CHALLENGES OF LEAN MANAGEMENT

Investigating the challenges and developing a recommendation for implementing Lean management techniques

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ABSTRACT

This thesis seeks to find out what the main challenges of implementing Lean management techniques and to develop a recommendation on how to manage these challenges. A qualitative research was conducted via questionnaire and one interview on several companies in Finland (five of whom responded to the research). These companies gave their opinions on the challenges they had in implementing Lean management.

The theory of this thesis was based largely on published literature, such as books, journals, and theses, as well as a few websites on the subject of Lean and Lean management.

The research method was a qualitative research in the form of an online questionnaire. The questionnaire was sent to a total of twenty-two similar, large, Finnish companies. A total of five companies responded. Also a phone interview was conducted with one of the responding companies.

The thesis reveals that the main challenge that the companies had was in having workers who were not motivated or not accepting the change, at least initially. Another challenge was in maintaining Lean. Lean management is meant to be a continuing process (it never ends), thus it is challenging for some of the companies to sustain it.

Companies need to understand the importance of motivating their workers as they are the ones who will ultimately deem the Lean implementation a success or failure. The workers need to have excellent leaders and the company needs to establish excellent communication channels so that the workers can be well motivated and feeling confident in embarking on the Lean journey.

This thesis topic could be developed further by focusing on one company and working closely with them in order to determine further internal and external challenges to Lean implementation and how this can be rectified.

Keywords Lean management, Muda, Mura, Muri

Pages 38 p. + appendices 1p.

ABBREVIATIONS

JIT – Just In Time

TPS – Toyota Production System

PDCA – Plan Do Check Act

IDEA – Investigate Design Execute Adjust

DMAIC – Design Measure Analyse Improve Control

DPMO – Defects per million opportunities

CONTENTS

1 INTRODUCTION AND RESEARCH METHODOLOGY

1.1 Background

The idea behind this thesis came from a personal interest in Lean management. Many companies are aware of the powerful and beneficial effects of integrating the Lean philosophy, especially with success stories such as Toyota's. However, no matter how beneficial it is, implementing Lean is not devoid of its challenges and this thesis seeks to identify these challenges and develop a recommendation.

1.2 Objective

The objective of this thesis is to research on the challenges of implementing Lean management techniques and tools. The research will be conducted on similar companies that will remain anonymous for the purpose of confidentiality. From this research, a recommendation will be created on the best way of implementing Lean so as to avoid the challenges. The research will be conducted via questionnaire and possible interviews. The thesis seeks to answer the following questions:

- What are the challenges that the company has had from implementing the Lean management technique?
- How has the company tried to solve these challenges practically?
- Did the solutions work?

1.3 Scope

The scope of the thesis is the results of the research on the challenges of Lean implementation as well as theoretical research on Lean management. The thesis will however not research on the successfulness of the implementation of the recommendation, as it is not known whether or not the recommendation will be implemented.

2 RESEARCH METHODOLOGY

There are various research methods tailored for different researches; it depends on what information the research seeks and how it seeks it. As this thesis is mainly based on the results of open-ended questions in a questionnaire, the research methodology used in this thesis would be classified as a 'qualitative research' method. The theoretical part of the thesis is based on several published literature on Lean management as well as credible websites on the topic.

2.1 Qualitative research

"One might assume that qualitative research is simply defined as research that does not use numbers or statistical procedures; however defining qualitative research is not as straightforward as it seems" (Cassel, Buehrins, Symon, & Johnson 2006, 161). Symon et al. (2006, 161) believe that this is so because of the range of various approaches that assume the name 'qualitative'.

A distinct difference between qualitative research and quantitative research is that the sampling in qualitative research is purposive, not random. Also the qualitative research is mostly exploratory, while a quantitative research focuses more on testing hypotheses. Furthermore, the results from a qualitative research cannot be graphed or displayed as a mathematical term (such as percentages) in the same way that a quantitative research can. "Qualitative research is also highly useful in policy and evaluation research, where understanding why and how certain outcomes were achieved is as important as establishing what those outcomes were." (Glenn 2010, 96)

In qualitative research, the most common way of data collecting is to categorize the data into patterns as the main basis for organizing and reporting of the results. Also the most common way of analysing qualitative data is known as 'observer impression'. This form of analysis is based on the researcher's analysis of the data. After analysing, the researcher forms an impression, and reports their impression in an often structured quantitative form. (Glenn 2010, 97).

This thesis can therefore be classified as qualitative research as it mostly uses open-ended questions (in a questionnaire) to gather data that cannot be quantified or represented in a graph, and use this data to develop a recommendation. This thesis heavily relies on theoretical data, gathered from various published literature and websites, in order to develop a well formed recommendation. As the thesis uses a questionnaire to gather data from the companies, it is important for the author to know the advantages and disadvantages of using a questionnaire, how to develop it, and how to evaluate the answers.

2.1.1 Questionnaire

Simply put, a questionnaire is a form of collecting information by creating a list of questions that is answered by a group. The list of questions should be identical for all those who answer it. The answers are the results that would be used, by the person or organization who created the questionnaire, for evaluation.

When creating a questionnaire, researchers should include some background information about the research at the beginning of the questionnaire, some instructions the could help the respondent know how to fill out the questionnaire, and some way of giving each completed questionnaire its own identifying code or number. These three are thought of as 'good

practice' in relation to any research questionnaire. (Denscombe 2010, 160).

There are two types of questions that may be asked in a questionnaire; open or closed questions. Open questions are questions that allow the respondent to decide what kind of answer to give; options of answers are not provided in a questionnaire for open questions. Closed questions are questions whose answers only fit in categories that were pre-determined by the researcher. The researcher provides the options of answers that the respondent can pick (for example yes or no). (Denscombe 2010, 166). This thesis used both open and closed questions, with more open than closed questions as it relied on the individual (and relatively unique) challenges that the companies each had.

Using a questionnaire is the best method for gathering the data for this thesis as it is relatively easy to create, uses standardized questions (as compared with an interview for example), and is relatively easy to answer. However, it may be difficult for company representatives to answer the questions if they simply do not have the time to do so (especially as this thesis seeks to gather the information from large companies). The questionnaire is an online questionnaire, which was sent to the different companies via a link in an email. The author of this thesis sought to send the questionnaire to a representative who was likely to have played a vital role in the implementation of Lean management such as a Production Manager, Lean Manager, or any other likely member of the Senior Management team.

The validity of the questionnaire depends on the results. The research should determine whether the results provide full information on the topic(s) of research and whether the results are accurate (Denscombe 2010, 168). The results of the questionnaire will be compared to the results of the theoretical research in order to see if there is a correlation; having a correlation increases the validity of the results.

2.2 Validity

The validity of a qualitative result is based on the authenticity of the respondents and the ways the researcher uses to validate the results. For example member check is the way in which the researcher confirms the authenticity of data reviewed by summarizing it and sending to the respondent of the research (or doing it as part of an interview). The respondent confirms whether the summary is true or does not correctly reflect what the respondent responded. "There are many different ways of establishing validity, including: member check, interviewer corroboration, peer debriefing, prolonged engagement, negative case analysis, auditability, confirmability, bracketing, and balance" (Glenn 2010, 98).

For this thesis, the way of checking the validity is by comparing the results to those that have already been published and to see if there is any correlation.

3 LEAN

Lean, also referred to as Lean Management, Lean Manufacturing, Lean Enterprise, or Lean Production, is a powerful set of tools and techniques that many companies choose to implement and sustain as a way of increasing the efficiency of production and the overall customer value while at the same time eliminating waste. Waste is anything that does not add value but adds costs to a company. Typically, seven wastes have been identified in Lean management: waiting, transportation, over-production, inventory, movement, over-processing, and re-work. (Drew, McCallum, & Roggenhoffer 2004, 15).

According to Dennis Hobbs, author of Applied Lean Business Transformation,

> Applied Lean methods are a series of scientific, objective techniques that cause work tasks in a process to be performed with a minimum of non-value-adding activities, resulting in greatly reduced wait time, queue time, move time, administrative time, and other delays. Lean operating systems seek to identify and eliminate all non-value adding activities in design, production, supply chain management, and other activities used to satisfy customer requirements. A Lean facility is capable of producing a product or service in only the sum of the value-added work content time required to change its form, fit, or function.
>
> (Hobbs 2011, 3).

Lean is commonly used in manufacturing and supply chain management, but it is a philosophy that can be applied to an entire company as long as the overall goal remains the same; to increase customer value while eliminating waste.

3.1 History

The concept of Lean Management can be traced as far back in history as the industrial revolution when machines, having shorter through-put times, replaced humans (Hobbs 2004, 14).

One well known Lean concept is the assembly line that was created by Henry Ford. Henry Ford, founder of Ford Motor Company, created a model of assembly line production that simplified the process of car manufacturing from individual production to mass production (Hobbs 2004, 14). This resulted in the elimination of wastes such as time, resources, and space wasted in assembling cars in individual productions. However, there was no variety in the cars that Henry Ford manufactured.

Meanwhile, in Japan, the Toyota Company was founded at a time when American automobile companies such as Ford and General Motors dominated the automobile field. World War II caused a disruption in the Toyota production and there was economic hardship post war as inventories of unsold cars increased. In order to reduce costs and inventory levels while

increasing profits, Toyota asserted that the customary thinking that Cost + Profit = Sales Price was incorrect. Instead, they believed that Profit = Sales Price – Cost. Thus Toyota began a manufacturing system that focused on the management of costs. Eventually costs were interpreted as waste, and all varieties of wastes were targeted for elimination. It is due to this advance in innovation that Toyota is referred to as the birthplace of lean. (Bicheno & Holweg 2009, 279; Hobbs 2004, 16)

"The term 'Lean production' was first used by Krafcik in 1988, and subsequently, Womack et al. of course used the term 'Lean production' to contrast Toyota with the Western 'mass production' system in the 'Machine' book. The name 'Lean' was born!" (Bicheno & Holweg 2009, 281-282)

3.2 The five Lean principles

The five Lean principles were developed by Womack and Jones in their book 'The Machine that Changed the World'. The book emphasised Lean Enterprise rather than Lean Manufacturing; Lean can be used in systems not just in manufacturing. (Bicheno & Holweg 2009, 12).

