead>
<tr>
<th>GENDER</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>19</td>
<td>86%</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section A.4

**CHART 4.5**

**RESPONSE RATE BY GENDER FROM JCI SA EMPLOYEES**

Source: Table 4.5 converted to a Pie Chart
Question A.5 in the research questionnaire asked the respondents to indicate their age. It can be seen in Table 4.6 that a large portion of the respondents was in the 31–40 years age group. This age group made up 55 per cent of the overall age group percentage. The second highest response rate came from the 25–30 years age group. They made up 27 per cent of the overall age group percentage.

**TABLE 4.6**

**RESPONSES BY AGE**

<table>
<thead>
<tr>
<th>AGE</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 25 years</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>25 - 30 years</td>
<td>6</td>
<td>27%</td>
</tr>
<tr>
<td>31 - 40 years</td>
<td>12</td>
<td>55%</td>
</tr>
<tr>
<td>41 - 50 years</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td>51 - 60 years</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>61 years and above</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section A.5
The respondents were also asked to indicate their length of employment at JCI SA when lean manufacturing was implemented. It can be seen in table 4.7 that 82 per cent of the respondents had been working for JCI SA for a number of years when lean manufacturing was implemented. Only 18 per cent of the respondents had been working less than a year when lean manufacturing was implemented.
## TABLE 4.7
RESPONSES BY LENGTH OF EMPLOYMENT

<table>
<thead>
<tr>
<th>LENGTH OF EMPLOYMENT</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>18</td>
<td>82%</td>
</tr>
<tr>
<td>Months</td>
<td>4</td>
<td>18%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>22</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section A.6

## CHART 4.7
RESPONSES BY LENGTH OF EMPLOYMENT

Source: Table 4.7 converted to a Pie Chart
The final question of the biographical study asked the respondents to indicate their highest level of qualification achieved to date. Table 4.8 illustrates that 5 per cent obtained a matric as their highest level of academic qualification achieved, 36 per cent indicated that they acquired a diploma qualification, 41 per cent had obtained a degree and 18 per cent obtained a post graduate.

**TABLE 4.8**

RESPONSES ACCORDING TO JCI SA ' S EMPLOYEES

QUALIFICATIONS

<table>
<thead>
<tr>
<th>QUALIFICATION</th>
<th>RESPONSE FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matric</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Diploma</td>
<td>8</td>
<td>36%</td>
</tr>
<tr>
<td>Degree</td>
<td>9</td>
<td>41%</td>
</tr>
<tr>
<td>Post Graduate</td>
<td>4</td>
<td>18%</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section A.6
CHART 4.8
RESPONSES ACCORDING TO JCI SA ' S EMPLOYEES QUALIFICATIONS

Source: Table 4.8 converted to a Pie Chart

4.6 CONCLUDING REMARKS

In this chapter the research process was documented and an analysis of the biographical information of the respondents were tabulated, presented graphically and analysed in detail.

Chapter 5 will analyse the theoretical information and interpret the empirical study to create a lean manufacturing model that JCI SA can utilise to maintain the market leader position in their business sector.
CHAPTER 5
ANALYSIS AND INTERPRETATION OF THE EMPIRICAL STUDY RESULTS

5.1 INTRODUCTION

In the previous chapter the research methodology used for the study was described. The respondents’ response rate and the biographical information was analysed and presented in tabular and chart format.

The aim of chapter five is to present the outcomes of the empirical study that was conducted on the JCI SA employees. This questionnaire was used to assess if the theoretical lean manufacturing model could be utilised by JCI SA.

This chapter also aims to resolve the second sub-problem: What lean manufacturing competencies do current JCI SA senior managers believe are required?

The results of section B (Lean manufacturing model for JCI SA) of the questionnaire was analysed and interpreted as follows:

B.1. Step 1 Pre-implementation phase;
B.2. Analysis of pilot line by current state map method;
B.3. Design and implement future state map;

B.4. The Lean Manufacturing tools that must be implemented simultaneously; and

B.5. The lean manufacturing model’s final step once all the lean manufacturing tools have been implemented simultaneously.

The questionnaire utilised for this empirical study can be found in Annexure 2.

