Performance Management in Lean Production

- A Case Study

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Summary

Title: Performance management in lean production:

Background: Lean production and performance management are very important aspect in the production process because when activities that do not add value to a product are not reduced or eliminated it would amount to waste which would eventually result to unnecessary cost for the organization. Thus it is vital to have the right performance management system in place to control of the organization.

Objectives: The purpose of this thesis is to first identify the different types of production wastes evident in the production process of the case companies and how these waste have been reduced or eliminated. As the management of performance in lean production is very important, the second objective of this study is find out how these companies are currently managing performance in lean production in comparison with the performance management systems model.

Method: This is a multiple-case study with systematic combining approach as the orientation. Interview and documents are the instruments of data collection. Empirical data from each case has been analyzed based on cross and within case analysis. Construct validity, external validity, and reliability are the basis for scientific credibility of this thesis.

Conclusions: Not all types of production wastes are evident in all the case companies studied due to one reason or the other. In reducing or eliminating these wastes, they have adopted different lean principles based on their product type. When it comes to managing performance in lean production it is clear that each of the case company adopts almost similar performance management systems although they have adopted different approach.

Suggestions for future research: It would be interesting to undergo a similar research in the service sector to see if the findings arrived would be the same or if it will lead to contradictory results. Additionally, since the main focus was on performance in within the studied case companies, it would be interesting to see the outcome of how performance management between these companies and their external suppliers would turn out.
Acknowledgement

The journey to completion of this thesis has been rough and tough and I acknowledge God for the strength he gave me when thoughts of quitting come to my mind. Firstly I would like to acknowledge Rikard Karlson, Rajko Kondic and Zoltan Erös at Electrolux production Laundry Systems Ljungby; Axel Carlsson of Volvo CE Braås and Jonas Johansson of Hammarplast AB whom I interviewed, they were of tremendous assistance all through my work with them despite their tight schedule.

I would also like to thank my tutor Helena Forslund and examiner Lars-Göran Aidemark. They have been very helpful giving me a lot of advice for improvements, constructive critique and support. Without them this thesis would not have been as good and well structured as it is today.

My girlfriend (Oyinda) is another person I would like to thank. She listened to all my thoughts and complains regarding the thesis and also giving me some advice. I will not forget my friend “Martynz” for the role he played.

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Oghenefejiro Awaritoma
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Chapter 1. Introduction

This introductory chapter begins with the background focusing on lean production with emphasis on types of production waste followed with the principles of lean. Further down looking into why managing lean production performance is important and the use performance management systems that will lead to the problem discussion. Based on the problems discussed some research questions will be formulated that will serve as guide through the thesis.

1.1 Background

What is Lean Production?

Can you do more by doing less? If you focus on doing the right things, the answer is decidedly, “yes.”


In relation to the above quote, Browning, (2000) pointed out that lean doesn’t always mean minimizing cost, cycle time, or waste but maximization of value and making available the right information at the right time and place.

Womack et al, (1990) in their bestselling book "The machine that changed the world” referred to Lean manufacturing as lean production. This rebirth was from the popular Toyota production System (TPS) developed over thirty years ago out of the desire to make better and more innovative products at a far lesser costs. This concept which was designed for the automotive industries is now been accepted into different other industries as a way of saving cost and time (Miller et al, 2006). Lean has become a universal production technique such that many companies are now using it, embracing its general idea of eliminating waste and producing only the items that are needed at the time and the quantity needed. Shah (2007) asserts that lean production can be seen from different perspectives- can be defined as a philosophy, set of principles and as bundles of practices. The concept of lean is quite the opposite of mass production in the sense that it uses half of all that goes into the production process like human effort, manufacturing space, investment in tools, engineering hours required to develop new product, less stock of inventory on site, less defects, and produces a greater and ever-growing variety of products. (Cheng-Wong et al, 2009). According to Julien and Tjahjono (2009) "Lean is not a set of tools. Instead, it is a philosophy of operation. Lean is about waste prevention.
whilst focusing on value for the customer in a flexible and responsive way to sustain and improve the business competitiveness” (Julien and Tjahjono, 2009, p 323). Different academicians have come with different definition of the concept in other to suit their situation. Engelund et al, (2009) sees it as a tool to abolish waste so as to create wealth for companies. According to Warnecke and Huser (1995) lean is an intellectual approach that is made up of a system of measures and methods, if used collectively brings about competitive advantage for a company.

When mention is made about lean production, the seven important production waste is always referred to because if the concept of lean is to be followed then these waste issues must be addressed (Cheng Wong, 2009). Since lean is all about the elimination of waste it is important to talk about the seven production waste which are: Waste from producing defects, Waste of transportation; Waste from inventory; Waste from overproduction; Waste of waiting time; Waste in processing; and Waste of motion. A detailed description of these seven types of waste will be discussed in the theoretical framework.

Another important aspect of lean is its principles that enable the implementation of lean. They are specify value, identifying the value stream, Creating flow, Pull, Perfection which will be discussed further in the theoretical part (Emiliani, 1998; Julien and Tjahjono, 2009; Engelund et al, 2009).

The essence of performance management in lean production is to ensure that there is continual flow in the production process so demand changes could easily be adjusted (Bhuiyan and Baghel, 2005). This will take us to the following sub-heading.

**Why Performance management in lean production?**

To begin with it is important to have a definition of what performance is so as to understand what performance management really means. Lebas (1995) stated that performance can only be defined over the future and that its precise definition is case specific; that is to say it means different thing to different people depending on how they can relate to it. The author however defined performance as “the potential for future successful implementation of actions in order to reach the objectives and targets” (Lebas, 1995, p 23).
Having defined what performance is, I will go further to define performance management. Amaratunga and Baldry (2002) used the definition of Procurement Executives’ Association which states “the use of performance measurement information to effect positive change in organizational culture, systems and processes, by helping to set agreed-upon performance goals, allocating and prioritizing resources, informing managers to either confirm or change current policy or programme directions to meet those goals, and sharing results of performance in pursuing those goals” (Amaratunga and Baldry, 2002, p 218).

From the definition above it is obvious that performance management requires the information gathered from a performance measurement to effectively manage the activities of the organization.

One would ask why manage performance of lean production? The answer is not farfetched. The performance management of lean in the production process will enable problems related area to be highlighted and ways to tackle them could be discovered. Where problems in lean production is viewed from a helicopter perspective, Segerstedt (1999) suggested that it could be taken care of when questions like "What is the purpose of embarking on a particular process?" and "Why it is being done in that way?" are asked.

According to Cunneen (2006, p 43) there is need for performance management for the following reasons:

- It must be a continuous process of coaching and feedback.
- Ensure managers are skilled in, and held accountable for, managing performance effectively.
- The focus should be on improving performance and developing talent rather than ticking boxes.
- Ensure there is a clear definition of what constitutes performance.
- Tailor performance management to suit the organization and its business needs.
- Make it a fundamental part of the business planning process.
- It must begin at, and be prominently modeled by, top management

Performance management is tightly associated with the concept of lean production. The idea is to keep a steady flow in the production process in other to adapt to demand changes (Bhuiyan
According to Bititci et al. (1997), performance management is seen as a process through which the performance of an organization is managed in such a way it is in tune with the corporate and functional strategies and objectives of the organization. The purpose according to them is create a “proactive closed loop control system, where the corporate and functional strategies are deployed to all business processes, activities, tasks and personnel, and feedback is obtained through the performance measurement system to enable appropriate management decisions” (Bititci et al., 1997, p 524) as shown in figure 1 below.

![Figure 1.1. The closed loop deployment and feedback system (Bititci et al., 1997, p 524).](image)

To be able to ascertain the lean production performance, it is paramount to evaluate its performance and this can be achieved by providing answers to questions such as "are actions taken in the direction of lean; what progress are being made on different variables"? In this manner, efforts can be made so as to achieve leanness according to Karlsson and Ahlstrom (1996).

De Toni and Tonchia (1996) suggested that there is need to connect all the processes so as to have a joined objective and the overall performance outcomes from an integrated and coordinated activities.

Medori and Steeple (2000); Neely et al (2005) mentioned different areas through which performance can be managed namely quality, time, flexibility, delivery.
1.2 Problem Discussion

Production waste and its reduction/elimination problems

Since production waste amounts to extra cost of production for companies and customers are not willing to bear the burden it becomes necessary to reduce or eliminate it. For companies to achieve profitability in the short run and long term expectations processes that amounts to production waste should be reduced or eliminated, as there is huge amount of waste plaguing most companies (Hanes and Taylor, 2000). In their opinion the idea of lean implementation for companies is to reduce or better still eliminate waste, thus they suggest that improving the productivity leads to leaner operations that would assist in exposing production waste and quality related problems in the system.

Karlsson and Åhlström (1996) asserts that although most companies’ experience the seven types of production wastes the most common source being that of inventory, their reason is that keeping of parts and products in stock does not add value thus it should be eliminated. They reiterated that it should not be done carelessly but rather focus should be on the reason why production waste occurs and ways to reduce or eliminate it; they suggest minimizing the down time in machines, reducing lot sizes, set-up times etc. In the same vein Murugaiah et al, (2010) stated that eliminating production waste, the root cause of the problem must be identified before it can be solved systematically.

Transportation waste that adds to production lead-time should also be reduced or eliminated. In their view they distinguished between rationalization and a removal for the need of transport and concluded that the later is better Karlsson and Åhlström (1996).

Defects waste relates to lack of quality which in turn demands rework is not value adding for either the company or their customers as a result it should be eliminated.

Chen et al, (2010) proposed that eliminating waste enables companies to better understand their customers and what they need thereby delivering it just how they want it and when they want it. They mentioned that identifying the specific production waste and successfully eliminating them transcend to reduce cost of manufacturing, higher product quality, improved customer satisfaction, and increased profits.

The five principles of lean mentioned earlier are fundamental in the elimination of production waste; they are easy to remember however not always easy to achieve as pointed out by Hines
and Taylor (2000). The knowledge of the different types of activity (Emiliani, 1998; Julien and Tjahjono, 2009; Engelund et al, 2009) within a company is vital in the elimination of production waste. Thus it is important to eliminate the non-value adding activity as it does make a product more valuable in the eyes of the end user.