The first principle is to "specify value from the point of view of the customer" (Bicheno & Holweg 2009, 12). Too often, manufacturers will give to their customers what is convenient for them (the manufacturers), or conceived as economical for the customers. It is important to know who the customer is: "the final customer, next process, next company along the supply chain, or the customer's customer" (Bicheno & Holweg 2009, 12).

The second principle is the Value Stream. This refers to the sequence of processes from raw materials to the final customer, or from the product to its market launch. The supply chain (if possible) should be viewed and analysed. After all, it is supply chains that compete, not companies. Focus should be on the product or customer, not the machine, department, or process step. Value streams are created by grouping similar products together in a company. The grouping of the products should depend on the company but could be centred on the characteristics, demand, and process routings. The value stream should allow for unhindered material, information, and people flow; the material flow focuses on the flow of materials from raw to final product, the information flow focuses on the communication flow of customer requirements and orders within a supply chain, and people flow focuses on how people are able to move within and around the processes. (Bicheno & Holweg 2009, 12; Drew et al. 2004, 36-38).

The third principle is Flow. Batch and queue processes should be avoided or continuously reduced so that there is a smooth and quick flow of information, products, and services. "Flow requires much preparation activity. But the most important thing is vision" (Bicheno & Holweg 2009, 12). When looking through the point of view of an entire supply chain, it makes sense for activities to be organized in a way that allows for uninterrupted flow of work at the rate of demand pull from the customer. Disrup-

tions to the supply chain flow affect the supply chain throughput, capacity, and cycle time and it ultimately "adds little value that the customers appreciate". (Trent 2008, 6).

The fourth principle is Pull. "Pull means short-term response to the customer's rate of demand, and not over producing". Pull is especially useful in cases when it is difficult for a company to maintain continuous flow at a part of the value stream. For example there may be a painting process in a value stream that is required to paint parts in batches of different colours. If these parts are required by several downstream assembly lines then it would be impossible to maintain a continuous flow for each line. Instead a kanban system can be set up (kanbans are discussed in further detail in chapter 4.4). A predefined number of boxes of parts are painted and stored. Every time a box part is taken by an assembly line, a kanban card that was attached to the box is returned to the painting process. When a certain number of kanban cards have accumulated, the paint processes changes over to replace the parts. (Bicheno & Holweg 2009, 13; Drew et al. 2004, 39).

The fifth principle is Perfection. Having worked consecutively through the previous four principles, a company would now be able to see that perfection within the company processes is now possible. This not only means a defect free company – but also means "delivering exactly what the customer wants, exactly when, at a fair price and with minimum waste" (Bicheno & Holweg 2009, 13).

There are also three more non-traditional principles that are discussed by Robert Trent in his book End-To-End Lean Management: A Guide to Complete Supply Chain Improvement (2008, 5). These three principles are optimization, standardization, and simplification.

"To optimize is to make something as perfect, effective, or functional as possible" (Trent 2008, 10). The results of optimizing are often a reduction of waste. Some of the areas (within a supply chain) that benefit from optimization are:

- "The design of products and physical processes"
- "Number of transportation carriers"
- "Number of customers within the customer base" (Trent 2008, 10)

"Standardization means to conform to something that is established as a model or ideal example (i.e., the standard)" (Trent 2008, 10). Standardization is not restricted to just processes but also documents, measurements, contracts, and policies. Failure to standardization may lead to overburden as it leads to unnecessary replication (or duplication) of effort. For example using custom designed components rather than standardized ones may lead to wasted time and resources. Standardization also creates a foundation for flexibility as long as workers are trained properly and are given the responsibility for maintaining the standards. If workers do not have the freedom of interpretation (but have to get permission from authority) then standardization can become constricting. Standardization allows for work-

ers to develop new skills as well as enjoy variety in their work. (Trent 2008, 10; Drew et al. 2004, 42).

These principles are not to be done once, but should be thought of as a continuous journey to improvement.

3.3 Muda, Muri, and Mura

Muda, Muri, and Mura are Japanese words that were often used by Toyota during their development of Lean. Muda means waste (which were further categorized into the seven wastes by Taiichi Ohno within the Toyota Production System), muri means overburden, and Mura means unevenness. These three concepts allow for a more complete understanding of Lean. (Lean Manufacturing Tools 2011).

"Variation in the order arrival rate and variation in the capacity is unevenness (Mura). Capacity is directly linked with overburden (Muri). … Mura and Muri lead to Muda" (Bicheno & Holweg 2009, 6)

The overburdening (Muri) of workers and machines is a waste. Workers want to be able to enjoy their working life, and they should be willing to be a part of the improvement of company processes. The quality of work-life should be enjoyable; ergonomics such as lighting, temperature, and comfort should be as work friendly as possible. Also, emphasis on safety in the work place is key. Workers should not be overburdened with work as this could result in stress and/or injury. Overburden leads to less efficient and low quality work done. Likewise machines can be pushed beyond their limits causing them to break down. Overburdening people and machines at the same time could result in accumulation of queues, which in turn would result in missing targets. (Bicheno & Holweg 2009, 6)

It is impossible to achieve a fast uninterrupted flow of production, information, or other company processes, when there is variation in demand. In other words achieving Mura is impossible. However there are ways of avoiding the increase of unevenness, as well as ways of making the entire production process more even. Ways of avoiding the increase of unevenness includes avoiding company policies such as end of month reporting and quantity discounts. Ways of making the production process more even includes, "encouraging both suppliers and customers to order and produce more evenly – often to mutual advantage". (Bicheno & Holweg 2009, 6).

Bicheno and Holweg (2009, 6) speculate that Mura may be the root cause of the wastes that occur in a company. Unevenness (Mura) causes overburden (Muri) resulting in waste (Muda) (waste of time and space for example). The increase in waste in turn causes even more unevenness. This becomes a cyclic problem that could escalate quickly if not dealt with. Also, many companies opt to eliminating Muda without identifying the root cause of it and so they end up reverting to their initial problems of customer demand fluctuations and supplier problems. Identification of Mura and Muri is necessary in order to truly tackle and eliminate the wastes that occur within a company. (Lean Manufacturing Tools, 2011).

3.4 Lean Enterprise

Lean Enterprise, according to Womack and Jones (2003, 276) is a "mechanism for looking at the whole, a channel for the value stream".

3.4.1 Objectives

The objectives of Lean enterprise are to:

- Correctly identify customer value
- Avoid companies along the stream having different interpretation of value, especially as these interpretation are normally in favour of the company
- Identify all the actions required from the time a product is conceptualized to the time it is with the customer
- All actions that do not add value are eliminated and all actions that do add value should be continuous (proceed in a continuous flow) based on customer demand (pull strategy)
- The final results are analysed (any necessary changes to be made are made) and the entire evaluation process is done again. (Womack & Jones 2003, 276)

The Lean enterprise mechanism is just as simple. In this mechanism, first a conference is held of all the companies along the stream (or companies along the supply chain). The conference, with assistance from technical staff that are part of the 'Lean functions' in the individual companies, conduct analyses from which the appropriate improvement action takes place. These analyses and actions are conducted periodically and quickly. All participants must treat each other with equal respect, and should have muda as the joint enemy. (Womack & Jones 2003, 276)

4 LEAN TOOLS AND TECHNIQUES

Many companies start off their Lean journey by viewing Lean as a set of 'tools' to implement. Sometimes the tools are even implemented individually. This may be beneficial for a while but will not suffice on the long run. "Real Lean is behaviour-driven. Behaviour is built by establishing principles such as pulling the Andon chord when a problem occurs but **ALWAYS** doing this, always expecting this, and always supporting this" (Bicheno & Holweg 2009, 2).

The Lean tool and techniques are, however, the backbone of Lean management and the most common tools that are implemented are highlighted below.

4.1 5S

5S is one of the most popular lean management tools used. However, it may not be a good idea to start the Lean journey with 5S. While 5S is easy to implement, has a positive impact on quality and productivity, it can also

serve as a diversion from real priorities or seen as merely tidying up. (Bicheno & Holweg 2009, 78)

5S is a very powerful tool and should not be equated to cleaning or tidying up. "The real objectives of a 5S program should be:

- To reduce waste
- To improve variation
- To improve productivity" (Bicheno & Holweg 2009, 78)

Thus 5S should be used as a 'pull' activity (that is it should be used when the need for it arises).

5S also serves to impact the mind-set of workers so that they stop thinking negatively of working in a messy and disorganized workplace and begin to think positively of working in a well-organized workplace where anything that is out of place is realized and corrected immediately. (Bicheno & Holweg 2009, 78)

Companies that have implemented 5S have reported some of the following positive results:

- Improved communication and information sharing
- Lower accident rate (thus the safety has improved)
- The levels of product quality have improved
- Machine downtime has reduced. (Hobbs 2011, 10)

Before implementing the 5S Lean technique, it is important for the senior management (or top management) to be on board and supportive. They should be the ones driving the 5S. Every employee must be completely committed to implementing it, not just those working on the shop floor (the shop floor is the part of a company where production takes place). (Carreira 2004, 241).