5.2 STEP 1: PRE-IMPLEMENTATION PHASE

It is illustrated in Table 5.1 and Chart 5.1 that 77 per cent of the respondents strongly agree that the first action that must be taken before implementing lean manufacturing is to stabilise the manufacturing process. Table 5.1 also depicts that 55 per cent of the respondents strongly agree and 45 per cent of the respondents agree that the second action taken must be to standardise the process, so that there will be no deviation from the manufacturing process. Action three as stated in the questionnaire received a 59 per cent strongly agree and also received a 36 per cent response rate that the respondents agree with this third step as sequentially laid out in the questionnaire.
### TABLE 5.1

#### STEP 1 – PRE-IMPLEMENTATION PHASE

<table>
<thead>
<tr>
<th>STEP 1 - PRE – IMPLEMENTATION PHASE</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action 1 - Stabilise the manufacturing process</td>
<td>No. 17</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Action 1 - Stabilise the manufacturing process</td>
<td>% 77.3%</td>
<td>22.7%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Action 2 - Standardise the process, so that there will be no deviation from the process</td>
<td>No. 12</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Action 2 - Standardise the process, so that there will be no deviation from the process</td>
<td>% 54.5%</td>
<td>45.5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Action 3 - Simplify the process so that it is easy for the operator to manufacture the required part</td>
<td>No. 13</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Action 3 - Simplify the process so that it is easy for the operator to manufacture the required part</td>
<td>% 59.1%</td>
<td>36.4%</td>
<td>4.5%</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section B1

### CHART 5.1

#### STEP 1 – PRE-IMPLEMENTATION PHASE

![Pie Chart](image-url)

Source: Table 5.1 converted to a Pie Chart
Chart 5.1 also illustrates that 63 per cent of the respondents strongly agree with the three pre-implementation steps, 35 per cent agree, 2 per cent disagree and not one of the respondents strongly disagreed with this pre-implementation phase.

5.3 ANALYSIS OF PILOT LINE BY CURRENT STATE MAP METHOD

TABLE 5.2

STEPS 2, 3 & 4: ANALYSIS OF PILOT LINE BY CURRENT STATE MAP METHOD

<table>
<thead>
<tr>
<th>STEPS 2, 3 &amp; 4 - ANALYSIS OF PILOT LINE BY CURRENT STATE MAP METHOD</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>To implement lean manufacturing, firstly decide on a pilot product line.</td>
<td>No.</td>
<td>14</td>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>63.6%</td>
<td>31.8%</td>
<td>4.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>To determine the value adding and non-value adding processes, the value stream map is used as a lean manufacturing tool to record this process.</td>
<td>No.</td>
<td>16</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>72.7%</td>
<td>27.3%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>The lean manufacturing improvement team uses the current state map as a reference to implement kaizen blitz projects, thus reducing the non-value added time.</td>
<td>No.</td>
<td>12</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>54.5%</td>
<td>40.9%</td>
<td>4.5%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section B.2
An analyses of Table 5.2 indicates the following:

- 64 per cent of the respondents strongly agree and 32 per cent of the respondents agree that to implement lean manufacturing, a pilot line must be agreed upon by the lean manufacturing team.

- 100 per cent of the respondents strongly agree/agree that the value stream map is used as the lean manufacturing tool to determine the value adding and non-value adding processes within the pilot line.

- 95 per cent of the respondents strongly agree/agree that a current state map must be utilised as a reference tool to implement the kaizen blitz projects that will reduce the non-value added time within the pilot line.

Chart 5.2 illustrates that 97 per cent of the respondents strongly agree/agree with steps 2, 3 and 4 of the lean manufacturing model and that is to analyse the pilot line by current state map method.
CHART 5.2