Performance Management problems in Lean Production

In a study of the use of, and satisfaction with performance management systems, Bain & Co concluded that over 80 percent of companies make use of Benchmarking, 50 percent practice a sort of “pay for performance” etc; their survey however was criticized on the ground that definitions of terms might not have been applied equally across all the organizations (Thorpe and Beasley, 2004).

The essence of performance management is to effectively steer on results and at the same time support employees in enabling them accomplish the desired results; where either of this is lacking de Waal (2004) suggest three elements (visible commitment, clear steering and support) should be considered. In another of his study, de Waal (2007) found out that 56 percent of performance management implementation fail because they do not use performance management systems (PMS) employees are familiar with and also that behavioural factors of performance are ignored.

According to Zairi and Jarrar (2000) as cited in De Waal (2003) there is need for managers to put into use the data from performance management to control lower managers and employees behaviour. To achieve this, managers require a great deal of understanding of human nature and behaviour within the organization.

Fryer et al (2009) argued that there are issues with performance management when it is used mainly for measurement and evaluation rather than as a tool for improvement; or that managers implement a performance system consisting of rules and regulations and instead of using leadership skills to motivate people to produce more results they leave it to functions by itself.

Three factors were identified as the main classes of problems namely technical, systems and improvement.

Performance management varies among countries and organization thus there is need for individual organizations to evaluate its PMS, discover the problem areas and decide on the solution that best fits it. This is however not the case because many organization according to
Fryer et al (2009) do not have the time to examine critically the situation therefore settle for solutions that do not relate to their specific problems. Performance management systems has been defined differently however Ferreira and Otley (2009) asserts that it has to do with the defining, controlling and managing both the accomplishment of results as well as the process employed to attain these results from a societal and organizational perspective rather than individual level. De Waal (2003) identifies the key features of a successful performance management system as being:

- alignment of the performance management system and the existing systems and strategies of the organization;
- leadership commitment;
- a culture in which it is seen as a way of improving and identifying good performance and not a burden that is used to chastise poor performers;
- stakeholder involvement; and
- continuous monitoring, feedback, dissemination and learning from results

Bititci et al. (2006) point of view stressed that it is also necessary that the performance management system is not fixed but advances as the management style and organizational culture changes.

1.3 Research Questions

Based on the above discussion I have formulated the following research questions that will serve as guide through this study.

RQ 1 “What are the types of production waste that exist in the production process and with which lean principles are these waste reduced or eliminated in the case companies?”

And

RQ 2 "How are they currently managing performance in their lean production process in comparison with the performance management systems model?"
1.4 Purpose

The objective of this thesis is in two folds: firstly is to identify the different types of production waste evident in the case companies and to see how the identified production wastes are reduced or eliminated. Second aim is to find out how the companies are managing performance in their production process through the lens of the performance management system model so as to highlight areas of compliance or deviation.
Chapter 2 Methodology

This part of the study deals with the methodological approach used in this thesis with a focus on the scientific perspectives, research strategy, and scientific approach. Other areas considered include the sampling selection, ways through which the data were collected and analyzed and lastly the scientific credibility of this thesis.

2.1 Scientific Perspectives

From the viewpoint of Bryman and Bell (2007) positivism is considered an epistemological position that supports the use of natural sciences methods to study social reality and beyond. Furthermore, positivism dictates that knowledge comes from strict scientific methods (Bryman and Bell, 2007). A positivist believes that their standpoint should be that of spectator so as not to have a bias judgement of the object of the research. It consists of a logical, rational, step-by-step approach in accordance with objective rules, beginning with the identification of a problem that leads to results as an end point. That is to say that it supports the use of the methods of natural sciences to study social phenomenon (Bryman and Bell, 2007). In the authors view the principles of positivism includes the principle of phenomenalism, deductivism, inductivism, and objectivism.

On a contrary view, the hermeneutics assumes a different standpoint as argued by Bryman and Bell (2007). The Hermeneutics tradition is founded upon interpretation and understanding as there is differences in the natural sciences when it comes to people and the objects under study. In this tradition the researcher assumes to be a part-taker as opposed to the positivists. The hermeneutist believes in more personal interpretive process geared towards understanding reality than just trying to explain causal relationship through means of objective and statistical analysis as used by the positivist. A pre-understanding is considered as a requirement in the hermeneutics because for a researcher to have an experience in a particular field of research to be able to understand and interpret a phenomenon there must be somewhat level of personal commitment.

Relevance to this thesis
This thesis will consider the standpoint of the positivistic perspective meaning it will be objective in nature. Based on the research question, the use of natural science methods will enable me describe the types of production waste faced by the case companies and highlight the different ways they have reduced or eliminated these waste. For the second part of the research question performance management of the case companies would be tested based on performance management systems theories. With this I will be able to study the case companies that is a social reality based on the principles, procedures, and philosophy of the natural science.

2.2 Research Strategy- Multiple case study

Yin (2003) described the case study as one of the numerous ways through which social science research can be conducted. According to him other ways are through experiments, survey, histories, interviews and analysis of archival record. In the case study method, researcher are able to maintain the holistic and meaningful characteristics of the real-life events like individual life cycle, processes in organization, industrial maturation. The case study research is comprised of both single and multiple-case studies and it could be exploratory, descriptive, and explanatory case studies. Yin (2003) highlighted the type of research question posed, the extent of control of the researcher over behavioural events, and the degree of focus on contemporary events as the three conditions on which the case study strategy should be used. The type of research question posed is an important determinant in the type of strategy that will be employed in a study. Thus questions relating to "how" and "why" are more explanatory and as a result the case study amongst others according to Yin (2003) is preferred. After the research question has been defined in terms of substance and form, the next step is to determine the extent of control over behavioural events and degree of focus on contemporary events. Yin (2003) pointed out that when the extent of control over behavioural events cannot be manipulated, the case study becomes preferred because it makes use of other sources of evidence like direct observation and interviews of the persons involved in the events.

Research Strategy of this Thesis

In this thesis the multiple case study method has been used so as to have a rich base for discussion, as more fact would emerge from a multiple case than from one case. With the existing theories about the seven-production wastes, this study wants to find out if all these
production waste exist in the studied cases. As have been suggested by Yin (2003) this study has adopted both the descriptive and explanatory approach. From a descriptive perspective this research will explain the studied case have eliminated/reduced the evident production waste in their production process leading to more understanding. Thus the first step to eliminating production waste is identifying it and further finding ways on how to eliminate/reduce it. Looking at the second research question, the issue of performance management is important because it requires a system(s) in place to evaluate how things are been done. In the case of eliminating production waste, the performance management system(s) will be able to actually check how production wastes are reduced in order to improve the production process. With a description of how the case companies manage performance of lean in their production process, an understanding of the holistic and meaningful characteristics of the real-life context would be gained without interfering or altering the real-life settings. I as the research did not interfere or have control over the behavioural events in the process of gathering the empirical evidence. Based on the performance management systems used in the case companies I would try to find out which of these systems overlaps.

Another reason for choosing the multiple cases over the single case is to have a well-grounded analytical conclusion that is based on several cases rather than just a single case.

2.3 Scientific Approach

A case study adopts either the inductive, deductive, or the abductive approaches. In between these two extremes is the abductive approach which Dubois and Gadde (2002) termed the systematic combining.

The abductive approach according to Dubois and Gadde (2002) is a continuous interaction between the theoretical framework, empirical fieldwork, and the case analysis that will lead to the development of new theories. In the same vein, Spens and Kovás (2005) added that it is generally understood as reasoning from effect to causes. Dubois and Gadde (2002) in discussing the adductive approach suggested two processes, matching theory with reality as the first and the direction and redirection as the second. They further pointed out that these processes are affected by four factors what is going on in reality, available theories, the case that gradually evolves, and the analytical frame-work. While Yin (2003) argued that the adductive approach should not be seen as a separate approach but a combination of both, Dubois and Gadde (2002) have a different view. In an abductive approach, the research move
back and forth going from empirical observation to theory and vice versa thereby expanding his knowledge of both theory and empirical phenomena. Through this expansion, new insight in relation to already established phenomena will be developed (Spens and Kovás, 2005).

In the abductive research approach, there is no particular way a research can be carried out. Some authors suggest it could start with a real life observation just as in the inductive research approach or it could start out with some pre-perceptions and theoretical knowledge where existing theories have been established prior to empirical observations (Spens and Kovás, 2005). In the diagram below, adductive reasoning begins at that point where the observed empirical research does not match with prior theoretical knowledge as such there is back and forth movement between theory and empirical observation "theory matching". This leads to new matching framework that is used to explain the observed deviation to understand the new phenomenon in a hypothetical way. The final process ends with the application of the hypothesis in an empirical setting (Spens and Kovás, 2005).

Figure 2.1 The abductive research process. (Spens and Kovás, 2005, p139)

Scientific Approach of this Thesis
For this thesis, the abductive research approach is used although with a stronger emphasis on the deductive approach. As one of the main requirements in this thesis is to contribute to existing theories, I have combined both the deductive and the inductive approaches. Since there is no particular way of starting it according to (Spens and Kovás, 2005), I began with developing existing theoretical background identifying the different types of production waste present, the lean principles associated with reduction of production waste and the performance management systems. Going further I adopts the abductive approach to enable me test the
established theories. Thus there is matching between theories and the empirical evidence gathered to be able to identify the types of production waste present in the studied cases and understand which of the lean principles of waste reduction has been employed. Thereafter attempt to find out what performance management systems the studied case currently make use of and sort of compare it with the performance management model.

2.4 Sampling selection

Eisenhardt (1989) argue that selecting of cases is a major aspect of building theory from case studies as notion of the population is fundamental. The author stressed that population forms the bases from which the research sample can be drawn and that it delineates extraneous variation and outlines the extent for generalization of the results.