As 5S may be a new concept to many in a company, they may have a difficult time understanding what it may really mean even if they understand the concept of it. One way of helping employees understand 5S is by using the model approach. A small area of the shop floor is targeted and 5S is implemented there. The 5S should be completed down to its smallest detail before any consideration is taken in moving on to another area. The main reason for doing this is to allow for employees to be able to see and compare the results of 5S (the new mindset) against their previous way of working (the old mindset). As 5S would inherently be better than their old ways, the employees would be eager and willing to proceed with it to other areas and ultimately the entire company. (Carreira 2004, 242)

The original 5S is in Japanese and are Seiri, Seiton, Seiso, Seiketsu, and Shitsuke. This is commonly translated to Sort, Set in order, Shine, Standardise and Sustain (Bicheno & Holweg 2009, 78)

4.1.1 Sort

All items in the work area are sorted. First they are sorted into those that are needed and those that are not. Those that are not needed or serve no purpose in the work area must be immediately discarded. When in doubt the company may choose to red tag items. A red tag is a label with a date on it and if the item is not used up until the date then it is discarded.

The items are further sorted according to the frequency of use. Those that are used frequently (perhaps everyday) are kept as close to the workers as possible so that time is not wasted reaching for them. Those that are used less frequently (perhaps once a week) are placed slightly further so that they are close enough to be easily reached but not so close as to disrupt the use of the frequently used items. Finally those that are rarely used (perhaps once a month) are kept furthest away.

The sorting should be done periodically, perhaps once a month, but this should be done as a regular activity and not as a re-launch of 5S. Also a company should be careful not to go over-the-top. They should, within reason, allow for a few personal items to be kept in the workplace. (Bicheno & Holweg 2009, 79)

The results of the sorting could be used for visual communication by taking before and after photographs and putting them on a 5S board for all the employees to see the improvements. (Carreira 2004, 243).

4.1.2 Set in order

Set in order deals with the location of each item. Each item should be placed in the best place that is ergonomic and that everyone knows where it is. Two ways to ensure that all workers know where the items are include colour matching them with their area (this could be done via labelling), and using shadow boards (a shadow board is a type of visual management tool that has paintings or outlines of tools so as to show their correct location). This stage should be repeated whenever there are any products, parts, or tools change (Bicheno & Holweg 2009, 79).

4.1.3 Shine

The work area should be kept physically tidy on a regular basis, and the workers should also be scanning the area for anything that is out of place and try to immediately correct it. One way of doing this is by having a five minute routine clean up every day (this routine should be standardized for the best results). The equipment used for cleaning and tidying must be suitably located and be well maintained. "'Cleaning is checking' means that these are integrated. You don't just clean up, you check for any abnormality and its root causes." (Bicheno & Holweg 2009, 79).

4.1.4 Standardize

Standards must be developed for the first 3Ss so as to ensure that the workers are doing what the company wants/requires of them. "Standard work aims at creating processes and procedures that are repeatable, reliable, and capable". The best standard is one that is regarded by the workers as so good and reliable that they would not want to do the procedure any other way (or doing the procedure any other way would be regarded as silly) (Bicheno & Holweg 2009, 84). These standards need to be well maintained in order for the implementation of the 5S to be a success.

4.1.5 Sustain

All workers should make the first four Ss a habit, and must therefore continuously strive at utilizing and improving them. Audits are carried out to make sure the 5S principles are being upheld.

4.2 Just-in-Time (JIT)

Just-in-Time is a lean technique that focuses on the continuous process of eliminating waste and improving productivity. Waste is defined as any activity that does not add value to the products/services created. Typical examples of wastes are excess lead times, overproduction, and scrap. (Lai 2009, 11). JIT may be thought of as a 'pull' activity based on customer demand rather than pushing products based on projected demand. (Lean Production.com 2010).

The main objective of JIT is to "produce and transport just what is needed, just when it is needed, in just the amount needed, within the shortest possible lead time" (Drew et al. 2004, 27).

Implementing JIT is often difficult because, as it was developed in Japan, JIT management has a high degree of Japanese culture embedded in it. Some of these cultural characteristics are:

- The Japanese culture emphasises 'customer orientation' and thus most of the business organizations in Japan operate using a pull strategy. This is seen in how JIT management results in meeting customer demand regardless of the level of demand
- The reduction of time as a waste is also part of the JIT management. This means that there is a reduction in time elapsed from the arrival of materials, to the processing and assembling of the final product. This may be as a result of the Japanese emphasis on speed and efficiency.
- JIT management results in a reduction of inventory and thus enabling more space for the utilization of company processes. This ties in with the Japanese concern for space as it a populous country.
- Yet another element of JIT management is the requirement of keeping the company clean so as to avoid any hindrances to production. Due to limited space, the Japanese culture is concerned with the cleanliness of their environment. (Lai 2009, 11-12)

JIT management can only work effectively if machine changeovers are reduced significantly so that manufacturers upstream continuously produce small amounts of parts at the rate they are required by the next process downstream. Also the downstream production should practice level scheduling so as to create a smooth day-to-day order flow that is free from any changes or problems that are unrelated to actual customer demand. (Womack & Jones 2003, 58).

When implementing JIT techniques in a company, it is important to first have an agreement and support with all those may be involved, typically those who work in the company, and companies involved within the supply chain (Lai 2009, 18). It would be impossible for a company to implement JIT without the support of its suppliers, for example as JIT affects replenishment lead times and order cycle times which would affect the suppliers.

"In sum, JIT is based on the concept of delivering raw materials just when needed and manufacturing products just when needed" (Lai 2009, 13).

4.3 Kaizen

Kaizen is one of the most recognized Japanese words. Kai means continuous and zen means improvement. It focuses on the fact that no process can ever be perfect and there is therefore always room for improvement. There must be "continuous improvement, in small increments, at all levels [of the company], forever". Kaizen is the centre of many lean tools and techniques as, after implementation, they can continuously be improved upon.
A less known word is 'kaikaku' which is a radical or revolutionary event, unlike kaizen that is an incremental event. "Proponents of reengineering would be more likely to endorse kaikaku". (Trent 2008, 140; Bicheno & Holweg 2009, 193).

The kaizen process is implemented in the form of formal events (known as kaizen events) and consists of three stages. The first stage involves preparing for the kaizen event, the second stage involves performing the event and the third stage involves checking whether the improvements are truly beneficial and if they are, whether they are permanent. Most kaizen events focus on a company's internal processes, but it is capable of application in any part of the supply chain. (Trent 2008, 140).

A kaizen event, from beginning to end, is often wrongly assumed as a process that requires it to be conducted in one week or less. The performance of the kaizen event may take five days or less but the processes involved before and after the event may take much more, and are equally as important as the event itself. (Trent 2008, 140-141).

In the first stage, or preparation stage for a kaizen event, the following processes (activities) must take place:

- As the aim of the kaizen event is to improve processes, the first thing to be done is to select the area within a company that needs improvement. This selection may be done via value mapping. The overall sys-

tem view should be taken into consideration so as to avoid working on the wrong process or a process that should not be there. This process should also be documented in a scope document. "The scope document includes an assessment of estimated costs and benefits, both soft and hard." (Trent 2008, 141; Bicheno & Holweg 2009, 195). Problems that could occur during the event should be identified and dealt with so that, if possible, the do not occur.

- A time for the event is also set and those involved in the event should be notified. There should be a kaizen leader to lead the rest of the team during the kaizen process.
- During the actual kaizen event, the leader and team members evaluate the work area (or process) and "improve the process to solve the performance issue, measure results, and communicate these results to stakeholders" (Trent 2008, 141). All that occurs each day of the kaizen event is documented.
- After the kaizen event, the leader ensures that the changes made are sustained. There should be a review of the area every month to ensure that that the improvement was a success and more importantly, is continuously improving (Trent 2008, 141; Bicheno & Holweg 2009, 196).

4.4 Kanban

"Kanban is the classic signalling device for production pull systems" (Bicheno & Holweg 2009, 149). It is therefore seen as a type of mechanism that is utilized in a pull-based process. There are several types of kanbans that are used in manufacturing systems and they will be highlighted below.

4.4.1 Single and dual card kanban

The most popular type of kanban used in lean management systems is the single card kanban. A single card kanban is a single card (or a pull signal) that is used between pairs of work stations. The kanban is the authorization to have a part or a whole container moved to a particular location.

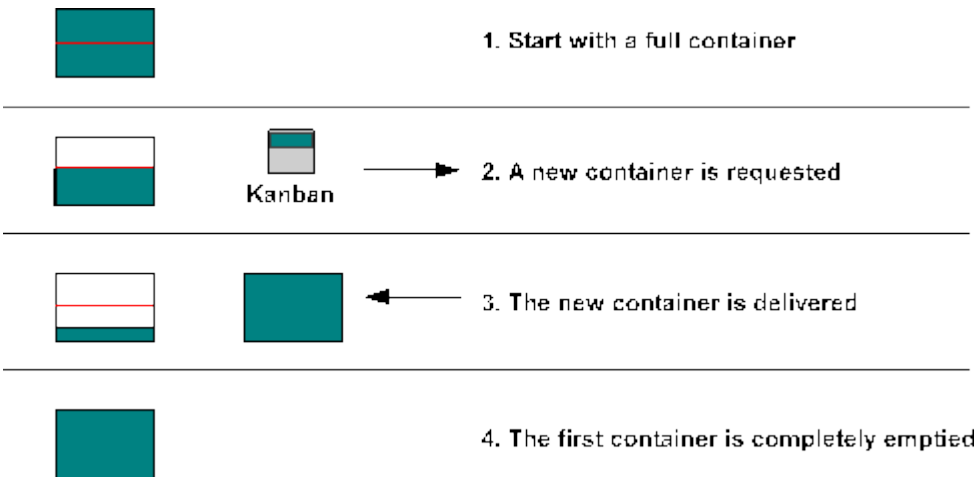

Figure 1 Example of a kanban system.