STEPS 2, 3 & 4 - ANALYSIS OF PILOT LINE BY CURRENT STATE MAP METHOD

Source: Table 5.2 converted to a Pie Chart

5.4 DESIGN AND IMPLEMENT FUTURE STATE MAP

TABLE 5.3

STEP 5 - DESIGN AND IMPLEMENT FUTURE STATE MAP

<table>
<thead>
<tr>
<th>STEP 5 - DESIGN AND IMPLEMENT FUTURE STATE MAP</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>At this stage in the lean manufacturing model, the lean manufacturing team will design the future state map.</td>
<td>No. 10</td>
<td>12</td>
<td>0.0%</td>
<td>0.0%</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>% 45.5%</td>
<td>54.5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>The future state map contains the kaizen blitz projects that must be implemented and the lean manufacturing tools</td>
<td>No. 6</td>
<td>14</td>
<td>2</td>
<td>0.0%</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>% 27.3%</td>
<td>63.6%</td>
<td>9.1%</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>The lean manufacturing team must implement all the lean tools at the same time and not exclude certain lean tools</td>
<td>No. 3</td>
<td>12</td>
<td>6</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>% 13.6%</td>
<td>54.5%</td>
<td>27.3%</td>
<td>4.5%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section B.3
CHART 5.3

STEP 5 - DESIGN AND IMPLEMENT FUTURE STATE MAP

Source: Table 5.3 converted to a Pie Chart

Table 5.3 shows that the respondents 100 per cent strongly agree/agree that step 5 in the lean manufacturing model, the future state map, must be created. 91 per cent of the respondent strongly agree/agree that the future state map contains the kaizen blitz projects and the lean manufacturing tools. 68 per cent of the respondents strongly agree/agree that all the lean tools must be implemented simultaneously. Kosiak, (2004) re-affirms this statement by explaining that companies fail at lean due to trying to
master individual lean tools and not incorporating all the lean tools that will direct the organisation to world class manufacturing levels. Chart 5.3 depicts that 86 per cent of the respondents strongly agree/agree that the future state map must be created in step 5 of the lean manufacturing model.


## 5.5 SIMULTANEOUS IMPLEMENTATION OF THE LEAN MANUFACTURING TOOLS

### TABLE 5.4

**STEP 6 - SIMULTANEOUS IMPLEMENTATION OF THE LEAN MANUFACTURING TOOLS**

<table>
<thead>
<tr>
<th>Listed below are lean manufacturing tools that must be implemented simultaneously:</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. One piece flow – pull system</td>
<td>No.</td>
<td>12</td>
<td>10</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>54.5%</td>
<td>45.5%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1.1 Cellular manufacturing</td>
<td>No.</td>
<td>8</td>
<td>14</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>36.4%</td>
<td>63.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2. Total productive maintenance</td>
<td>No.</td>
<td>9</td>
<td>12</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>40.9%</td>
<td>54.5%</td>
<td>4.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>3. Total quality management</td>
<td>No.</td>
<td>11</td>
<td>10</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>50.0%</td>
<td>45.5%</td>
<td>4.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>4. Kanban</td>
<td>No.</td>
<td>10</td>
<td>12</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>45.5%</td>
<td>54.5%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Lean manufacturing tools will reduce or even eliminate the non-value adding time when producing the product.</td>
<td>No.</td>
<td>15</td>
<td>7</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>68.2%</td>
<td>31.8%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Companies that fail at lean are those that try to master individual lean tools and do not focus on implementing all the tools simultaneously.</td>
<td>No.</td>
<td>3</td>
<td>14</td>
<td>5</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>13.6%</td>
<td>63.6%</td>
<td>22.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Lean manufacturing team draws a future state map of pilot line before implementing changes, this will assist in applying the lean tools and philosophies on production line.</td>
<td>No.</td>
<td>9</td>
<td>12</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>40.9%</td>
<td>54.5%</td>
<td>4.5%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section B.4
Table 5.4 illustrates that 100 per cent of the respondents strongly agree/agree that one piece flow – pull manufacturing is a lean tool. 100 per cent of the respondents strongly agree/agree that cellular manufacturing is a sub-unit of one piece flow and is a lean manufacturing tool. 95 per cent of the respondents strongly agree/agree that Total Productive Maintenance and Total Quality Management are lean manufacturing tools. 100 per cent of the respondents strongly agree/agree that kanban is a lean manufacturing tool.

Chart 5.4 depicts that 73 per cent of the respondents strongly agree/agree that simultaneous implementation of the lean manufacturing tools is the sixth step in the lean manufacturing model and that this step must be implemented in this manner.
CHART 5.4

STEP 6: SIMULTANEOUS IMPLEMENTATION OF THE LEAN MANUFACTURING TOOLS.