Sampling selection of this Thesis

The cases for this thesis have been selected in other to be able to respond to the research questions. In selecting the sample I considered the type of industry “production industries” I want to focus on, whether they are small, medium or large sized organization, and how long they have been using lean. Another consideration was geographical location; I focused on selecting companies within the Kronoberg region and also took into account the persons that should be interviewed at these companies and their positions. Hong and Jeongs (2006) stated that the primary criteria of classifying companies as SME are that they should have below 500 employees. Thus for this research I have selected three large production companies in the Kronoberg region. I considered them large companies as all of their staff strength exceeds 500.

2.5 Data Collection

Yin (2003) enumerated six different ways through which data are collected for a case study type of research, namely documentation, archival records, interviews, direct observation, participant- observation, and physical artefacts. In this type of study more than data source is recommended however Yin (2003) suggest the use of interview methods is one of the most important source of gathering information in case study. According to the author conducting a case study interview requires the interviewer to maintain two distinct levels simultaneously: one is satisfying the purpose of the interview and the other is asking questions that do not pose any form of threat or inconvenience to the respondent. The focused and the structured
interviews are other types of interviews apart from the open-ended interview as suggested by Yin (2003). There are two major sources of data namely primary and secondary data respectively. The former is data collected specifically for the research purpose the researcher is studying (Ghauri and Gronhaug, 2005). Primary data includes observation, experiments, surveys (questionnaires) and interviews. Data collected in this way are more consistent with the purpose and objectives of the research. Ghauri and Gronhaug (2005) gave the following as types of primary data: status and state of affairs data, psychological and lifestyle data, attitude and opinion data, awareness and knowledge data, data of intuitions, data of motivations, and data of behaviour. While secondary data on the other hand are data that has already been collected by others for different purpose not specifically relating to ours. These types of data not only provide information necessary to tackle our research problem but also to give a clearer understanding and explanations in our research area. Examples includes books, journal articles, online data sources like webpage of firms, catalogues etc. It important to know that apart from providing answer to some research questions, secondary data sources sometimes assist in formulation of the problem or devising more concrete and focused research questions; deciding the appropriate research method and providing benchmarking measures (Ghauri and Gronhaug, 2005).

**Data Collection of this Thesis**

In this thesis both primary and secondary sources of data were collected. Primary data sources in this thesis were typically that of interviews that were of semi-structured. The interview questions were structured in a such a way to get was necessitated out of the fact I wanted to be flexible to enable me ask questions that would trigger respondent to provide detailed opinion. Different key personnel in Electrolux Laundry Systems AB Ljungby, Volvo Construction Equipment Braås and Hammarplast AB Tingsryd were interviewed so as to get a rich theoretical framework and to show areas of similarities and difference. The interview questions were designed to find out if all the different types of production waste are actually present in the case companies and how these waste have been reduced or eliminated. Also the questions would reveal how these companies are currently managing lean performance and ways it can be improved.

The interview with Electrolux Laundry Systems AB Ljungby lasted about two hours where I interviewed Rikard Karlson and Rajko Kondic (lean experts). I also had a telephone interview with Zoltan Erös (production leader line A & B) that lasted between thirty to forty-five
minutes. Questions about areas not clear were mailed to them and response clarifying those areas was sent back. For Volvo Construction Equipment Braâs, I had a telephone interviewed Axel Carlsson (material control manager) that lasted for about forty-five minutes. On few occasions I had some questions mailed to him and he responded through mails too.

For Hammarplast AB, I had a telephone interview with Johnas Johansson (Production manager) that lasted for about forty-five minutes. Just like I did with other companies further questions that were not properly understood was attended to through mail.

During the interview session, I made a recording of all our conversations and pictures and documents where also collected to further clarify areas that needed more clarification. Secondary data for this thesis were also collected from the case companies websites and other organizational materials.

The interviewer name along with their position and the date the interview was conducted is shown in the table below.

<table>
<thead>
<tr>
<th>Company</th>
<th>Interviewees</th>
<th>Position</th>
<th>Date of Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrolux AB</strong></td>
<td>Rikard Karlsson</td>
<td>Lean expert</td>
<td>01/04/2010</td>
</tr>
<tr>
<td></td>
<td>Rajko Kondic</td>
<td>Lean expert</td>
<td>01/04/2010</td>
</tr>
<tr>
<td></td>
<td>Zoltan Erös</td>
<td>Production leader</td>
<td>28/06/2010</td>
</tr>
<tr>
<td><strong>Volvo Construction</strong></td>
<td>Axel Carlsson</td>
<td>Manager material control</td>
<td>30/06/2010</td>
</tr>
<tr>
<td><strong>Equipment Braâs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hammarplast AB</strong></td>
<td>Jonas Johansson</td>
<td>Production manager</td>
<td>30/06/2010</td>
</tr>
</tbody>
</table>

Figure 2.2 Interviews conducted at the different case companies

### 2.6 Data analysis methods

Data analysis according to Eisenhardt (1989) asserts that it is the main part I building theory from case studies, in her view it is the trickiest part but less coding is required. According to the author there are two steps of analysis namely cross case and within case analysis.
Cross case analysis in her point of view entails seeing the data from different perspectives that requires comparison to be done ways as stated below:

- **One tactic is to select categories or dimensions, and then to look for within-group similarities coupled with intergroup differences.** Dimensions can be suggested by the research problem of by existing literature, or the researcher, or researcher can simply choose some dimensions.

- **A second tactic is to select pairs of cases and then to list the similarities and differences between each pair.** This tactic forces researchers to look for the subtle similarities and differences between cases.

- **A third strategy is to divide the data by data source.** This tactic exploits the unique insights possible from different types of data collection. When a pattern from one data source is corroborated by the evidence from another, the finding is stronger and better grounded. When evidence conflicts, the researcher can sometimes reconcile the evidence through deeper probing of the meaning of the differences.

“Overall, the idea behind these cross-case searching tactics is to force investigators to go beyond initial impressions, especially through the use of structured and diverse lenses on the data. These tactics improve the likelihood of accurate and reliable theory, that is, a theory with a close fit with the data. Also cross-case searching tactics enhance the probability of that the investigators will capture the novel findings which may exist in the data” (Eisenhardt 1989, p.541).

Then for within case analysis, the author argues that is although there is no formalized way of doing this, She urges that within case analysis allows each case distinctive pattern to be highlighted. The author went further to state that it is mainly descriptive that makes the researcher have a rich and deep acquaintance with each of the case that gives room for a cross case analysis.

**Data analysis of this Thesis**

Based on the interviews session with the case companies, the information collected was transcribed accordingly to identify the types of production wastes evident and the performance management systems currently in use in each of the companies.
In the analysis of the data I first approached it with the within case analytical method to show the uniqueness of each case companies in the types of production waste evident and how they have been reduced or eliminated inline with theories of waste reduction to show confirmation or deviation. And also to describe what performance management systems is in place and how these systems are used to manage performance in relation to existing theories. Based on this a table highlighting the areas of differences and similarities would be constructed.

Thereafter the cross case analysis method is used to highlight areas of similarities and differences between the case companies in terms of the types of production waste that is common among them or not and to the different lean principles that have been adopted in its reduction or elimination. This will also be used to show the similarities or differences in the way they manage performance through the lens of the performance management systems model.

2.7 Scientific Credibility

Yin (2003) suggested four tests commonly used to establish the quality of a case study research is construct validity, internal validity, external validity and reliability.

**Construct validity**
According to Ghauri and Gronhaug (2005) construct validity is important for meaningful and interpretable research findings and that it can be used in different ways. The authors point out that a study that lacks construct validity findings are assumed to be meaningless, this goes a long way in also affecting the internal and external validity of the findings. Yin (2003) mentioned three tactics in relation to construct validity when performing a case study: multiple source of evidence, establishing a chain of evidence, and reviewing report by key informants.

**Construct validity of this Thesis**
In this thesis the test of construct validity is necessitated through the conduct of various interviews with different key personnel in the form of a multiple case study in relation to Yin (2003). A chain of evidence has been established and maintained through the matching of research questions, the purpose of study, data collection and analyzing process. In compliance with the third tactics as suggested by Yin (2003) empirical data have been reviewed by key informants in the different case companies to ensure the accuracy of the transcribed empirical data.
External validity

This test treats the issue of developing a platform on which generalization can be made in a case study and applied in other studies (Ghauri and Gronhaug, 2005; Yin, 2003). However it should be noted that generalization might not be possible to the extent and depth required.

External Validity of this Thesis

As a researcher I tried to analyze the types of production waste eminent in the case companies and how they have reduced them and also review the current performance management systems in place in the case companies to see how they currently manage performance of lean. All these I have done according to the theoretical framework used.

I have assessed multiple case study approach to enable me make generalizations that can be transferred or related to similar case within the production industries.

Reliability

This simply relates to the stability of the measure from Ghauri and Gronhaug (2005) perspective. Yin (2003) opinion is that the objective is to be sure that if ever another researcher applies the same procedure previously used in a case study, his conclusion and findings arrived at should not be different as already been established. The goal of reliability is to minimize every form errors and biases in the study. To tackle the problem of reliability requires developing many operational steps as possible and to conduct the research in such a manner where the researcher feels there is no room for mistake.

Reliability of this Thesis

In this project reliability has been maintained throughout from data collection, transcribing the data I ensured missed points were explained further by the interviewee and analyzed thoroughly; such that if another researcher repeats the same procedure there is possibility of arriving at the same results. To also ensure reliability in this project case study protocol has been developed which consist of the case study plan illustrating the steps followed during the period of this project. Shown in the appendix are the interview guide and the transcription of the interview with the case companies.

2.8 Summary of the methodologies

The figure below shows an overview of the methodologies used in this thesis.
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Figure 2.3 Summary of my methodological choices
Chapter 3 Theoretical Framework

This chapter presents theories in relation to the area of study. Discussed theories are the seven types of production waste, lean principles. Thereafter different performance management systems and lastly, this chapter end with a summary showing the different theories that has been discussed.