Source:
http://help.sap.com/saphelp_40b/helpdata/en/cb/7f8ad543b711d189410000e829fbbd/content.htm

Kanbans are used because they are easily understood, easily seen, and relatively easy to implement. (Bicheno & Holweg 2009, 149).

A product kanban is a type of single card kanban. In product kanban, whenever a product or container is pulled from it, another one simply replaces it. If there is no pull then that means that there was no authorization and therefore no production. (Bicheno & Holweg 2009, 149).

Dual card kanban was established by Toyota and entails the use of two kanban cards; the production kanban card and the conveyance kanban card. The production kanban card is for the supplier process and the conveyance kanban card is for the customer process. The supplier process is the process of a supplier replenishing parts, while the customer process is any process that involves raw materials being converted to finished products (such as assembly). (syque quality 2005)

When parts used in the assembly (customer) process goes below a certain level as defined by the conveyance kanban card, the card is placed out for the Materials Handler. The Materials Handler replenishes the parts needed by retrieving them from the stock point and having them taken to the assembly point. The parts at the stock point then also need replenishment. At the stock point is where the production card is. During the process of the Material Handler retrieving parts, the production card is moved to a special rack which signals the suppliers to replenish the stock point. (syque quality 2005).

When the supplier receives the production kanban card, they use it to trigger a materials retrieving cycle from the manufacturer or assembly of parts, to the stock point. After replenishing the stock point the supplier also puts the production kanban card (which now indicates that the stock items have been replenished) back at the stock point. (syque quality 2005).

It is important to note that the conveyance and production kanban card should have a matching number of parts/items on them. If the numbers do not match then this could result in an unnecessary build-up of inventory, or the stock point would run out of parts. (syque quality 2005).

A kanban is not necessarily a concrete card. It can be electronic, a square known as a kanban square, or a kanban container. A kanban square is a rectangle or square which is painted on a factory floor and the signal for replenishing it is when it is empty. Similarly a kanban container is a container that can typically hold a fixed number of parts and when it is empty this acts as a signal for replenishment. (syque quality 2005).

4.5 Improvement Cycles: PDCA and IDEA

Improvement cycles give the framework for the process of continuous improvement. Having a standardized approach towards continuous improvement is of great value for any organization. There are different variations of improvement cycles but the concept is similar.

4.5.1 Plan Do Check Act (PDCA)

This is the most well-known and widely used improvement cycle in the world. The different components that make up PDCA must, however, be well balanced for it to work efficiently. (Bicheno & Holweg 2009, 182)

In this cycle, a company must begin by planning. The planning involves creating a hypothesis with the end customer and their requirements in mind. There must be constant communication and discussion in developing a hypothesis that predicts a desired outcome. This stage should also develop a time plan. (Bicheno & Holweg 2009, 183)

After planning comes doing. Doing simply involves implementing the improvement that was planned in the plan stage.

Then comes checking which involves checking if what was done was as predicted/planned, and if not why not. (Bicheno & Holweg 2009, 183)

Once the checking stage is complete, the company can then act on the results of checking. The necessary adjustments are made and standards are created. As the cycle begins once again the end result standards are continuously improved upon. If there is a large deviation from the standard then this should indicate that something went wrong. (Bicheno & Holweg 2009, 183)

4.5.2 Investigate Design Execute Adjust (IDEA)

The cycle of IDEA is similar to that of PDCA. It is used by companies like Toyota for innovation and design. (Bicheno & Holweg 2009, 183)

This cycle begins by investigating anything that gives the company cause to investigate; a problem, customers, data, and so on. After investigating, a new solution is designed. The new solution is then executed and is subsequently adjusted to prepare for the next cycle and to bring it closer to company requirements. (Bicheno & Holweg 2009, 183).

4.6 Value Stream Mapping

Value Stream Mapping is a visual improvement tool, that involves the creation of maps to show the "Current State, Future State, Ideal State, and Action Plan" of a company. The process of mapping must lead to action otherwise it will be regarded as waste. The maps are typically created for a specific area in a company. The aim of value stream mapping is to identify

the processes within a company that add or do not add value to an end product. The information and material flow of a product are defined and the linkages (or conversion processes) between them are documented. The individual tasks within these linkages are further documented and separated into value-adding and non-value-adding tasks. The future state map is then created using only the value-adding tasks. The non-value-adding tasks are then assessed for possible elimination. (Bicheno and Holweg 2009, 94; Hobbs 2011, 7-8)

Value stream mapping is conducted by assembling a team whose sole purpose for a given time is to conduct it. The team typically assembles in a conference rooms and using tools as common as 'Post It notes' they note down all the processes involved in producing a product and post them on a wall. Once all the processes have been identified, the team then notes and sticks on a separate part of the wall value-adding tasks embedded within the identified processes in a bid to identify the non-value-adding tasks. After this is done the notes are rearranged into the value-adding and non-value-adding tasks. The value-adding tasks are used to create a future state map while the non-value adding tasks are marked for elimination. The team is divided into the individual members whose tasks are to eliminate the non-value adding tasks. (Hobbs 2011, 8)

A map should not be created unless a company has a vision in mind. Once the vision is known the mapping process can commence. The maps should be created in such a way as to highlight areas for improvement. The creation of maps should also be a continuous process. Thus maps should be appropriately labelled with dates and new ones created whenever there are major changes to processes made. (Bicheno and Holweg 2009, 94)

As value stream mapping is easy to implement, it can easily serve as a cover for senior management members who are not fully invested in the implementation and transformation of lean. They can blame the team if it is not a success or take the credit if it is. Value stream mapping only shows the magnitude of Lean opportunities, it should not be seen or called Lean itself. (Hobbs 2011, 9).

4.7 Poka-yoke

"Poka-Yoke is fool-proofing, which is the basis of the Zero Quality Control (ZQC) approach, which is a technique for avoiding and eliminating mistakes." (Poka-yoke 2011). This technique is not limited to use in manufacturing only but can also be used in office processes (such as invoicing), hospitals, among others. Poka-yoke enables a company to prevent a problem or defect from occurring, or stop a process immediately a problem occurs. A typical and everyday example of how poka-yoke works is the clutch in a car; the car will not start unless the clutch is pressed. (Poka-yoke 2011; Drew et al. 2004, 33).

4.8 Takt time

The word "takt" is German for the baton that a conductor would use when orchestrating in order to maintain a certain speed. Thus Takt time is "rate time". "Lean Production uses Takt Time as the rate that a completed product needs to be finished in order to meet customer demand." (isixsigma 2013). For example, if a manufacturing plant has a takt time of 5 minutes, this means that every five minutes a final product is produced of the assembly line.

Takt time is determined by the rate at which customers buy a product. When customers buy more of a product then takt time decreases and vice versa. Companies can use this information to determine an optimal staffing plan; only the right number of staff is used for working at a specific Takt time, no more or less. (isixsigma 2013).

5 LEAN SIX SIGMA

Lean management is often combined with the quality management tool, six sigma. They should, however, not be used interchangeably. Bicheno and Holweg (2009, 45) advice companies to begin by implementing lean concepts before integrating six sigma (and six sigma should only be integrated if it is needed).

5.1 Six Sigma

"The term 'Six Sigma' derives from the spread or variation inherent in any process" (Bicheno & Holweg 2009, 174. Six Sigma allows for a company to deduce how many defects (on average) occur per process. These defects are deviations from pre-determined bound limits. A company would typically set upper and lower bound limits. Any product or service that is defined to be either higher than the upper bound limits or lower than the lower bound limits would be described as defective. (Bicheno & Holweg 2009, 174).

Discovering and correcting defects as soon as they are detected is paramount for a company. For example, in Toyota car plants, assembly workers have the authority to stop an entire assembly line if they detect any defects that cannot be solved quickly or within the normal work cycle. Detecting and fixing a defect as soon as it occurs pushes a company towards continuous improvement. (Drew et al. 2004, 44)

The implementation of Six Sigma is done through the improvement cycle DMAIC – Define Measure Analyse Improve Control.

5.1.1 Define Measure Analyse Improve Control (DMAIC)

"The Six Sigma methodology uses a variation of PDCA known as DMAIC" (Bicheno & Holweg 2009, 183). Unlike PDCA however,

DMAIC has expanded on the 'Plan' stage, which is often viewed as the critical stage. (Bicheno & Holweg 2009, 183).

The first phase in the DMAIC improvement cycle is 'Define'. A company defines any problems that they would like to fix. First, those who are leading the DMAIC project begin by identifying a process that needs to be improved, and creates a Project Charter (the scope of the project) so that they can view the process properly. This phase also helps the project team to understand the customers of the process and their needs. (Go leansixsigma 2012).

The second phase of DMAIC is 'Measure'. The current state of the process is identified without making any changes. This current state (or baseline) will become the standard against which any improvement changes will be measured against. In this phase the project team also begins to try and uncover the root cause of the problems in the process. (Go leansixsigma 2012).

The third phase of DMAIC is 'Analyse'. This phase is often linked with the 'measure' phase. The project team analyses the information collected from the Measure phase and as the extract data from the Measure phase they may choose to adjust their data collection to include additional data. The team's main objective is to determine, from the data collected, the root cause of the wastes and defects in the process. (Go leansixsigma 2012).

The fourth phase of DMAIC is 'Improve'. Once the root cause of the problems has been identified, the team can then begin the process of eliminating the wastes or fixing the machines that are causing the defects. The team first brainstorms on what would be the best solution to use. The solution should show a measurable improvement compared to the data collected in the Measure phase. (Go leansixsigma 2012).

The fifth and final phase of DMAIC is 'Control'. Control involves sustaining the solution(s) implemented in the process. The project team updates and finalizes their documentation, and informs the workers involved in the process of the changes made and how they can maintain it. Since DMAIC is an improvement cycle it is important to make it continuous as continuous improvement is the core of Lean principles. (Go leansixsigma 2012).