Source: Table 5.4 converted to a Pie Chart
## 5.6 STEP 7: THE FINAL STEP IN THE LEAN MANUFACTURING MODEL

### TABLE 5.5

**STEP 7: FINAL STEP OF THE LEAN MANUFACTURING MODEL**

<table>
<thead>
<tr>
<th>STEP 7 - FINAL STEP OF THE LEAN MANUFACTURING MODEL</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous evaluation of the lean improvements (reduction in non-value added time) must take place.</td>
<td>No. % 10</td>
<td>12</td>
<td>0%</td>
<td>0%</td>
<td>22</td>
</tr>
<tr>
<td>If a lean goal has not been achieved, a kaizen blitz meeting is held to find the route cause of the problem and to find a solution to the route cause.</td>
<td>No. % 8</td>
<td>14</td>
<td>0%</td>
<td>0%</td>
<td>22</td>
</tr>
<tr>
<td>Once the lean manufacturing team has achieved all the goals that were set out for them, the improved pilot line is handed over to the process owner (production manager/value stream manager).</td>
<td>No. % 9</td>
<td>12</td>
<td>1%</td>
<td>0%</td>
<td>22</td>
</tr>
</tbody>
</table>

Source: Survey Questionnaire, Section B.5

### CHART 5.5

**STEP 7: FINAL STEP OF THE LEAN MANUFACTURING MODEL**

Source: Table 5.5 converted to a Pie Chart
In Table 5.5, 100 per cent of the respondents strongly agree/agree that continuous evaluation of the lean improvements must take place for the implementation to be a success and to be sustained. 95 per cent of the respondents strongly agree/agree that once the lean manufacturing team has achieved their goals that were set out by the team and the improvements are standardised, the team will hand the improved pilot line over to the process owner that was involved and part of the team. The lean manufacturing team will then look at further improving the pilot line by going through the model in a cyclic manner. Chart 5.5 illustrates that 98 per cent of the respondents strongly agree/agree that step 7 (hanging over to the process owner once all the goals have been achieved by the lean team and the improvements have been stabilised.) is the final step of the lean manufacturing model.

5.7 OTHER FINDINGS

Listed below are the comments of the respondents’ reasons why they did not agree with certain of the lean manufacturing model’s steps.
The first comment from a respondent was that not all the tools need to be implemented simultaneously. The type of process that forms part of the pilot line, and its current state of performance should dictate the tools that needs to be implemented. An example given was total productive maintenance and total quality management should already be entrenched, and form part of the stabilisation phase.

Another comment that a respondent strongly disagreed with in the questionnaire was the fact that, after implementation, a pilot line is then handed back to the process owner to run with the improved process. The process owner should be driving the lean roll-out and not wait for the lean manufacturing team to improve his/her process. The reason stated is that ultimately the accountability for the process rests with the process owner.

5.8 CONCLUDING REMARKS

The purpose of Chapter 5 was to analyse and interpret the empirical data obtained from the lean manufacturing research questionnaire. The data shows that the respondents agree with the lean manufacturing model and the theoretical reasoning behind the model.
Chapter 6 will further assess the findings from this chapter and will focus on various recommendations on how to implement the lean manufacturing model in JCI SA.
CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

In this chapter, the main findings of the lean manufacturing model for JCI SA will be summarised and contrasted with the main problem and the three sub-problems.

The problems, limitations and challenges that were met by the researcher will be described in this final chapter. There will also be opportunities and recommendations noted that could be utilised for future research.

6.2 MAIN FINDINGS

By theoretically assessing the lean manufacturing process, a lean manufacturing model was established for JCI SA, so that this organisation can reach lean manufacturing standards. A research questionnaire comprising of the theoretical lean manufacturing model was issued to the JCI SA staff that had direct experience with improving the manufacturing facility. The main findings regarding the lean manufacturing model was divided into the following sections.
6.2.1 Pre-Implementation phase

In chapter 3 the theoretical research study indicates that before any lean manufacturing journey can take place, the organisation’s manufacturing process must be stable, standard and lastly uncomplicated for the operator to manufacture the required part.

The empirical study in chapter 5 also indicates that (97 per cent strongly agree/agree) this three step pre-implementation process is vital as a base for an organisation’s lean manufacturing implementation.