3.1 The Seven Types of Production Waste

Karlsson and Ahlstrom (1996) stated that in the elimination of production waste, anything that does not add value to the product and customers are not willing to pay for amounts to waste therefore should be eliminated. Discussed below are the seven types of production waste according to theory.

According to Kippenberger (1997) the first type of production waste is over-production, which relates to producing goods that are not needed at the moment. Martins (2010) further defined over-production as the anticipation of changes in customer demand requirement would lead to wastage of materials and labour. The effect of this creates longer process cycle times and higher costs. Thus in a lean environment, its practitioners make an effort in eliminating this type of production waste by matching available capacity to actual demand thereby only producing when it is needed.

According to Rother and Shook (2003), over-production waste is the most significant source of production waste. In their opinion they claim it amounts to shortages as the wrong things are produced and that it results to longer lead-time as it impair your ability to be adaptable and easily respond to customer requirement.

The second type in Kippenberger (1997) perspective is waste as a result of waiting by employees either due to movement of goods or for a process to complete. This waste results when people wait for materials, information or resources necessary to begin or finish their work, or when equipment is left idle, loss of process time, and cycle time and production cost increases (Martins, 2010). Amongst the many negative effect caused by this waste of waiting is the delay in moving production to downstream work operations.
This type of production waste results when time is not used effectively, Hines and Rich (1997) points out that this waste is encountered when products are not moving or is being worked on and the result of this is that both the product and employees are thus forced to wait unnecessary. In their view they assert that waiting time should be used to train employees, maintenance or Kaizen activities.

The third waste is that of **transportation**, where goods are moved from one point to another unnecessary amounts to transportation cost which creates waste. Transportation waste result when information or materials have to be moved through unnecessary intermediaries. Cost is increased whenever unnecessary work, inspection, or storage locations are added to a process thereby leading to transportation waste.

When parts are transported from one location to another within the factory, value is not added to the product only to manufacturing lead-time thus its reduction according to Karlsson and Ahlstrom (1996) is very important.

**Over-processing waste** forms the fourth type and it is the result of different circumstances. Adding of unnecessary features and functions to a product leads to increased cycle time and cost associated to design and production of that product (Martins, 2010).

Hines and Rich (1997) claims that over processing is as a result of making use of over complex solutions for simple procedures *that is to say* when large inflexible machines are used rather than small flexible ones. They stressed that the outcome of this situation discourages employees and it gives room to poor layout thus leading to excessive transport and poor communication. Another factors that leads to over processing is using machines without having sufficient safeguards such as poke-yoke or jidoka devices.

**Inventory waste** forms the fifth type of production waste. This form of waste occurs when a work object that has not being requested by a customer is produced. The risk associated with this type of production waste is building-up of inventory that leads to tied down capital. This waste can however be minimized if demand is matched with supply. The waste of inventory in Karlsson and Ahlstrom (1996) opinion is the most important source of waste which is associated with the keeping of parts and products in stock. According to them this does not add value thus it should eliminated. They asserted that waste of inventory could be reduced through the reduction of lot size which indirectly has positive effects such as increasing flexibility.
The sixth is the waste of motion, which has to do with unnecessary movement of employees from one point to another (Kippenberger, 1997). This type of waste results when a specific work process is not performed efficiently; this leads to higher cycle times and cost. Avoiding this type of waste requires an understanding of the different processes involved in performing a task and devising the best way to achieve it (Martins, 2010).

Hines and Rich (1997) states this waste results when employees have to stretch bend and pick up thereby causing unnecessary movement when such actions could have been avoided. They claim that the outcome of such wasteful activities makes employees to be tired and might lead to poor productivity and sometimes lead to quality problems.

Lastly is the waste of defects, which relates to the mistakes in the production process that requires rectification in Kippenberger (1997) opinion. Where work products do not meet customer’s specification and rework is done leads to higher cycle time and production cost. Minimizing the waste that results from defects would lead to increased customers’ satisfaction amongst other benefits (Martins, 2010).

Manufacturing parts and products that are defective would amount to rework is an evidence of waste as a result of defects should be eliminated. They stressed that waste as a result of parts scrapping is another source of defective waste.

### 3.2 Lean Principles

According to Emiliani (1998) specifying value is the first principle of lean production is customer-based; the customer to a large extent determines what should be produced. In the same vein, Julien and Tjahjono (2009) simply see it as what makes the customer happy. Identifying the value stream is the next step and is about identifying the processes involved in the production of a specific product from the point of view of the end-customer. In this way the production unit can identify processes that add value, eliminate those that do not add value and lastly are those that cannot add value and cannot be avoided (Emiliani, 1998). The third principle which is Creating flow, Julien and Tjahjono, 2009; Emiliani, 1998) suggested that the value should continuously flow and never should a value-adding activity be delayed. This they pointed out would reduce the cost of the product by eliminating lengthy queue times and large quantities of expensive inventory that would have been the case of batch and queue production methods. The fourth principle relates to the production of only the products that are required by the customer is known as Pull. This principle holds that production must be just-in-time (JIT)
both internally and externally. The last is **Perfection**, which is all about perfecting every process in the production by the reduction of waste thereby focus only on activities that create value. In lean production, perfection cannot be attained however it facilitates the endless utilization of opportunities of all types of assets (Emiliani, 1998; Julien and Tjahjono, 2009; Engelund et al, 2009). Figure 5 below identifies the five principles of lean production as described above.

![Figure 3.1 Principles of lean production](http://www.lean.org/WhatsLean/Principles.cfm, 08/05/10)

**5S**

Sekine (1998) in the same vein with Chen and Meng (2008) pointed out the areas of 5S and stressed that it’s a philosophy that is aimed at increasing efficiency through the elimination of waste and the improvement of the flow of work. It is a component of lean production which creates room for standardized environment for work, with a centre point of waste elimination and involves five steps: the first **Seiri (sort)** relates to an arrangement of things in the workplace thereby taking out items that are not needed. **Seiton (Straighten)** has to do with putting the needed items in an easy reachable place; the third is **Seiso (Shine)** involves keeping of the worksite clean at all times thereby easily detecting defected equipments. The fourth is
Seiketsu (Standardized) involves formulation of visible controls and guidelines through which the worksite can be organized and cleaned. Shitsuke (sustain) is the fifth step, which involves training and discipline so that everyone complies with all the steps (Chen and Meng, 2008). According to Liker (2004) 5S assist in the elimination of waste that result from mass production thus covering up problem areas. In connection with other lean principles, the 5S create a continuous process for improving the work environment as illustrated in the figure below.

Incorporating 5S into the daily activities in the production process can yield beneficial results like forming good basis for quality improvement activities; The biggest cultural breakthrough for 5-S is the taking of responsibility for tidying up one’s work area; 5-S has been seen as a useful catalyst to get things sorted and straightened out. Other benefits include better housekeeping, safety and working environment; improved quality, efficiency, stock accuracy and productivity; reduced waste, lead times and costs; smoother work flow; culture change; visual improvement; customer awareness; disciplined approach; empowerment and
standardized operations and organized workplace and improved work flow (Warwood and Knowles, 2004).

Continuous improvement

Kaizen "Continuous improvement" is a Japanese word, which simply means incremental improvement of products, processes or service according to Emiliani (1998). From Farris et al, (2009) point of view, it is a specific and well-planned continuous improvement project where a cross functional team is used to accomplish a clearly defined objectives in an accelerated timeframe. The main goal as stated by Emiliani (1998) is to reduce waste in order to improve the functionality of the work environment/ performance of the product. This process reduces the processing time and associated cost in the production process as processes are constantly improved (Emiliani, 1998). Kaizen does not only reduce errors associated with production it also locate the root of such errors thus workers involvement is a vital aspect in the process which is gained through monitoring and detection of irregularities in the process. Through their contributions in the reorganization, workers ideas assist in delivering product improvement through continuous innovation (Ian, 1999). Consequently as lean production is about reducing and eliminating of waste it has to be a continuous process which is the focus of continuous improvement effort (Henderson and Larco, 2003).

Ahlstrom (1998) added that operators in continuous improvement should be structured in a problem solving approach that lead to improved manufacturing process. In an example “Office Machines launched a structured continuous improvement initiative in January 1995. Each multi- functional team was divided into several continuous improvement teams. The ideas for improvements that the teams came up with were instantly rewarded and the teams participated in implementing the suggestions” (Ahlstrom, 1998, p 331).

Also Karlsson and Ahlstrom (1996) stated that continuous improvement is all about constantly improving the system with the attainment the perfection being the only goal.

Visual Management (Control)

Mann (2005) argued for visual management in this way “If takt time is the heart of lean production, visual management and the process surrounding them represent the nervous system in lean management” (Martin, 2010, p 39).

Henderson and Larco (2003) refer to visual management as management by sight, not by
computer whose purpose is to “see” the factory, its performance, its problems and its opportunities for improvement. As the authors pointed out, visual management plays an important role if employees are to be empowered. According to them there is no employee empowerment if there is no available information, which is derived from visual management (Henderson and Larco, 2003). One of the many principles suggested by the authors is 5S, which they say is a critical foundation of visual management-a safe, orderly, and completely clean work area.

Visual management entails that a factory should be structured in such a way that there is flow from incoming receiving through fabrication/subassembly operation onward to the final assembly as illustrated in the figure below

![Idealized factory flow](image)

Figure 3.3 Idealized factory flow (Henderson and Larco, 2003, p175).

Information displays forms another crucial piece in visual management. Information should be shown at two levels: individual work area performance and overall plant performance according to Henderson and Larco, (2003).

Mann (2005) suggested that visual control if not properly used would amount to wallpaper. Thus management must ensure total adherence so as to achieve its objective of establishing and maintaining a lean management system.

**PDCA (Plan, Do, Check and Act)**

This concept forms the basis for continuous improvement and it’s all about planning, evaluating, and the identification of problems and its causes. It is made up of four stages according to Bergman et al, (2001).
Plan is the first stage in the cycle and it’s about identification of problems and its root cause. Do is the second stage and involves the execution of the decision made in the first stage. Check is carried out to evaluate the how effectively the first two stages have been implemented. It is also known as the follow-up stage (Bergman et al, 2001). Act is the last stage of the cycle and it is where the improved changes are introduced into the current processes of the organization. It is a continuous improvement process in the sense that when gaps occur due to movement from one stage to another, steps are taken to correct these gaps. The cycle thus begins all over again from the planning stage (Oakland, 1999).