5.2 How to calculate a Sigma level

The sigma level of a process is the approximate percentage of a defect occurring. The tolerance levels must be distinct and the process well defined, before beginning to calculate the Sigma level. In order to calculate the Sigma level, the number of defects per million opportunities (DPMO) must be identified (an 'opportunity' is every time a process is run). (Bicheno & Holweg 2009, 176).

The formula for calculating the DPMO is Number of Defects/Number of units produced * 1 000 000. Table 1 below can then be used to convert the

DPMO result to a Sigma level. If the DPMO falls between two Sigma levels (for example between 3.0 and 3.1) then the lower Sigma level should be used. (Bicheno & Holweg 2009, 177).

Table 1 Sigma levels and coinciding DPMO (Bicheno & Holweg 2009, 176)

Sigma level - tenths											
		0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	1	-	-	-	-	-	500 000	460 200	420 700	382 100	344 600
	2	308 500	274 300	242 000	211 900	184 100	158 700	135 700	115 100	96 800	80 760
Sigma	3	66 810	54 800	44 570	35 930	28 720	22 750	17 860	13 900	10 720	8 198
level -	4	6 210	4 661	3 467	2 555	1 866	1 350	968	687	484	337
whole	5	233	159	108	72	48	32	21	13.4	8.6	5.4
number	6	3.4	-	-	-	-	-	-	-	-	-

A practical example of how a Sigma level is calculated: a company that produces pencils would like to measure their six Sigma level. Every hour, the company produces 200 000 pencils. The company checks the quality of the pencils every hour for 6 hours and a total of 3 000 pencils are rejected. The DPMO is calculated (3000/[200 000*6] * 1 000 000) and is found to be 2 500. Using table 1 above, the DPMO level gives a Sigma level of 4.3. The company can therefore find out and solve the reason why there are a high number of defects in order to raise the Sigma level to 6.

5.3 Integrating Lean and Six Sigma

Lean and Six Sigma are both powerful concepts. Integrating both requires a company to carefully outline a plan of action on how to do so otherwise implementing them separately would be costly. One way of integrating both is by implementing a top down Lean Sigma programme where Lean eliminates wastes and non-value adding activities, while Six Sigma is used to control variation of the value adding activities. (Bicheno & Holweg 2009, 178)

6 CHANGE MANAGEMENT

According to Shorter English Dictionary, a change is any "alteration in the state or quality of anything" (Finch 2011, 1), while according to Murthy (2007, 22) change management is "managing the process of implementing major changes in information technology, business process, organizational structures and job assignments to reduce the risks and costs of change and optimize its benefits". The objective of change management is for one to understand why and how change happens and how to make it a positive and welcoming concept. Another way of putting it is that there are typically two major problems that change practitioners try to find the solutions to – "how to plan better for implementation and how to overcome employee resistance" (Murthy 2007, 22; Anderson & Anderson 2001, 2).

As implementing Lean management is a significant change to an organization, it is important to instigate a positive attitude (or mindset) and behaviour in the workers as they are the ones who will be expected to sustain

the changes over time. Thus the success of sustaining lean depends on the people. (Drew et al. 2004, 20).

There are several different ways for an organization to implement change successfully. Organization change comes about either as a planned event or as a reaction to an unanticipated event. There are also several models of change that have been developed. Two of these models are Lewin's change model and Planning model (Murthy 2007, 76)

6.1 Change models

6.1.1 Lewin's change model

Kurt Lewin (1952) was a psychologist who developed a three phase model for organizations implementing change. The three stages are unfreezing, change, and freezing. (Murthy 2007, 76)

In unfreezing, preparation is done in anticipation for the change. A senior manager builds a good relationship with all those who are involved in the area where the change will take place. It is important to make sure that the workers understand why there is going to be a change so that they do not resist the change once it takes place. (Murthy 2007, 77).

In changing, the change is implemented. It is important for senior managers, in this stage, to make sure that they have identified "new, more effective behaviours to be followed" as well as the related changes in people, tasks, technology, and so on. Allows for senior managers to identify any problems and think of solutions. (Murthy 2007, 77).

Finally in refreezing, the senior management creates an environment for the workers in which they are rewarded for the new behaviour (the reward could be by seeing the benefits of the changes) and the new behaviour is accepted and continued (the workers do not revert to their old ways of working). (Murthy 2007, 77).

6.1.2 Planning model

This model was developed by Lippit, Watson, and Westley (1958) and was further developed by Kolb and Frohman in 1970. It aims to implement planned change within an organization by focussing on the principle that information must flow freely and shared between a change agent and the organization. There are seven steps involved in this model:

- Scouting: The change agent and the organization analyse the area that requires change
- Entry: In this step the change agent and the organization develop a mutual understand of their expectations and contact
- Diagnosis: Explicit improvement goals are determined

- Planning: The improvement goals that were identified in the diagnosis stage are further planned in this step, as well as identifying possible causes to resistance to change
- Action: Implementing the improvement goals
- Stabilization and evaluation: The successfulness of the action step is identified in this step as well as any need for further action or elimination.
- Termination: In this step, the decision on whether to leave this change process and begin another is made. (Murthy 2007, 139-140).

The change agent and organization (or rather the organization representative such as a manager) is not required to follow the sequence of the steps but can modify them depending on the problem identified (whether it needs further definition, or can be broken down to further problems, and so on). (Murthy 2007, 140).

6.2 Mindset

"In any organization, whether or not change sticks has a lot to do with how those involved perceive it" (Drew et al 2004, 20). Not many managers are used to thinking about their employees' mindsets mainly because they cannot be seen and are often difficult to influence and understand. The behaviour and mindsets of the employees is often referred to as organizational culture and it is this that helps determine whether or not changes made to the organization can be maintained over time.

> Organisation culture is the system of shared values, beliefs and habits within an organisation that interacts with the formal structure to produce behavioural norms, influence employees degree of job satisfaction and the level and quality of their performance.
>
> Murthy 2007, 118

The importance of having a positive influence on the mindset of employees can be seen through the maintenance of standardized processes. Lean management calls for processes to be standardized so as to ensure safety, consistency, and productivity for the workers. In order for standardized processes to be implemented successfully, front-line employees need to be disciplined in how they deal with the processes (with respect). On the long term, front-line employees will need to know how to use their experiences to adapt to changing circumstances. This may be difficult for middle managers to deal with as they are used to just issuing instructions. Middle managers would need to dig deeper and act as coaches for the front-line employees, showing them how to adapt to the new ways of working. They would also need to learn to welcome any identification of problems rather than punishing the employee who pointed the problem out. In order for such changes in behaviour to occur, the senior management must set their expectations of employee behaviour. Employees learn to gauge their behaviour based on the senior management; they look up to their leaders as models. It is therefore important for senior management members to interact as often as possible with front-line employees. (Drew et al. 20-21).

6.3 Employee types

According to Hobbs (2011, 121), there are three general categories for an employee's mindset and behaviour towards change. The categories are:

- Good soldiers
- Skeptics
- Resisters

While managers or change agents are certainly not psychologists, assessing employees based on types plays an important role when making a change to Lean because emotional motivation does come into play in order for the change to be a success. Managers need to know which employees share their vision, which are sceptical about it and which ones resist the change outright and why. (Hobbs 2011, 124).

6.3.1 Good soldiers

Good soldiers are the employees that do what is the expected of them and usually without question. They do as they are told and are flexible to any changes in their work area. They do not challenge any authoritative figure in the work place or suggest any alternative solutions to any problems identified. They are ready to accept any new changes (such as policies and procedures) with few to no questions asked (and they are apt to accept the first answer they receive to any questions they may have). Overall, they are simply happy doing their jobs. They are, however, more interested in earning money than in the job they do to earn it. They see their jobs as a means of financial support and because of that they are happy to do it. "They are the backbone of a company's workforce". (Hobbs 2011, 121-122).

6.3.2 Skeptics

Similar to good soldiers, skeptics are regarded as excellent employees. Skeptics often consist of long-time employees who have seen and experience many improvement programs come and go. Thus they become cynical and sceptical about changes. They do not readily accept change but will always challenge it. They need to know the reasons for any change implemented and these reasons must be convincing enough for them to accept it. This challenge towards change should be viewed as concern for a company's welfare. It is therefore important for a senior management team member or an authoritative figure in the company to address any concerns and questions skeptics have about the changes in the company. Skeptics will be willing to embrace the new implementation only if they are convinced that it will be an improvement and benefit them and that it will long lasting. If they are not convinced, however, they may continue their scepticism which may negatively impact the implementation of the new change. As long as they do not try to negatively influence other workers (or are negatively impacting the implementation itself) then con-

tinued scepticism can be viewed by a company as a workable situation. (Hobbs 2011, 122).

6.3.3 Resisters

Skeptics and good soldiers make up about 70% of the worker population. The remaining 20% are resisters. Resisters are the most difficult category of workers to deal with. Resisters adamantly oppose any changes made in the workplace. They can be especially hard to deal with if the change affects or takes place in their work area as they may take 'ownership' of the processes they work in and refuse to have an changes made to them. (Hobbs 2011, 122).

It is difficult to identify resisters as they rarely speak up or protest. They are clever enough to know that if they protest outright then this could have a negative effect on them personally. Rather than expressing they true feelings publicly, they recruit other resisters by speaking to them privately and often on a one-on-one basis. Their motive for doing this is to recruit enough resisters to delay or even end any implementation of change (such as lean implementation). (Hobbs 2011, 122).