6.2.2 Analysis of pilot line by current state map method

The theoretical research study explains that the current state map is a tool that is used to record the entire value stream of the pilot line from the customer to its suppliers. By plotting the current state map, it will highlight the value adding and non-value adding elements in the process. This is a critical step in the lean process, as an organisation must eliminate the non-value adding processes to become a lean manufacturing facility.
The empirical study also shows that the respondents agree (97 per cent) strongly agree/agree that the plotting of the pilot lines current state map is important.

6.2.3 Design and implement future state map

Chapter 3 highlights that the future state map is an important task to be carried out by the lean manufacturing team, as this is when the team will action kaizen blitz projects and also determine where specifically all the lean tools can be implemented.

The empirical study depicts that the respondents agree with the fifth step in the lean manufacturing model, as the strongly agree/agree response rate in the research questionnaire to this question was 86 per cent.

6.2.4 Simultaneous implementation of the lean manufacturing tools.

The theoretical study that was presented in chapter 3 states that companies fail at implementing lean manufacturing successfully, as these companies focus on mastering one lean tool at a time. For a company to be truly successful in lean manufacturing, the company
must implement all the lean tools simultaneously. It is vital that this occurs as each tool is dependent on each other. A practical example would be if an organisation wanted to implement TQM, the organisation must have TPM in place. TQM and TPM are both lean tools and do rely on each other in a symbiotic manner.

What lean manufacturing capabilities must middle managers incorporate in JCI SA?

The empirical study also shows that the JCI SA respondents agree (73 per cent strongly agree/agree) with the simultaneous implementation of the lean manufacturing tools.

6.2.5 Continuous evaluation and hand-over process

For lean manufacturing to be a success and truly to understand what the real problems are within the manufacturing process, the lean manufacturing team must evaluate at each step in the lean model what the cause and effect of each lean improvement was.

Once the improvements have been achieved and the lean manufacturing team has met all the goals set out by the team, the pilot line is handed back to the process owner. What is also important to note, is that the process owner is also the leader of the
lean manufacturing team and the lean implementer facilitates the team.

The research questionnaire shows that the JCI SA respondents agree (98 per cent strongly agree/agree) with the final step in the lean manufacturing model. The team will follow a cyclic format of improving the pilot line further, as can be seen in fig 3.1.

In chapter 1, an outline of the main and sub-problems were stated as below. The research data will be assessed to see if the research data helped in solving these problem statements.

- **MAIN PROBLEM**

What lean manufacturing capabilities must middle managers incorporate in JCI SA?

- **SUB-PROBLEMS**

An analysis of the main problem allows identification of the following sub-problems.
**Sub-problem 1**

What Lean manufacturing competencies does the literature reveal that JCI SA requires?

**Sub-problem 2**

What Lean manufacturing competencies do current JCI SA senior managers believe are required?

**Sub-problem 3**

How can the results obtained from the resolution of the two sub-problems (1 and 2 above) be integrated into a model of how to reach lean manufacturing standards within the JCI manufacturing industry in South Africa?

Sub-problem 1 was dealt with in chapter 3, as a literature study of the lean manufacturing competencies for an organisation was recorded and this information can be transferred to an organisation like JCI SA. The reason for this is that JCI SA is a manufacturing organisation that lends its thinking to the lean and J.I.T philosophies of the Japanese. This JCI SA philosophy has been noted in chapter 2 by referencing the lean manufacturing philosophies that have been incorporated in the organisation to date.
The solution to sub-problem 2 was provided by the results of chapter 5, as the senior managers of JCI SA indicated what they thought from their experience what lean manufacturing competencies are required for JCI SA. Chapter 5 also provided a solution to sub-problem 3, as the theoretical model that was depicted in chapter 3 was strongly agreed upon by the JCI SA respondents. This model therefore can be integrated into JCI SA, as the model of how to reach lean manufacturing standards within JCI SA.

6.3 PROBLEMS AND LIMITATIONS

No major problems were encountered in the research. The respondents for the lean manufacturing questionnaire were accessible via e-mail or by physically handing the questionnaire to the respondents. Only a small number of JCI respondents did not respond (15 per cent) and thus there was an unlikely probability of prejudice within the empirical study.