**Standardized Work**

Henderson and Larco (2003) defined standardized work as a repetitive process through which work in an assembly line is carried out. The work methods and motions have to be properly studied and understood so as to determine the best possible way in which standardized work can be executed. It not enough to only study the work methods but the people that are to use should be trained in executing the process. An illustration was given by the authors of united parcel service where they have guidelines on steps a delivery person should follow in leaving the truck, and which hands a parcel should be held so as to maximize efficiency (Henderson and Larco, 2003). Martin (2010) stated that immediately a product and all its production work activities have been made simpler, the next appropriate step is to standardize work so as to reduce work variation. According to the author this method reduces the overall cycle time and the rate of recurrence of processing errors required to produce products.

Martin (2010) suggests a 5S approach in standardizing work process activities as illustrated in the figure below
Figure 3.4 Standardized work (Martin, 2010 p 110).

Sorting entails removing unnecessary materials and information not required to execute the current work task from a work area. Setting in order involves arranging the needed materials and information for easy reach and usage. Shining the work area as the third 5S approach in standardizing work activities includes keeping the work area clean always. This enables the employees to easily detect abnormal processing conditions so as to improve their work areas. Standardization ensures that everyone does work tasks exactly the same way every day. Sustain develop controls to make sure work improvement are maintained the same way all the time irrespective of the person in charge (Martin, 2010).

**Teamwork empowerment**

The idea behind teamwork empowerment is based on the tenet that decision with regards to what should be done should be left to those who are directly involved in the situation. It is made up of individuals from different disciplines that are assigned specific task and are given room to make decision as they deem necessary. They are obligated to think outside the box if processes are to be improved and thus implement any change they think is vital towards improving output quality. However it is important to note that teamwork without cooperation
and *esprit d’corps* (morale) will obviously hinder the success of such teams. Henderson and Larco, (2003) came up with four stages through which teams advance: forming “*acquaintance stage*”, norming “*settling down stage*”, storming “*conflict resolution stage*”, and performing “*tried and tested stage*”. Going through the above-mentioned stages as suggested by the authors creates a sort of experience that its members will always remember thus forming a very strong bond.

In the formation of people that make up these teams, it is important to include personnel from different department (finance, quality assurance, materials supply etc) of the company. In a typical lean production environment teams are made in groups of production cell, which have meetings at regular intervals so as to discuss and solve problems peculiar to them. And these meetings should last 10-15 minutes between operators and leaders preferably at the beginning of each shift. During such meetings performance from previous day is assessed, and production goal for the day ahead is set.

Aside the daily short meetings held, there should be a half hour meeting every week where crucial issues such as performance, quality, production and overtime schedules are tackled and decision is reached and implementation is affected. This is continuous improvement in action (Henderson and Larco, 2003). This will no doubt require the consistent and systematic training of the company employees so as to ensure a successful culture change.

As one CEO quoted “No vision, no strategy can be achieved without able and empowered employees” (Harvard business review, 1999, p 102).

Through teamwork empowerment they are able to take responsibility in some certain indirect task such as maintenance, procurement, quality, and material handling and control (Ahlstrom, 1998).

**Training**

Training is another important tool that is sometimes not paid adequate attention to, however it is found that training is required in the following areas: overall lean concepts, team empowerment, change management, specific lean tools, and lean accounting.

Cross training of operators simply means training every member of the team on the line to be able to perform the all jobs on the line. Cross training enables the members of the teams to be multi-skilled that affords tremendous benefits such as job rotation, which reduces fatigue, and increase the output quality. In as much as management oversee such training program, it is important to allow some form of organization and coordination by the group itself, and for the
most part, done on the job (Henderson and Larco, 2003).

**Motivation**

Motivation in the standpoint of Robbins (2005) is seen as the processes that make up for an individual’s painstaking effort towards achieving a goal in an organizational context. In their definition they stressed on the *intensity, direction* and *persistence* and argued that having high intensity without proper channeling of effort in the right direction will not be beneficial to the organization. Thus consideration must be given to the quality of effort and its intensity simultaneously so as to achieve the organization’s goals. Persistency on the other hand according to them is a measure of how long an individual can keep up with their effort. Motivation can be of two type’s namely *intrinsic* and *extrinsic motivation*. According to Kohn (1999) *intrinsic motivation* are factors that stern from within personal interest, desire and fulfillment. From the author viewpoint, a manager should consider the three C’s of motivation: collaboration (*an environment that encourages team spirit thereby leading to cooperation through assisting one another*), content (*employees knowledge that their little contribution adds value to the organization overall goals makes them take pride in their work*) and choice (*employees ability to make decisions in relation to their work creates a feeling of empowerment*).

*Extrinsic motivation* is as a result of external factors that are outside of the organization which influences internal needs, wants and/or subsequent behavior. This type of motivation causes employees to perform a task based on the anticipated reward (Kohn, 1999).

**Communication**

Simply defined according to Robbins and Coulter (2007), communication is the transfer and understanding of meaning. From this definition the transfer of meaning has been highlighted that is to say communication is incomplete when information and ideas have not been conveyed. In the same vein, for communication to be considered complete its intended meaning must be imparted and understood. Robbins (2005) suggested communication includes both transference and the understanding of meaning. Effective communication between management and employees is of great importance because it provides the information that enables work to be done efficiently. Thus there is a connection between communication and managerial performance (Robbins and Coulter, 2007).

Communication could be downstream or upstream; the former is flow of information that is
from the top to bottom example is from managers to employees in an organization in the form of assigning of goal, provision of job instruction, enlighten employees about policies and procedures. While the later is bottom-top kind of information flow in the form of feedback to top management, update on progress towards goals and convey current problems. A third type of communication per se could be said to lateral or horizontal. It exists between employees who are of the same work group, among managers at the same levels.

Communication can be oral (speeches, formal one-to-one and group discussion, informal rumor mill or grapevine), written (memos, letters, fax transmissions, electronic mail instant messaging, bulletin boards) and non-verbal (body movements, intonations or emphasizing of words, facial expression, physical distance between sender and receiver) (Robbins, 2005).

Within a group or organization, communication plays four important role namely control, motivation, emotional expression, and information. Communication as a control tool forms guidelines employees are expected to follow. Through communication, employees are motivated to know what they have to do, how well it should be done and ways to improve it. Communication with regards to emotional expression enables employees to express their feelings of satisfaction and resentment in their work group (Robbins, 2005).

**Kanban**

According to the Institute for manufacturing a Kanban system is a system that works on the basis that each process on a production line pulls just the number and type of components the process requires, at the right time. There are two types of Kanban system namely a withdrawal and production-ordering Kanban systems; the former indicates the type and quantity of a product that should be withdrawn form a preceding process by a manufacturing process while the later spells out the type and quantity of product that should be produced by the preceding (http://www.ifm.eng.cam.ac.uk/dstools/process/kanban.html, accessed on 04/08/2010). Kumar and Panneerselvam (2006) suggests that the Kanban system operating with a single card is known as the production-order Kanban and where there is short distance between workstations only buffer is placed in-between that functions as both an inbound and out bound buffer. On the other hand in a two-card system where the distance between the workstation is more there will be separate inbound and outbound buffers serving each workstation. The cards are referred to as production order and withdrawal Kanban correspondingly.

The simple steps adopted in kanban system are as follows
• The container of the succeeding workstation $j+1$ is moved to the preceding workstation $j$ with the withdrawal kanban (WK) and placed it in its output buffer.

• (a) Consequently it pulls the parts from output buffer of the workstation $j$ and detach the production order kanban (POK) attached to those parts and then places the POK in the POK-post of the workstation $j$.

(b) Work station $j$ starts its production as per the production order in its POK post.

• The container along with the parts and WK moves again to its succeeding workstation $j+1$. Then it delivers the parts to the input buffer of the workstation $j+1$ and places the WK to the WK-post of the workstation $j+1$.

• When the parts in the containers of the workstation $j+1$ are fully used, then the steps from 1 to 3 are repeated (Kumar and Panneerselvam 2006, p 394).

Figure 3.5 Single card and two-card Kanban system  (Kumar and Panneerselvam 2006, p 394-395).

### 3.3 Performance Management Systems

To begin with Performance management according to the United States Office of Personnel Management is “the systematic process by which an agency involves its employees, as individuals and members of a group, in improving organizational effectiveness in the accomplishment of agency mission and goals” (United States Office of Personnel Management, [http://www.opm.gov/perform/overview.asp](http://www.opm.gov/perform/overview.asp), Assessed on 14/09/2010).

Going further it includes activities such as planning work and setting expectations, continually monitoring performance, developing the capacity to perform, periodically rating performance
in a summary fashion, and *rewarding* good performance (Broadbent and Laughlin, 2009, p 284)

De Toni and Tonchia (1996) referred to performance management as management by process. They argued that for the company to have a unified goal centered on all aspect of customer satisfaction and the overall performance in terms of quality timeliness, efficiency, flexibility, management should endeavor to link all the activities together.

In the light of the above definitions (Neely et al, 2000; Bhasin 2008) stated that the management process becomes useless when the information collected is not properly utilized or that organizations lack the effective system required to translate the feedback into an effective strategy for action.

Through feedback from measurement outcome implemented, performance management offer organizations the chance to refine and make better their processes (Amaratunga and Baldry 2002).

Hoque (2008) clearly highlights the importance of aligning performance management systems with the strategic goals of the organization which in relation to Cheng (2006, p 765) is the key to success of the organization. He stated that “... ensuring congruence between all operational elements, encompassing employees at all levels in all departments, requiring total management
commitment to teamwork, and information systems integrate with those of the customers and the suppliers.”