A resisters non-committal stance in a company means that they are always in a winning position no matter what the outcome of the change is; they are not accountable if the change is not successful, and they reap the benefits of the change if it is. Managers or change agents can identify resisters by how they hang back during meetings discussing change (or support the change passively), and keep quiet publically. (Hobbs 2011, 122).

7 IMPLEMENTING LEAN

There are several approaches to lean implementation. Implementing lean mainly depends on a company. The approach to lean should be based on the needs of the company (different sized companies producing different types of products or services in different volumes will inherently have different approaches to lean implementation). There is therefore no one perfect way to lean implementation.

7.1 Implementing stand-alone lean techniques

Stand-alone lean techniques are typically techniques such as improvement cycles or six sigma that do not entail making large changes to a company. Companies that opt to begin the lean journey with such techniques do so by implementing them one at a time as a safe strategy. While making any improvement effort is viewed as positive, implementing stand-alone techniques will rarely yield the expected results and this then leads to disappointment. Stand-alone techniques should therefore not be substituted for Lean management. (Hobbs 2011, 7)

7.2 Implementing Lean according to the five Lean principles

The five principles of Lean, as briefly outlined in subchapter 3.2, were developed by Womack and Jones in their book, 'The Machine That Changed the World'. Implementing Lean according to these principles will be further explained in this subchapter.

When a company begins its journey with Lean, the first thing it must identify is its value as defined by the customer. It is meaningful to express this "in terms of a specific product [and/or service] which meets the customer's needs at a specific price at a specific time". (Womack & Jones 2003, 16). However, many producers globally have a difficult time accurately defining value. According to Womack & Jones (2003, 17)) managers throughout the world are apt to say, "This product is what we know how to produce using assets we've already bought, so if customers don't respond, we'll adjust the price or add bells and whistles." The definition of value, therefore, tends to get side-swept by outdated thoughts of economies of scale, technologies, and un-depreciated assets. The needs of the company (or often, the needs of the senior management), takes precedence over the need to create and specify customer value. Starting the lean journey by specifying customer value also means that an organization has to redefine the roles of the organization's technical experts because they typically aim at advancing the organization via existing assets and technologies rather than on a product-line basis. (Womack & Jones 2003, 17-19).

The next step in the journey to lean is to identify the entire value stream for each product (or product family). "The value stream is the set of all the specific actions required to bring a specific product through the three critical management tasks of any business." (Womack & Jones 2003, 19). The three critical management tasks are the problem-solving task (such as design), the information management task (such as order-taking, and scheduling), and the physical transformation task (such as the conversion of raw materials to a finished product). (Womack & Jones 2003, 19). This means that the value stream analysis encompasses an entire organization and not just the production or manufacturing area.

> Value stream management sets the stage to implement a lean transformation throughout the whole enterprise and keeps an organization from falling back into the traditional suboptimal approach of improving departmental level efficiencies
>
> Keyte & Locher 2004, 1

There are three types of action that occur along the value stream during the value stream analysis:

- Certain steps (or processes) will be found to create value
- Certain steps (or processes) will be found not to create value but are still necessary due to current technologies and production assets (such as the process of inspecting products to ensure quality). Womack & Jones (2003, 20) term this as type one muda.
- Certain steps (processes) will be found not to create any value and are also unecessary (type two muda). (Womack & Jones 2003, 20)

Through the value stream analysis, an organization is able to unearth the main sources of waste among its processes. These wastes (type two muda) should be eliminated.

The view that lean thinking goes beyond the organization can be seen through the process of value stream analysis. This is because the analysis enables an organization to focus on product conception and throughout all the activities (and all the other organizations involved) needed to get the product into the hands of the customer. In this way, Womack & Jones (2003) introduce the concept of Lean Enterprise. Lean Enterprise is, "a continuing conference of all the concerned parties to create a channel for the entire value stream, dredging away all the muda." (Womack & Jones 2003, 19-21).

Once value has been defined, and the value stream mapping of a product has been done, the next step is to make the processes that create value to flow. (Womack & Jones 2003, 21). Many organizations find this step particularly difficult to implement because they are accustomed to the batch-and-queue system way of thinking. Batch processing is viewed as "efficient" even though it leads to bottlenecks and waiting time. Organizations look at batch processing as a way of benefiting them and not necessarily the product. Continuous flow, on the other hand, allows for products to be produced faster and more efficiently as there are no bottlenecks or any other similar forms of waste.

A perfect example of the positive effects of switching from batch processing to continuous flow is that of Henry Ford. He managed to reduce the efforts required to assemble a Model T Ford car by ninety per cent when he switched the final assembly process to continuous flow. He eventually managed to achieve continuous flow from raw material to shipment. This switch was, however, relatively easy for Ford to do as he was producing very high volumes of the same model of car for many years. This means that the machines assembled the same parts to make the same cars. The challenge (which Toyota took up) was to "create a continuous flow in small-lot production when dozens or hundreds of copies of a product were needed, not millions." Toyota achieved this by having machines (or tools) quickly change over from one product to another during production, and enabling machines to conduct different types of processing steps (such as molding, or painting) immediately adjacent to each other while a product is maintained in continuous flow. The benefits of having done this meant that productivity increased by up to double its size and there was a reduction in error and/or scrap (waste) (Womack & Jones 2003, 23).

The introduction of continuous flow means that time taken from concept to launch and all other activities to get a product to a customer, drastically reduces. It allows for organizations to design and schedule products and production according to what a customer wants and when they want it. This introduces the next step in lean implementation which is turning production to a pull-based system. Pull means that the product is made when a customer demands it rather than being made based on forecasting (when a customer might demand it). Having production based on forecasted de-

mand could mean that some of the product would go unwanted and there would be a waste in assets in having created them. This is why many companies have discounts so that they may have a guarantee that customers will buy as many of their products as possible even when customers do not necessarily want it at the time. Producing based on what the customer demands means that the customer demand will become more stable because the customer knows that they are able to get what they want when they want it. (Womack & Jones 2003, 24-25;)

Having defined value, identified the entire value stream, made value-adding process flow continuously, and let the customer demand dictate production, the need for perfection arises. Perfection means performing the first four principles in a cyclic manner so as to drive production to produce products exactly as the customer wants it. Product teams interact with customers to find out more and more specific information for defining value. The more specific the value definition, allows for a better and faster flow which exposes hidden wastes in the value stream. Faster flow also in turn means pulling harder and this reveals flaws in the flow which can be changed or eliminated. The most significant way of achieving perfection is transparency; everyone involved in the lean system is able to see everything. This not only allows for the discovery of better ways to create value, but also since the results of lean are instantaneous, employees become more motivated to continue the improvement process.

8 THE CHALLENGES OF LEAN

Though the lean concept is a significant one when correctly implemented, it is not devoid of challenges.

The most common challenge in lean implementation is maintaining it. Lean is a continuous process. Even though Toyota implemented lean more than fifty years ago, they are still utilizing it and continuously striving for improvement. Many companies implement lean concepts thinking it is to be done only once. Maintaining lean is challenging and requires a lot of work that companies are not prepared to commit to. “The journey to lean is not for the timid, and there are no stopping places along the way… Making the transition is highly challenging and many fall by the wayside” (Drew et al 2004, 8)

Another common challenge in implementing lean is assuming that it can only be used in manufacturing. Womack and Jones introduced the concept of Lean Enterprise which entails the use of lean management throughout all departments in a company. This includes (but is not limited to) accounting, distribution, human resource, and marketing. If lean is implemented in just one department, the immediate results may be positive but with time, since the department is affected or affects other departments, the results would begin to wane. (Bicheno & Holweg 2009, 3).

Yet another challenge that companies may have in implementing lean is the fact that “lean systems are inherently knowledge-intensive” (Drew et al. 2004, 7). Toyota has had the advantage of having many years of learn-

ing and developing knowledge in lean principles and concepts. The knowledge of lean is not only captured in systems and processes but is also captured in the workers; they think 'lean'. Years of lean thinking enabled Toyota works to know how to respond (and when) to changes in production. (Drew et al. 2004, 7). Some companies may not be willing to invest so much time in developing a lean mind set in the workers.

Lean implementation is a radical process as it changes the way of operating (such as eliminating the customary way of accumulating inventory) and senior management may be opposed to such drastic change. (Drew et al. 2004, 7). This presents a challenge in fully implementing lean.

Understanding the full implications of lean and making sure that all those involved in the lean process know what is required of them is essential to avoiding challenges of lean implementation and management.

According to Bicheno and Holweg (2009, 44) a survey conducted in the year 2007 on the leading one thousand Canadian manufacturing companies showed that going back to the old ways of doing things and the lack of implementation knowledge were the greatest obstacles to Lean.

It is a common misunderstanding that lean implementation begins from the bottom of a company and works itself up. Since lean, no matter which part of an organization it is implemented in, will soon work its way into and change work organisation, it is important to have the senior management support from the first instance that lean management is implemented. The senior management team is able to create rewards and incentives to encourage employees to continue to contribute to the company's lean efforts, or better yet they could lead by actively participating. (Bicheno & Holweg 2009, 44).

Many organizations have a tendency to run various improvement programs over time, sometimes in parallel. If workers are not made to understand that these programs lead to the same goals ("value enhancement, lead time reduction, reduction in defects or variability, and ultimately, cost reduction" (Womack & Jones 2009, 45)) and that they fit within the already existing lean system, the improvement programs would lead to confusion, indifference, or simply sitting them out. The workers would wonder why there is a different program being run when the previous one was a success, or why they should put in any effort if there is going to be another new improvement program implement in a few months' time. They need to understand that each new programme is not to be perceived as a replacement of the current one but as adding on to it. (Womack & Jones 2009, 45).