The following minor problems were encountered in the research study:

- The respondents outside the Port Elizabeth region did not all return the questionnaire to the researcher within the stipulated timing period. To address this issue, the researcher
utilised both e-mail and telephone media to remind the respondents; and

- Two of the respondents from the Port Elizabeth region misplaced their questionnaire and therefore asked the researcher to e-mail the questionnaire to them. These questionnaires were received within the closing date.

### 6.4 RECOMMENDATIONS

The main objective of this research study was to determine the lean manufacturing capabilities that middle managers of JCI SA should incorporate into the organisation. This objective has been met through the consultation of various literature sources and an empirical study that allowed the researcher to formulate a lean manufacturing model for JCI SA.

Since this main objective has been met, but recognising that there is no simple method of reaching the lean manufacturing capabilities, the recommendations to achieve lean manufacturing will be stated as per the research findings. The following approach needs to be adopted to reach this Lean Manufacturing objective.
The first step in the lean manufacturing model would be the pre-implementation phase. In this phase a three-step approach must be taken. The first action is to stabilise the manufacturing process. The second action is to standardise the process so that the operation is consistently executed in the same manner over and over again. The third and final action before embarking on the lean implementation phase would be to simplify the process even further, so that there is no misunderstanding of how to manufacture the product.

The second step that follows the pre-implementation phase is identifying the pilot line that must be improved to a lean status. This is the first step in the implementation phase, but the second step of the lean manufacturing model.

Step three in the lean manufacturing model that will assist JCI SA to achieve the lean manufacturing competencies would be to capture the current process by utilising a current state map. The lean manufacturing team would then analyse the value added and non-value added processes within the pilot line (step 4), as this will be illustrated on the current state map.
• Step 5 would be to design the future state map of the pilot line and the reason for this is that the lean manufacturing team can diagrammatically illustrate how they would like to see this line functioning in the future. The lean manufacturing tools and kaizen blitz projects will be recorded on the future state map.

• Step 6 is where the lean manufacturing team implements the future state map kaizen improvements and all the lean tools that must be implemented simultaneously. It is vital that the tools are implemented simultaneously, as the Japanese plants, especially Toyota, have achieved great success in implementing the lean competencies in this manner.

• The final step of the lean model to achieve the lean competencies would be to hand the pilot line over to the process owner once the team has achieved all the goals. It is vital that the process owner leads this lean manufacturing team to success and is facilitated by the lean implementer throughout this model. The next step (cyclic manner) for the lean team will be to revert back to stabilising the process to the improved lean standard. Throughout the lean
manufacturing model process, the lean manufacturing team must evaluate each step.

6.5 OPPORTUNITIES FOR FURTHER RESEARCH

This lean manufacturing study can be utilised as a basis for further research and therefore recommendations for further research need to be made.

This research study was only confined to JCI SA and therefore the research results of JCI Europe and JCI America could result in different outcomes to what was recorded in this research study. One of the reasons that the outcomes could be different is that both JCI Europe and America have been practising the lean manufacturing competencies for a longer period of time.

6.6 CONCLUSION

South African organisations are new players in the global market and are also under attack by foreign organisations in their home market. It is therefore vital that a South African organisation does not only aim to achieve benchmark standards, but to be the benchmark for other organisations to achieve their standards. In saying this it is
important that JCI SA investigates the competencies required to achieve lean manufacturing, as once achieved both productivity and quality is improved to a great extent.

The research study shows that the lean manufacturing model can be used to achieve the lean competencies as stated in the main problem. The theoretical and empirical findings confirm that the implementation of the lean manufacturing model will be the appropriate tool for JCI SA to achieve the lean manufacturing standards.

To conclude, the research study findings were directly related to the main problem and solutions were also obtained for the three sub-problems.
REFERENCES


**Internet sources**

Barth, J. 2005. *Chairman and Chief Executive Officer of JCI 2005 review.*

www.jci.com


http://www.devicelink.com/mddi/archive/04/09/016.html


www.granite-bay.com/articles2.html


http://www.automfg.com/articles/010-005.html
25/09/2005

Dear respondent

PROPOSED LEAN MANUFACTURING MODEL FOR JOHNSON CONTROLS SOUTH AFRICA (JCI SA.)