De Waal (2006) stressed that for the PMS to be successful there must be mechanism in place that would ascertain if the organization is functioning at its optimum. He went further to say it should be adopted across the organization and managers should consistently use it; and its outcome should lead to improved organizational performance. To this end the PMS and the attitude of staff within the organization needs to be of extremely high standard.

“The performance management systems is seen as a closed loop control system which deploys policy and strategy, and obtains feedback from various levels in order to manage the performance of the business” (Bititci et al 1997, p. 524).

Ferreira and Otley (2009) asserts that it has to do with the defining, controlling and managing both the accomplishment of results as well as the process employed to attain these results from a societal and organizational perspective rather than individual level. They assumed this name so as to reflect a shift to a wider perspective of the role of control in managing organizational performance from the usual compartmentalized ways; it also give a managerial emphasis, by integrating various dimensions of managerial activity with the control system (Ferreira and Otley (2009, p 266).

Ferreira and Otley (2009) suggested twelve key areas that should be taken into consideration in developing the structure for performance management systems; similar to Otley (1999) five main steps regarding issues that should be considered when developing a system for managing organization performance. Joyce et al. (2003a) cited in Grønholdt and Martensen (2009) identified eight management practices and divided them into “primary management practices” representing the fundamentals of business, and the last four are “secondary management practices” (Grønholdt and Martensen, 2009, p 48).

Ferreira and Otley (2009) twelve key areas are shown in the figure below.
Discussions of the twelve components of the performance management follow below.

**Vision and Mission**
There cannot be control without objectives on which evaluation of performance is based. Thus it will be appropriate to say objectives are the starting point of performance management. The general direction an organization wish to pursue is expressed in its vision and mission. The vision states the future position the organizations aspires to attain while the mission outlines the overriding purpose of the organization in relation to the values of stakeholders. Vision and mission statement serves as pointers that direct the process of deciding changes that should be made or not in strategies and activities in the face of ever changing environment.

**Key success factors**
Key success factors are those factors, activities, attributes, competencies, and capabilities that are seen as critical prerequisites for the success of an organization in its industry at a certain point in time. For an organization to move its vision forward these factors must be achieved and their identification and monitoring is important for the accomplishment of strategic goals.

**Organizational structure**

The organizational structure spells out the responsibilities and accountabilities of the participants in the organization by specifying the roles individuals should not pay attention to. There are multiple types of organizational structure depending on the choice regarding decentralization/centralization of authority, differentiation/standardization, and the level of formalization of rules and procedures. There is connection between organizational structure decisions and key success factors and strategic decisions. The identification of key success factors requires organizations to assess the suitability of existing structures.

**Strategies and plans**

As a way of accomplishing the organizational objectives, chosen strategy points towards the direction an organization decides to follow to achieve its objectives over a period of time. As argued by the authors’ organization needs to develop the strengths that correspond to its key success factors so as to accomplish the goals set before them. An important aspect of this requires a translation of strategic goals to operational goals to realize alignment. Accordingly, researchers also propose matching the environment; strategy and internal structures together would result to higher performance. Lack of direction is one of the key control problems observed in practice and failure to communicate strategies and plans to organizational members may result in a lack of understanding of how individual actions contribute to the overall strategy.

**Key performance measures**

These are financial and non-financial measures used to assess the success of the organization in achieving its objectives, key success factors, strategies, and plans at different levels and simultaneously satisfying stakeholder’s expectations. Key performance measures in performance management framework are specifically highlighted; it reflects its importance and influence on individual behavior within the organization. There is evidence that alignment
between performance measures and strategy affect performance; in particular, the pairing of quality-based manufacturing strategies with the extensive use of subjective non-financial performance measures was found to have a positive performance effect. Attention should be paid to consider both area that measures are absent and area where they are in use.

**Target setting**

This forms an important aspect of the performance management framework because the set targets are used as a basis on which performance of the organization is evaluated. Research has it that when targets levels are set it has a positive effect on performance with about 80 to 90 percent chance success. Consequently, some authors are of the opinion that when there is need for cooperation between units, target setting is not connected to higher performance.

**Performance evaluation**

This is the evaluation of performance of the organization as a whole in general and groups of individuals in particular. Performance evaluations can either be objective, subjective or in-between both extremes. In the former there is no scope for ambiguity in the weightings; assessment is based only on the actual results and, typically, they do not allow for adjustments to the agreed standards of performance nor to their weightings. Subjective on the other hand the person in charge of the evaluation knows and determines the specific weightings assigned on different dimensions of performance. Its importance is that it detects error in performance measurement and corrects them.

**Reward systems**

When performance is evaluated the result is the reward that could include expressions of approval and recognition by senior management; financial rewards; long-term progression and promotion. Non-financial reward could be in form of subtle attributes and behavior. The workings of performance management system could be affected in a situation where subordinates receive a positive or negative comments with regards to their work progress will influence their behavior. The relationship between rewards, motivation and performance is complex, perhaps more so than it appears at first sight. Reward as a way of motivating subordinates would enable them to align their personal goals with those of the organization. By so doing unwanted behaviors are put aside. Group reward although have attracted increased attention, it is however faced with difficulty of a situation where individual see themselves as
not part of the group, potentials for free riders.

Information flows, systems and networks
Information flows, system and networks are the nervous system that hold together the whole system and is an important facilitator to any performance management system. Through system accounting and control information can be managed and they form a part of the information system. Networks are also another part of the information system.

In traditional organization performance management revolved around budgeting system, however recent trends now see organization embracing broader performance management systems like production, quality control, logistics systems etc.

Performance management systems use
The use made of information and controls is a cornerstone of the performance management system. Evidence from case study suggests that the use of control information can be more significant than the formal design of the control system. There is considerable scope for the development and operationalization of the concept of use, and for research to ascertain the effects of different types of use of control systems.

Performance management systems change
Owing to environmental and organizational change, performance management systems change was included in the framework as they are also requires change. This change is imminent so as to keep their importance and usefulness. Talking about performance management change, it relate to the design infrastructure that strengthens the performance management systems as well as the way performance management information is utilized. Strategies are important factor when mention is made about performance management systems as a result it is vital for organizations to consider the scope of strategic change in an ever competitive environment. The extent to which strategies have changed is an issue of interest for understanding the functioning of the performance management system. Thus when change is considered it is the extent and type of change that have resulted that focus should be on rather than the process of the change itself.

Strength and coherence
In a bid to understand the operation of the performance management system, the strength and coherence between the links within the performance management system is important. The
performance management system as a whole is greater than any individual part; thus it is paramount for all the different parts to be aligned and organized so as to meet its purpose. In speaking of strength and coherence, all the eleven components that have been discussed so far are connected.

The authors’ provides hints as to what to look for when examining the strength and coherence of the performance management systems. They suggested that judgement should be made about the extent to which the control system “consider(s) multiple stakeholders; measure(s) efficiency, effectiveness and equity; capture(s) financial and non-financial outcomes; provide(s) vertical links between strategy and operations and horizontal links across the value chain; provide(s) information on how the organization relates to its external environment and its ability to adapt” (Ferreira and Otley, 2009, p 276).

### 3.4 Summary of the theoretical framework

#### 3.1 Seven types of Production Waste
- Transportation
- Over-production
- Waiting
- Inventory
- Defects
- Motion
- Processing

#### 3.2 Lean Principles
- Specifying value, Identifying the value stream, Creating flow, Pull, Perfection
- 5S
- Continuous Improvement
- Visual Management
- PDCA
- Standardized work
- Teamwork empowerment
- Training
- Motivation
- Communication
- Kanban

### 3.3 Performance Management Systems

- **Vision and Mission**
  1. Key success factors
  2. Organizational structure
  3. Strategies and plans
  4. Key performance measures
  5. Target setting
  6. Performance evaluation
  7. Reward systems
  8. Information flows, systems and networks
  9. Performance management systems use
  10. Performance management systems change
  11. Strength and coherence
Chapter 4 Empirical Findings

In this chapter the empirical data collected are presented. All the case companies interviewed follows the same structure for easy flow.

The figure below shows the connection between the chosen research questions and the empirical evidence that has been collected which will assist in answering the research questions.

<table>
<thead>
<tr>
<th>Research questions</th>
<th>Empirical evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “What are the types of production waste that exist in the production process and with which lean principles are these waste reduced or eliminated in the case companies?”</td>
<td>Case company A: Electrolux Laundry Systems AB</td>
</tr>
<tr>
<td>2. &quot;How are they currently managing performance in their lean production process in comparison with the performance management systems model?”</td>
<td>Case company B: Volvo CE Braås</td>
</tr>
<tr>
<td></td>
<td>Case company C: Hammaplast AB</td>
</tr>
</tbody>
</table>

Figure 4.1 Relationship between research questions and empirical data

4.1 Case company I: Electrolux Laundry Systems AB (EPS)

4.1.1 General information

Electrolux Laundry Systems Sweden AB was acquired by Electrolux in 1973, and belongs today to the product line of Electrolux Laundry Systems. Electrolux Laundry System is part of the Electrolux group with factories in Sweden (Ljungby), Thailand, and France. All three factories specialize in manufacturing professional laundry equipment.
They are a part in the daily life of hundreds of millions of families around the world. Each year, their products such as cookers and cooktops, ovens, fridges and freezers, dishwashers, washing machines, tumble dryers, room air conditioners and vacuum cleaners is consumed by about forty million in more than one hundred and fifty countries.

Electrolux Ljungby employs approximately 550 people. The production unit is comprised of 380 employees out of which 300 are employed in production of equipment and 80 in R & D, production planning, logistics and purchasing.

The Swedish sales- and service organization employs 71 persons and supply and service customized laundry solutions to apartment house laundries, hotels and health care institutions in Sweden.

Electrolux Ljunby factory is one of the world’s leading manufacturers of professional washer extractors and tumble dryers. For 100 years they have manufactured professional laundry equipment.

They specialize in the production of high-, normal-, medium- and extra-spin washer extractors with drum volumes ranging from 55 to 850 litres. It has a production capacity of 128 units per day and produced 27,618 washers and dryers in 2009. The facilities are certified according to ISO 9001 and ISO 14001 (http://www.laundrysystems.electrolux.com/ 18/04/10).