Two of the most common mistakes that companies make in implementing lean are implementing it for the reduction of inventory and labour (ultimately reducing costs). The reasons for a company having inventory is often for a good purpose; it may be to buffer against internal and external uncertainties or other such imbalances in the company. Drastically reducing inventory without addressing underlying issues first leads to an erup-

tion of many problems and eventually a company would go back to the old way of having inventory. The Lean way of reducing inventory is to do so gradually by first identifying and solving (or eliminating) one problem at a time. With time, the inventory levels will reduce. Reduction of inventory levels should not be a goal for a company. Rather, it should be a way of identifying sources of waste.

Similar to the reduction of inventory is the reduction of the workforce. The workforce has a direct impact on productivity and reducing any labour that may have been saved by the lean system would lead to the workforce viewing lean as negative. They would eventually be unwilling to continue with the improvement cycle feeling that it could eventually lead to the loss of their jobs. Instead, as a lean system does eventually lead to an increase in productivity (and hence a need for more workforce), a company could in the meantime use the 'spare' work force as a kaizen team. (Womack & Jones 2009, 46-47)

9 LEAN CASE STUDIES

Toyota Motor Company is one of the most widely used case studies in lean management mainly as it is where 'lean' was developed. There are, however, other lean case studies that are used as examples of the best ways to implement lean.

9.1 Lantech case study

The Lantech case study is an excellent example of the challenges implementing and maintaining the lean concept.

The company Lantech was started by Pat Lancaster, an American inventor. Pat Lancaster had, and developed his idea of creating 'stretch wrap' plastic for wrapping pallet loads as opposed to the most commonly used 'shrink wrap' of that time (Lancaster developed his idea in the early seventies). Shrink-wrapping was widely used by manufacturers and distributors; they would loosely place plastic bags on to cover pallet loads and then they would run the pallet load through an oven so that the plastic could shrink and therefore wrap tightly around the load. (Womack & Jones 2003, 102)

However, stretch-wrapping entailed pulling the plastic wrap very tightly around the pallet load as it was rotated on a turntable. This alternative method eliminated the wastes that were used in shrink-wrapping; these wastes were time, energy, and effort consumed, and equipment. Also, stretch-wrapping meant that the amount of plastic required was significantly less than in shrink-wrapping. (Womack & Jones 2003, 102)

Lancaster also discovered "that a complex set of precision rollers could exert a smooth force on the plastic to stretch it dramatically before it was wound around the pallet" (Womack & Jones 2003, 102-103). Lancaster patented his inventions and the market for these inventions was supplied

by the energy crisis of 1973. Energy prices increased and the new technique of stretch-wrapping (which, as mentioned before, uses less energy and plastic) would provide a significant advantage over shrink-wrapping. Therefore the company Lantech, like many start-up businesses, was born lean. (Womack & Jones 2003, 103).

Lancaster was then faced with the challenge of producing his machine in volume. As he had no experience in production, and sales, he hired an operations manager and a sales manager. He also hired an engineering manager as he knew that he would need variations of his basic invention to cater for different wrapping tasks. (Womack & Jones 2003, 103).

The operations manager created different departments in the manufacturing plant to cater for different stages of building a Lantech stretch-wrapper. Lantech would then build four basic types of the machine in batches as this was thought to be the most efficient way. Up to ten or fifteen of each type of machine would be created at a go. This was, however, inefficient as a typical customer would only purchase one machine so many machines would have to be stored in a finished goods area therefore the company would often have a large inventory of the machines. The machines were also often covered in grime and nicks (small dents) due to movement from department to department these had to be dealt with once it was time for shipment. Often the machines would also be sent back to Final Assembly for customization based on customer desires (Womack & Jones 2003, 103-104). There was, therefore, a large build up in waste of space, energy, costs, and time in creating an inventory of machines and having to make changes to them before shipping. These challenges clearly go against basic lean concepts.

There were also problems in communication between the departments because, whereas the actual processing time of an order was less than two days, there were often delays for the orders to travel from one department to another as each department would have its own waiting list of orders (Womack & Jones 2003, 106).

As each department would create parts in batches, there was a lot of time wasted in waiting for each batch to be created and stored for use in the next department. This would result in long lead times (up to sixteen weeks), when the actual time need to create a machine from raw material to final product was three days. (Womack & Jones 2003, 106).

Lantech needed to take steps in order to rectify the problems in communication, consolidation between the departments, and the long lead times. The company's first approach to improvement was to reduce variability by reorganizing the company and dividing the basic product lines and customized product lines. Thus customized product lines would have their own flow line. (Kovacheva 2010).

To improve communication and information flow and to build trust between the management and workforce in the company, authoritarian and

controlling managers were replaced by those willing to work in a team-based organization. (Kovacheva 2010).

Also, in order to eliminate the wastes that were as a direct result from batch-and-queue process, Lancaster decided to have a continuous flow process created for production. This means that the flow from raw materials to final product would be devoid of the stoppage and storage times that were in the batch-and-queue process. These changes lead to lead times of a week or less, and also resulted in smoother flow of production. Also, the number of defects reported by customers was a small fraction compared to those of previous products. (Womack & Jones 2003, 118-121).

Surprisingly, the amount of investment for such a large transformation was substantially zero. "The tools were moved and reconfigured, for the most part, by workers freed up from inefficient production tasks" (Womack & Jones 2003, 121). The same was done for the offices (Womack & Jones 2003, 121).

Lantech went through various processes in order to eliminate waste and transform the growing company back to its original concept; lean.

9.2 The Wiremold Company case study

Wiremold is a company that creates "wire management systems that route complex combinations of power, voice, and data wiring through buildings, and power protection devices…which protect sensitive electronic equipment from voltage fluctuations" (Womack & Jones 2003, 125).

When the new CEO of Wiremold (Art Byrne) joined the company, it was in a poor state. The company had large batches and mountainous inventories, machines were overburdened and often defective, the workforce was in excess, lead times were up to six weeks, orders were processed in a week or more, new products required from two and a half to three years from concept to launch, and departmental and functional walls hindered the visual of the work flow as well as the work flow itself. (Womack & Jones 2003, 131)

Byrne had had prior intensive experience in implementing lean, having 'leaned' eight separate companies for the company Danaher. He used this experience to implement lean at Wiremold. (Womack & Jones 2003, 133).

The first thing that Byrne did in lean implementation was to get rid of the excess people, and to teach the remaining workforce the importance of continuous improvement and embracing positive change. Byrne felt that the best way for lean implementation was to lead by example. Therefore he conducted sessions where he taught lean principles, and also conducted kaizen event exercises. (Womack & Jones 2003, 133-134).

Soon the Wiremold force was striving to achieve perfection at every value stream through continuous improvement. Kaizen events were conducted on a regular basis. They expected quick results from the continuous im-

provement process and if there were no results in three days then someone was doing something wrong. (Womack & Jones 2003, 134)

Byrne introduced various other lean changes to the company such as continuous production flow (or single piece flow) as opposed to the batch-and-queue system, reducing the number of suppliers (as well as introducing the suppliers to lean management via kaizen events), and reducing inventory by implementing the Just-In-Time system. Five years later some of the results from these changes includes, the time taken for product development had been reduced by seventy-five per cent; the time taken to receive, process and ship an order took less than a day (with the batch system it would take up to a week), and the sales per employee increased by more than one hundred per cent. (Womack & Jones 135-150).

Wiremold was able, through aggressive lean changes, to make a significant improvement. The Wiremold case study shows the importance of having the entire company thinking 'lean' and striving for continuous improvement. However, the Wiremold Company also presents the case of how easily, and in a short period of time, lean principles and processes within a company can disintegrate. Wiremold was eventually bought by Legrand, an owner with little interest in learning about the lean principles being implemented at Wiremold. As Art Byrne and other original lean members retired soon after (around 2002), lean lost its support in the management team and in the end the success of the Wiremold case soon faded. (Bicheno & Holweg 2009, 48).

The lesson learned is that, if not sustained for as long as a company is running, lean systems, having taking relatively long years to properly establish, can fall apart within a relatively short time.

10 RESEARCH RESULTS

The research was done using an online questionnaire. Twenty-two questionnaires were sent to various large and similar companies in Finland. Of these twenty-two there were five companies that responded.

10.1 Summary and analysis of results

To summarize, the main reason why companies chose to go Lean was to improve productivity as well as the overall processes in the company. To do so would mean having a competitive advantage as well as reaping other benefits that comes with implementing Lean (such as elimination of wastes). Though most of the Lean books and websites that were used as sources for this thesis refer to the significance of planning Lean implementation based on customer value, not one of the companies that responded mentioned this. This may be indicative of why they may have had certain challenges during the change process, but no concrete conclusion can be arrived at from this fact as there was no possibility to follow up with more questions to the companies.

All but one of the companies have implemented (or are in the process of implementing) Lean to the entire company. Implementing Lean in the entire company is similar to the concept outlined by Womack and Jones (2009) on the Lean Enterprise in which focus on Lean is not just exclusively for production or manufacturing but can be used in other departments such as Human Resource or Sales. The one company that implemented Lean in just one part of the company (the production area) did not have similar challenges to those that implemented in the entire company. For one thing their workers seemed very accepting and satisfied with the changes implemented ("In the end of the day everyone was satisfied"). As it was the only company to implement Lean in a part of the company in the survey, no concrete conclusions can be made on the significance of this. Had there been more responses from companies implementing Lean in a part of the company, comparison between them as well as the other companies could have been made and a more concrete conclusion could have been arrived upon.

All the companies have implemented improvement cycles, with the most common one being 5S. Again, as the author was unable to follow up the companies for more information, the author cannot know if these were implemented as stand-alone techniques or were implemented as part of a bigger Lean strategy. According to Hobbs (2011, 7) and Bicheno & Holweg (2009, 2), implementing stand-alone techniques will not usually reap the expected results and could lead to disappointment. This is because it is not enough to simply implement them, it is also important to note that Lean is behaviour-driven. The workers involved in the implementation (including the senior management team/leaders) need to be motivated to maintain the continuous improvement that is the Lean concept. Perhaps the reason why some of the companies had problems motivating their workers was because the company implemented the continuous improvement tools as stand-alone techniques; this conclusion cannot however be proven.