Your assistance in completing and returning the attached questionnaire (via e-mail) relating to the above will be greatly appreciated. It should take only a few minutes of your time.

This information is needed for the completion of my Masters in Business Administration (MBA) studies that I have enrolled for at the Nelson Mandela Metropolitan University.

It would be appreciated if you could complete the questionnaire and return it to me (via e-mail) by the 30 September 2005.

Yours sincerely

Carl Andersson
Researcher

* SEE REVERSE FOR LEAN MANUFACTURING MODEL.
LEAN MANUFACTURING MODEL

Step 1: Pre-Implementation Phase

**Action 1**
Stabilise Process

**Action 2**
Standardise Process

**Action 3**
Simplify Process

Implementation Phase

**Step 2**
Identify Pilot Production Line

**Step 3**
Capture Current State Map

**Step 4**
Analyse Non Value added and Value added processes on map

**Step 5**
Design Future State Map

**Step 6**
Implement Lean Manufacturing tools and philosophies

**Step 7**
Hand over to process owner for full accountability

Evaluate
ANNEXURE 2

RESEARCH QUESTIONNAIRE

SECTION A: BIOGRAPHICAL DATA

Please answer the following questions by indicating with an ‘X’ in the appropriate box.

A.1 Which JCI SA division do you work for?

<table>
<thead>
<tr>
<th>Division</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trim cut and sew manufacturing</td>
<td></td>
</tr>
<tr>
<td>J.I.T seating</td>
<td></td>
</tr>
<tr>
<td>J.I.T cockpit</td>
<td></td>
</tr>
<tr>
<td>Head office</td>
<td></td>
</tr>
</tbody>
</table>

A.2 In which region is your division situated

<table>
<thead>
<tr>
<th>Region</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Elizabeth</td>
<td></td>
</tr>
<tr>
<td>East London</td>
<td></td>
</tr>
<tr>
<td>Pretoria</td>
<td></td>
</tr>
</tbody>
</table>

A.3 Please indicate your level in JCI SA

<table>
<thead>
<tr>
<th>Level</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Top management</td>
<td></td>
</tr>
<tr>
<td>Middle Management</td>
<td></td>
</tr>
<tr>
<td>Junior management</td>
<td></td>
</tr>
<tr>
<td>Continuous Improvements Expert</td>
<td></td>
</tr>
</tbody>
</table>

A.4 Please indicate your gender

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
</tr>
</tbody>
</table>

A.5 Please indicate your age

<table>
<thead>
<tr>
<th>Age</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 25 years</td>
<td></td>
</tr>
<tr>
<td>25 – 30 years</td>
<td></td>
</tr>
<tr>
<td>31 – 40 years</td>
<td></td>
</tr>
<tr>
<td>41-50 years</td>
<td></td>
</tr>
<tr>
<td>51 – 60 years</td>
<td></td>
</tr>
<tr>
<td>61 years and above</td>
<td></td>
</tr>
</tbody>
</table>

A.6 How long had you been working at JCI SA when lean manufacturing was implemented?

<table>
<thead>
<tr>
<th>Time Unit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Months</td>
<td></td>
</tr>
</tbody>
</table>
A.7 Please indicate your highest level of qualification.

<table>
<thead>
<tr>
<th>Matric</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diploma</td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td></td>
</tr>
<tr>
<td>Post Graduate</td>
<td></td>
</tr>
<tr>
<td>Other (please specify course)</td>
<td></td>
</tr>
</tbody>
</table>

SECTION B: LEAN MANUFACTURING MODEL FOR JCI S.A

B.1. Step 1 Pre-implementation Phase

Please indicate the degree to which you agree that the following actions should be taken before embarking on the lean implementation.