Electrolux laundry systems Ljungby AB developed a production system known as the EPS “Electrolux Production Systems” just as the TPS. The base forms the main principles they are using at the moment and it is considered the foundation on which other lean tools will be built on. In the pillars are other lean tools that will be utilized but requires that the main tools be implemented first. The level they are at the moment comprises of the first two steps illustrated in figure below.
Figure 4.2 Electrolux production systems

The following information was extracted from the interview conducted with Rikard Karlsson and Rajko Kondic (lean expert) on 01/04/2010, and Zoltan Erös (Production Leader) on 28/06/2010

4.1.2 The types of Production Waste

Types of production waste experience at Electrolux Laundry Systems AB:

- Over-production waste
- Waiting waste
- Transportation waste
- Over-processing waste
- Inventory waste
- Motion waste
- Defects waste
Over-production waste in EPS is reduced because in the first place employees cannot over produce as no one can start the next machine before the whole line is finished. When the process starts it must be completed before another process begins. “We have been able to control the waste of over production by only producing what customer need. They have a production capacity of one hundred and eighty-five (185) units per day and when that point is reached; the assembly line is short down. Production capacity is increased when demand from customers increase.

Waiting waste is the waste that results from waiting for materials. In EPS there was a lot of waiting because tools and materials were not properly kept thus requires longer times to either get the appropriate tool to work with or transport the needed material to the assembly line. This wait causes idle time for both employees and equipment. As a result of the new assembly line that was built, waste of waiting has been reduced to twenty-four minutes per day. The total lead-time for the assembly line is two hours per day depending on the output.

Lead-time per line is calculated as follows:
Line A is 9 stations * 8mins
Line B is 13 stations * 8mins
Line C is 9 stations * 40mins. (Larger machines take longer time).
With the new assembly line in place it becomes easier to have a well-balanced line because it reduces waiting waste to a large extent. Materials and tools needed are brought close by and within reach as at when needed.

Transportation waste in EPS is a result of movement of products or materials not actually required in the production process. To tackle this waste, they built a shorter assembly line to reduce and possibly eliminate unnecessary transportation. The assembly line is fed regularly to avoid unnecessary transportation as a result of shortage of materials. In their new line they both tools and materials are properly kept through the use of 5S. 5S has helped to reduce the transportation waste because now the necessary tools needed by employees to do their work are always kept in the right place. Milk run is done 4 times a day so as reduce transportation waste.

Over-processing waste in EPS is not so evident because they do not include unnecessary adds on that has not been requested by customers. They thus produce according to customers’
specification. Since they do not add unnecessary features and functions to their product cost that would have been associated with designing and production of that product is eliminated.

**Inventory waste** in EPS’s old line was the result of products that are yet to be completed or that materials used for production were not properly stored. The building of the new line has reduced the inventory waste by moving the inventory that was formally stored on the assembly line to the supermarket. As a way of reducing inventory waste further, they are working on pushing it from the supermarket all the way to the internal supplier. After this is achieved the next step will be to push it to their external suppliers. Milk run is done 4 times a day so as to reduce inventory waste. Materials are collected from their supplier and delivered directly to the workers on the assembly line. This reduces the inventory that would have been stored on the line as it was done before.

**Motion waste** in EPS is evident in their old assembly line because employees had to move the machine about which was a non-value adding activity. With the new assembly line in place, the line is shorter thus machines and materials required for the production process is located within reach. Every material is also delivered on the line so unnecessary movement is reduced according to milk run. The train runs on the line and the employee works in a 2*2 space where every material and equipment needed by the workers is within reach so they do not have to leave their work area to look for a specific tool. On the new line, products and machines cannot be moved just as it was done before on the old line. The benefit of implementing and following the principle behind 5S becomes evident in EPS.

**Defects waste** in EPS is experienced due to errors that occur as a result of missing a particular step in the assembly process. Another reason for defect could be as a result of the similar colours “black & white” and “blue” on the screen that can easily be mistaken when employees are fatigue. With the standardized work in every work area, errors are quickly detected and corrections are made. Audit is carried out in the assembly line several times a week as check to make sure everyone understand the process. 5S has also contributed in reducing the waste of defects because everything is in place. They have built into their task system the touch pan where you press “ok” or “andon”, and easily see what you are doing thereby reducing errors due to fatigue. The product can be scanned using the bar code checked against the bill of materials just to be sure nothing is
forgotten. They stressed that Poka-yoke comes in handy as it helps to detect errors when it occurs thereby reducing and correcting it.

### 4.1.3 Lean Principles in EPS

**Teamwork empowerment**

Through teamwork they are able to work efficiently by meeting 5 minutes everyday to ask questions with regards to the previous day. In this way they are able to work as a group and tackle issues that came up the previous day. Employees in EPS are allowed to come up with ideas and suggestions to make little changes in their work area so as to function more effectively.

**Training**

Training is sometimes carried on the line. The reason for the on line training is to save time and enable the employee to have a proper understanding of the operation process. In EPS, employees in the assembly area are trained at every station so that anybody can work on any task based on job rotation.

As part of training, they visited another Electrolux company to see how the production process is been done. They were involved in a lean game where they were they put into use the principle of 5S and standardized work. At the end of the game according to them they realised the importance of 5S and standardized work in everyday working environment. The practical implication they understood from the game was that through 5S and standardized work a lot of time that would be wasted as a result of tools and materials not in the right place was saved. Before they implemented 5S and standardized work, their assembly line was in a mess and tools and materials were not arranged properly thus made work difficult and a lot of time was wasted in the production process.

**Motivation**

Every worker is allowed to work independently but must work in accordance with the standardized work. EPS gives room for every worker to come up with ideas to improve the efficiency in the work area and the quality of the product. Suggestions for changes within the work area are channelled through the team leader to the production or plant manager.
As a way of motivating their employees, they rotate the task performed so that they don’t get bored or just stay on one point for too long and cause the quality of work to go down. Multitasking enables workers to easily switch from one job to another; thus they are trained to be able to perform any task in the assembly line.

The opportunity given to employees to decide how best tools in their work area should be kept and room to come up with suggestions for improvement in the assembly line gives them the feeling of acceptance. During daily and weekly meetings held, employees suggestions are discussed and any decision arrived at is immediately introduced and made as working standard.

**Communication**

In EPS, communication plays an important role in passing of information within employees themselves and between them and the different managers in the assembly line. Visual management in place makes the flow of communication to be easy. They said suggestions for improvement from employees is sent (upstream) through the appropriate channel to management and feedback is passed down (downstream) in form of decisions reached to employees. In the meetings held, issues discussed are made available to everyone concerned so that everybody can be on the same pace. Sometimes critical decisions are delayed for weeks and even months due to communication gaps between the middle and top management.

**Standardized work**

In Electrolux, this is one of the key lean tools they use. The principle behind standardized work is simply the best or normal way work can be carried out by everyone involved. According to them they said before they started using standardized work people where not following any laid down steps of how things should be done. Through the implementation of standardized work people now follow the laid down steps. As such it is the responsibility of the team leader to ensure that everybody knows what he or she should do on a daily basis. If there are adjustments everyone must accept it and then it becomes a standard. To aid easy understanding and utilization, pictures and charts are placed in such way that the worker is guided to follow procedures. Through these standardized work chart pasted in each workstation employees can quickly notice and correct missed step in the production process.

**Visual management**
EPS makes use of visual management and it is one of the key principles they make use of in their production process. The principle behind visual management as demonstrated in EPS is that everyone can see, understand and follow the production process as reflected in their standardized work. In the assembly line of EPS they have charts and instructions pasted everywhere for the workers to understand what goes on in the factory. Rikard (01/04/10) mentioned that workers get a lot of information in this way that becomes useful in performing their task efficiently. In every cell they have a booklet showing the standardized work so everyone knows what they should do and how it should be done. Visual management enables team members to know how they are performing in a particular task and what area they should improve. From the EPS board shown in figure 4.3 everyone is able to see everything and have first hand information about the production process.

![Figure 4.3 Visual Management board of EPS](image)

**Continuous improvement**

Continuous improvement in EPS is very important to them because if they must be effective in and efficient in their lean production journey. They allow employees to work independently on their own who gives them room to make little decision and come up with suggestions on how to improve their work area.
Continuous improvement is also evident in our 5S where employee work with tools in his/her work area becomes familiar with the arrangement, he/she can come up with suggestions on the best possible location for different tools being that they are used to the arrangement. This way they are continuously improving their work area.

In our PDCA, we utilize continuous improvement too because the idea behind it is to come up with good decision that would improve our production process.

**PDCA (Plan, Do, Check, Act)**

Problem are stored in the task system and when it occurs more than once it is transferred to the PDCA so that cross functional heads can meet and look into the issue. This meeting usually last between five to ten minutes and during such meetings issues that have occurred are tackled and solutions are fed back to the team leader and further to the employees on the assembly line.

Rajko said “it easy to put up some instructions for employees to follow but difficult to get it living. Because someone has to update and some other person must be interested to read it and the manager must have interest to follow up all these”.

They use SPQLE technique that stands for:

**S (Säkerhet)- Safety or Security**

The goal of EPS is to have a zero injuries at all time during work and around the assembly line.

**P (Personalläget)- Staff position**

They ensure that everyone contributes to the continuous improvement process.

**Q (Rätt från början)- Right from start**

**L (Leveransprecision)- Performance Delivery**

They strive to deliver on time customers’ orders by optimizing the entire supply chain.

**E (Effektivitet)- Efficiency**

They have as one of their goal to maximize their production efficiency so as to benefit both the customer and shareholders.


**Competence Matrix**

The competence matrix in EPS shows the capability of all the employees in the assembly line at every point in time. The figure below shows the competence matrix of the EPS.