All but one company revealed that their workers had problems accepting the Lean implementation, at least initially. Understandably so, implementing change can prove difficult for workers to accept. The workers could feel that the change could lead to loss of jobs, or feel that it is not in the organization's best interest to have the change implemented, or could simply fear the unknown. (Murthy 2007, 68). However, one company felt that how the workers responded to the change would depend on the leadership and improvement strategy they had; "in some areas, they embraced the tool, e.g. 5S, in others they did not really adapt it depending on the improvement strategy and involvement/understanding of the leader".

Again, all but one company showed that it was challenging to maintain the Lean implementation. For most, it ties in with the resistance to change from the workers; it is difficult to sustain Lean if the workers are opposed to it. Also, many changes in a company are done once; such as implementing a new process in production, or introducing a new team leader. These changes do not have to be continuous. Workers may have become used to this way of thinking; they focus on a change until it is done and then cease

focussing on it. Therefore it is difficult to ensure that Lean implementation is done as continuous improvement process as it needs continual focus and attention.

The results of the questionnaire were compared to published information on the subject of implementing Lean in order to see if there was a correlation (a correlation would mean that the data acquired was reliable). Authors such as Drew et al. (2004), Bicheno & Holweg (2009), Hobbs (2011), and the thesis paper by Kovacheva (2010) have all researched extensively on the subject of Lean and have included information on the challenges of Lean, which is further discussed in chapter 8. This information was compared to the thesis questionnaire results. Also the promise of not mentioning the company name may add to the reliability of the answers. Knowing that the company will not be mentioned might have motivated the respondents to give answers that are more honest.

11 RECOMMENDATION

This recommendation seeks to develop a plan on how best to implement Lean management tools so as to avoid the challenges that the responding companies had.

11.1 Communication

It is important to ensure that proper communication channels are being utilized by the company in order to guarantee that the workers (who are the ones who are mainly involved in the actual implementation of Lean) are fully aware of the change that is to come and are less likely to resist it. If the company has a large number of workers, it would be difficult to communicate to all them at once via personal interactive channels such as meetings. If the workers have company email addresses, the company could opt to sending them emails about Lean management; when they would like to implement it, how it would affect the workers' current way of working, and what the workers' opinions or suggestions are towards it. Workers who may feel shy having to speak up during meetings may find it easier to give their opinions via email. In order to ensure that all the workers have read their emails the senior management could at least announce to the workers via their team leaders (or if the company has a public address system then this could be used) that important emails were sent to them. Letters or brochures could also be sent to the workers (they may be more likely to open a letter from the company than check their emails though this cannot be proved).

The company may also opt to divide the company according to the different departments or different processes so that they would then be dealing with smaller groups of workers. The senior management team could then hold meetings with each of these teams in order to give them clear and concise information on Lean implementation. It is important to ensure that all workers, especially 'Skeptics' and 'Resisters' are fully aware of the

benefits of Lean, how it would directly benefit them, and what role they would have to play in the implementation and maintenance process.

It should also be clearly communicated that Lean management is a continuous process and not a 'one-time' thing. Simple improvement cycles such as Plan Do Check Act (PDCA), or Investigate, Design, Execute, Adjust (IDEA) could be taught to the workers via training and the senior management team should encourage them to constantly try and improve their way of working via these cycles (this encouragement could be done through kaizen events, or incentives and rewards). Posters of these cycles could be put up on walls as visual management to remind the workers of what is required of them.

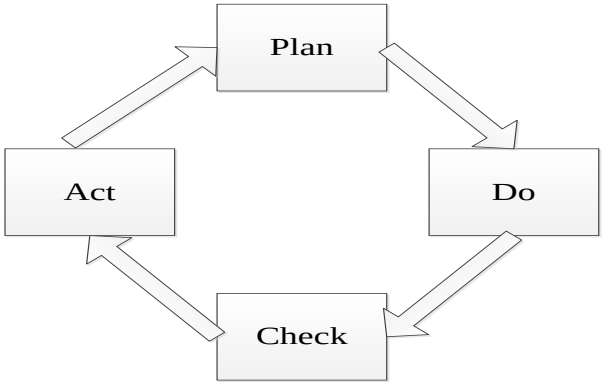

Figure 2 Example of a simple PDCA poster

It is vital to remember that communication goes both ways. The senior management team should create an environment that makes workers feel confident in giving their feedback on Lean. For example the senior management team could explain to the workers (via emails or meetings) that their (the workers) input is vital in making the implementation a success and should therefore take any opportunity they can get to voice their opinions or concerns on Lean. Questionnaires could also be used in retrieving information from the workers. The senior management team should not just collect this information but also use it. When the workers see that their suggestions are being used or taken into consideration they may be more willing to take part and contribute in the change. "Effective communication is a prerequisite to successful change, helping to shape the mindsets and behaviours of everyone involved, but it must be a two-way dialogue, not a one-way broadcast." (Drew et al. 2004, 94).

11.2 How to motivate workers

One of the main challenges that most of the companies who responded had was in motivating the workers. There may always be some (if not all) workers who have the most challenge in accepting the Lean implementation; one company identified the middle managers as having the most problems in accepting the change.

One way of avoiding workers resistance to change is by involving them in the entire processes of Lean implementation from beginning to end. The

senior management has to communicate with them on the reasons why they want to implement lean and to take the workers opinions into consideration. The workers need to be prepared for the future change. The process of implementation might initially require more work from them and they need to understand that this will not all be in vain. Visual management tools depicting the future goals of the company can be used as incentives for the workers; if they know where they are headed and they can clearly see the benefits of where they are headed then they may be more willing to work harder and to accept the inherent change.

Senior management can also use other incentives such as picking the employee of the month or even using monetary rewards (such as a certain sum of money goes to the worker that has made the most improvement Lean-wise for the company per month) as a way of motivating the workers to work at implementing the change and not give up halfway.

The support of senior management is also important, not only in motivating the workers, but in sustaining Lean. "Change on such a scale will soon grind to a halt if it doesn't have the support of the CEO and senior managers." (Drew et al. 2004, 84). The workers need to see that the senior management is involved in the implementation, not just in giving instructions but in leading as well. Also the senior management team needs to see how well Lean implementation is benefiting their company and the best way to do this is to visit the shop floor and even get involved in the Lean implementation on this level. "…forging a strong link between decision makers and the front line is vital to a successful lean transformation." (Drew et al. 2004, 90) One way of doing this is leading kaizen events. They do not necessarily have to lead all the kaizen events that occur but at least in the implementation stage when Lean management is still a new concept.

Finally proper training is necessary in motivating the workers. The concept of Lean may be new to many of the workers and they may be resistant to the change due to the fear of the unknown. Training acts as a way of educating them on how to go about making the changes and how to maintain it. (Murthy 2007, 68). The training could be done such that the workers gain hands on experience on Lean implementation and should be able to effectively communicate with the training leader about any doubts, or opinions, or suggestions. Training is especially important for the more complex lean tools such as lean six sigma.

11.3 How to implement the Lean tools

Lean tools should be implemented one at a time (thoroughly) so as to avoid confusion and diminishing focus on the project. It even helps to implement one project on a small scale first as a form of visual management so that workers can see (by comparing the old way of working to the new way) the benefits of the change. For example implementing 5S on a small scale first (further explained in chapter 4.1).

Once implemented, necessary steps such as kaizen events are needed in order to make sure that the tool is properly maintained and do not remain

stagnant. Audits could also be planned once a month to check individual processes (or departments) against a standardized form in order to ensure that the processes are properly sustained. The Lean tools processes themselves should also be standardized. Standardized processes ensure that the process is carried out effectively, consistently, and allows for a process to be optimized. (Lean Manufacturing.net 2009)

12 CONCLUSION

It has been made clear that throughout the process of lean implementation, importance on focussing on customer value should be emphasized. Also equally important is noting that (like Bicheno and Holweg (2009, 2) Lean is "behaviour-driven"; those implementing and maintaining it must know that it is continuous and should be driven at making it so.

As lean management is a large and significant undertaking, there may have been more challenges that were explicit to the company. It would have been nice to have had the opportunity to dig deeper for the challenges of implementing as well as received information from the workers themselves on what they think about lean management (those responding to the questionnaire were mostly in the senior management team or in an otherwise leadership position in the company).

12.1 Challenges of thesis

The main challenge in developing this thesis was in conducting the questionnaire. No company responded to the questionnaire when it was emailed and most of them had to be contacted more than once in order to gain their attention, even so less than half of the companies responded on time.

Another challenge was difficulty managing time. A tight schedule was created for the thesis and therefore there was little room for any unexpected events such as the HAMK network ceasing to work in remote computers. It was therefore a challenge to finish the thesis on time.

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Appendix 1

QUESTIONNAIRE

1) Which part of the company was the lean management implemented?
    a. The entire organization
    b. A part of the organization

2) If a part of the organization, which part? (e.g warehouse)

3) What made the company decide to implement lean?

4) Which type of lean management technique/tools have you implemented? (e.g. 5S or PDCA).

5) How did the workers respond the change?

6) Has it been difficult to maintain lean?

7) If yes, in what ways? Please elaborate

8) Please explain as thoroughly as possible the challenges that your company (has) faced during the process of implementing lean management techniques and tools

9) Has the company tried to solve these challenges?

10) If yes, in what ways has the company tried to solve these challenges?

11) May I interview you if I require further information? (Yes or No question).

12) Name and contact of company