<table>
<thead>
<tr>
<th>STEP 1 - PRE-IMPLEMENTATION PHASE</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action 1 - Stabilise the manufacturing process</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action 2 - Standardise the process, so that there will be no deviation from the process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action 3 - Simplify the process so that it is easy for the operator to manufacture the required part.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B.2 Analysis of pilot line by Current state map method

Please indicate the degree to which you agree with the following statements regarding the analysis of the pilot line by means of a current state map.
STEPS 2, 3 & 4 - ANALYSIS OF PILOT LINE BY CURRENT STATE MAP METHOD

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>To implement lean manufacturing, firstly decide on a pilot product line.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To determine the value adding and non-value adding processes, the value stream map is used as a lean manufacturing tool to record this process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The lean manufacturing improvement team uses the current state map as a reference to implement kaizen blitz projects, thus reducing the non-value added time.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B.3 Design and implement future state map

Please indicate the degree to which you agree with the following statements regarding the design and implementation of the Future state map.

<table>
<thead>
<tr>
<th>STEP 5 - DESIGN AND IMPLEMENT FUTURE STATE MAP</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>At this stage in the lean manufacturing model, the lean manufacturing team will design the future state map.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The future state map contains the kaizen blitz projects that must be implemented and the lean manufacturing tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The lean manufacturing team must implement all the lean tools at the same time and not exclude certain Lean tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B.4 The lean manufacturing tools that must be implemented simultaneously
Please indicate the degree to which you agree with the following statements regarding the Lean Manufacturing tools that must be implemented simultaneously.

<table>
<thead>
<tr>
<th>STEP 6 - SIMULTANEOUS IMPLEMENTATION OF THE LEAN MANUFACTURING TOOLS.</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listed below are lean-manufacturing tools that must be implemented simultaneously:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. One piece flow – pull system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Cellular manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Total Productive maintenance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Total quality management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Kanban</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean manufacturing tools will reduce or even eliminate the non-value adding time when producing the product.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Companies that fail at lean are those that try to master individual lean tools and do not focus on implementing all the tools simultaneously.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean manufacturing team draws a future state map of pilot line before implementing changes, this will assist in applying the lean tools and philosophies on production line.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B.5. The lean manufacturing model’s final step once all the lean manufacturing tools have been implemented simultaneously

Please indicate the degree to which you agree with the following statements regarding the lean manufacturing model’s final step once all the lean manufacturing tools have been implemented simultaneously.
**STEP 7 - FINAL STEP OF THE LEAN MANUFACTURING MODEL.**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous evaluation of the lean improvements (reduction in non-value added time) must take place.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If a lean goal has not been achieved, a kaizen blitz meeting is held to find the route cause of the problem and to find a solution to the route cause.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once the lean manufacturing team has achieved all the goals that were set out for them, the improved pilot line is handed over to the process owner (production manager/value stream manager).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many thanks for participating in this project. Your time and input are greatly appreciated.
LEAN MANUFACTURING MODEL FOR JOHNSON CONTROLS AUTOMOTIVE S.A

By
Carl Andersson

Submitted in partial fulfilment of the requirements for the degree of

Masters in Business Administration

MBA Unit, Nelson Mandela Metropolitan University in the faculty of Business and Economic Sciences

Promoter: Prof. D.M Berry

January 2006
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DECLARATION

This work has not been previously accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed:………………………..
Date:…………………………..

STATEMENT 1

This dissertation is being submitted in partial fulfilment of the requirements for the degree of Masters in Business Administration.

Signed: :………………………..
Date:…………………………..

STATEMENT 2

The dissertation is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references. A reference list is appended.

Signed: :………………………..
Date:…………………………..
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- Professor Dave Berry, for his guidance, advice and patience.

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ABSTRACT

An increase in global competitiveness has forced manufacturing organisations to re–look at their facility from an output and quality standpoint.

Leveraging a manufacturing operation into a competitive advantage must at all times support the organisation’s objectives. It is therefore vital that the operation reviews its strategy so that it fulfils the ever-changing needs of its market.

The main objective of this research was to identify possible approaches that Johnson Controls South Africa (JCI SA) could pursue when implementing a Lean Manufacturing model. In doing this it will improve JCI SA’s manufacturing efficiency and quality, thus giving the organisation a competitive edge over its opposition.

The research presented an empirical study of how a Lean Manufacturing model should be implemented in JCI SA.

A theoretical and empirical study was conducted on how to successfully implement Lean Manufacturing within an organisation. The main purpose was to establish a theoretical Lean Manufacturing model that the organisation can utilise as a strategic plan to become the global leader in its market place.