![Competence Matrix](image)

**Figure 4.4 Competence Matrix of EPS**

According to Rikard one pie in the chart represents the worker ability to know the element sheet and how to assemble it as shown below. Two pies represent the worker’s ability to perform the task safely in the right quality but not within the takt time. Three pies represent the worker’s ability to perform the job safely, in the right quality and within the takt time. Four pies represent the worker’s ability to perform all activities and also be able to train someone else in any of the different task. With the competence matrix, the team leader can easily know the competence of a particular worker in terms of what they can do and which aspect they can function well. Based on this task is assigned to workers in the assembly line.

**Layered Audit**

The team leader makes audit three times a week, production leader makes it once a week anywhere on the assembly line. Productions chief or manager makes it twice a month. The lean
experts (Rikard and Rajko) make it once a month. The layered audit is the most important aspect in the lean implementation because it requires continuous flow. Everything that goes on in the assembly line is shown on the layered audit because it is carried out on a daily basis. For example, job rotation that determines who does what and how well it was done is recorded in the layered audit. Through this audit checks is carried out to see if the process steps have been adhered to according to the standardized work. Based on these checks non-conformities are treated immediately and observed reactions from workers are documented. The figure below is the layered audit of EPS, where follow up for their most important processes are recorded. The red dots indicate processes are still ongoing while the green dots indicate already completed processes.

![Layered Audit of EPS](image)

Figure 4.5 Layered audits of EPS

4.1.4 Performance Management systems in EPS

Vision and mission

EPS has as its vision to be the world leader providing their customers the best total solutions for their laundry needs whereas its vision is to drive operational excellence in safety,
environment sustainability, quality, efficiency and delivery performance through people engagement.

**Key success factors**

EPS has as its key success factors the process used in its assembly line. Amongst these factors are

- **People engagement** – develop a culture where everyone contributes to the continuous improvement process.
- **Safety** – achieve world-class workplace safety performance with everyone taking ownership.
  
  In line with EPS goal to achieve world-class workplace safety performance, standard work audit ensures that escape routes are clearly visible.
- **Environment** – minimize the environmental impact and optimize the energy efficiency of our production process
- **Quality** – deliver products that exceed customers’ requirement every time.
- **Efficiency** – maximize production efficiency to benefit both customer and shareholders
- **Delivery performance** – deliver on time what the customers wants by optimizing the entire supply chain. All these goals will enable EPS to accomplish its vision and mission.

**Organizational structure**

The organizational structure in EPS as stated by Ferreira and Otley (2009) spells out the responsibilities of its employees on what they should and should not do. The structure of EPS is more like a decentralized one where employees are free to make certain suggestions and decision concerning their assigned task.

**Strategies and plans**

To achieve the goal of becoming the world leader providing their customers the best total solutions for their laundry needs EPS ensures they produce quality product that meets customers satisfaction always. As a result team leaders, production leaders and chief perform audit regularly. Also through employees empowerment they ensure they contribute to the continuously improve the production process. Allowing employees to think outside the box gives room for improvement suggestions that would lead to

**Key performance measures**
The layered audit is one of the key performance measures of EPS. Management uses information gathered by the layered audit for decision-making. The layered audit shows the activity that takes place in the assembly line; through it individual performance is easily known.

**Target setting**
Their set target is measuring the stop time that is set at 26 minutes; thus all assembly line workers are encouraged to meet this target.

**Performance evaluation**
Performance evaluation in EPS is carried out using the layered audit that ascertain how well employees have performed and the yearly audit that evaluates all the different aspect in the production process. Evaluation in this way provides information that is useful to management to decide areas that require attention.

**Reward systems**
EPS do not have financial reward system in place because they do not believe so much in it. However they have a non-financial reward system in place that rewards teamwork at the end of a particular project through seminars and training.

**Information flows, systems and networks**
The use of visual management boards, layered audit standardized work enables information to be transferred however can be said to EPS does not have any formal information system in place to aid the effective flow of information.

**PM systems use**
The use of the performance management systems in EPS is seen in various aspects. Through the lean principles “PDCA, layered audit and visual management” they have in place, EPS is able to effectively control the production process and make decision that would improvement. At the group level there is easy flow of information as they meet regularly to discuss and exchange ideas. Although information retrieved from the performance management system is used to make management decision; there is still the problem of delayed feedback from management to the employees at the production floor due to middle management.
**PM system change**

They believe in continuous improvement that is practiced in every aspect of their production process thus there is need for an update of their production board in real time. This as we know is the corner stone for reducing or eliminating unnecessary waste and improving the production process.

**Strength and coherence**

The inclusion of continuous improvement in every aspect of their production process attests to the fact that there is coherence between the different systems in place. The vision and mission is tightly connected with the key success factors and also the strategies with which they would achieve their goals.

### 4.2 Case company II: Volvo CE Braås

#### 4.2.1 General information

Volvo CE is one of the main business areas of the Volvo Group Different kinds of equipment are offered in this Business area (e.g. wheel loaders, excavators, motor graders, compact machines etcetera). The headquarters for the articulated hauler production is in Braås (Sweden) and it is their main product. A second production plant is situated in Pederneiras (Brazil) where only assembly is done. The production plant in Braås not only assembles but also manufactures components such as front and rear frames, and bodies. In addition the administrative departments (e.g. human resources, economy), after sales support, research & development (R&D) as well as IT, purchasing and global marketing are situated there. The total workforce of the production plant comprise of about 650 employees presently.
Between 2001 and 2007 the production volume at Volvo CE Braås increased by 86% in 2005 with a production of 50 haulers per week. Today, even more than 50 Haulers are produced and a strong increase is planned for the next years. Volvo CE Braås leads the development of articulated haulers and with a market share of 34 % also holds the world leading position in manufacturing and selling articulated haulers. (http://www.volvo.com/trucks/global/engb/aboutus/history/1920s/ accessed 30/06/2010).

Volvo CE has two lines-the big and small lines. The bog one assembles the bigger haulers and the small line assembles the small haulers. The small line comprises of 18 employees and they assemble A25E and A30E haulers, while the big line is made up of 25 employees and they assemble the bigger haulers A35E and A40E. There two shifts at Volvo CE from Monday through Thursday and Friday. The shift starts at 6am up to 3pm in the afternoon while the second shift starts at 3pm and ends at 12 midnight. Between the end of the first shift and the start of the second shift, there is usually a meeting where information is exchanged.

Volvo developed a production system known as the VPS “Volvo Production System” as we have the TPS “Total Production System”. The purpose of this system is to measure and
improve the production processes by satisfying their customers through continuous improvement, built in quality and JIT. The figure below shows the Volvo way that encompasses the entire Volvo organization environment.

![Volvo Production System](image)

Figure 4.6 Volvo Production System Internal Power point presentation

The following information is a transcription from the interview conducted with Axel Carlsson (Manager Material Control) on 30/06/2010.

### 4.2.2 The types of Production Waste

In Volvo CE Braås not all types of waste are present. They have been able to identify and reduce the evident waste in the following ways:

- Over-production waste
- Waiting waste
- Transportation waste
- Inventory waste
- Motion waste

**Over-production** is producing goods not needed at the moment ahead of time. In Volvo CE
they currently use the push production system where the haulers are pushed from one workstation to the next for further processing or storing. Over-production results when there is an unpredictable change in demand or production resulting to production of units that are not needed at the moment. However they are shifting to pull system such as kanban so as to reduce this type of waste. Where production is pulled from its current workstation by the succeeding workstation rather than being pushed.

*Waiting waste* results due to waiting for the production process to commence. In Volvo CE there is currently the waste of waiting due to materials not been received early enough in the assembly line; employees forgets to immediately place orders and the assembly lines run out of supplies causes delays because they have to wait for supplies before work can commence. This also affects the supplies because there will be pile up of orders causing the assembly lines to wait for deliveries.

Stoppages in the production process are attributed to waste of waiting which is as a result of waiting that occurs due to maintenance of machines or stops to fix problems as they arise in the production process. The takt time for assembling one hauler in the big line is 85 minutes and 123 minutes for the smaller line.

This he claims has helped to improve the workstation. Axel said “there is waiting as a result of narrow lanes in the assembly area thus an operator of the forklift sometimes have to wait for another operator to complete his process before he can commence. This type of waste does not add value to the production process”.

*Transportation waste* is the moving of products that are not actually required in the production process. “This waste is experienced here because we produce large machines that require large parts, so distance for instance is a very big problem here. This leads to waste of transportation” (Axel Carlsson). In Volvo CE apart from internal storage they also have external storage in Åseda, Växjö and Hyab in Braås. Tires are delivered to Åseda and Växjö and rims delivered to Hyab by suppliers when ordered. The cost for further delivery in smaller quantities for production purpose is borne by Volvo CE which amounts to transportation waste. They have seven forklift drivers operating on the narrow transportation routes apart from the main route all other fits only one forklift at a time. The forklift driver often has to adjust back and forward before the forklift is in the right position for accessing the shelf.

Volvo CE is internally investigating the possibilities of using other transport equipments other
than the forklifts so as to reduce the movement of unnecessary transportation within the assembly area.

**Inventory waste** in Volvo CE is tackled by adopting the pull system as used in tackling the over-production waste. Some materials for assembly are stored along the sides in the assembly area in shelves, there are also other areas where larger parts such as engines, axles and batteries that are stored on the floor. Still yet there are other much larger parts that are pre-assembled outside the assembly lines. The pull system being used is Kanban where cards are used to place orders for material supplies when the inventory is low. This way inventory waste is reduced to a large extent.

**Motion waste** in Volvo CE is reduced through continuously improving every workstation to ensure that the distances are optimal. “Due to the large size of our machines and parts it becomes a challenge to find possible ways through which this type of waste can be addressed. Thus through continuous improvement of our workstation we try to reduce the distance in the best way”.

### 4.2.3 Lean Principles in Volvo CE

**Employee empowerment**

Ordinarily in Volvo CE there is normal daily meetings held for ten minutes by all team heads and some weekly at normal team levels. During these meetings discussions about how to improve their work are decided, what this means is that results based on their work is interpreted and possible actions are taken. These meetings are overseen by a higher manager who gives the final go ahead to implement the decision. Twice a year each manager gathers his immediate work force and talk with them for one day about their strategy and strength of their competitors and together they come up with ideas on how to mobilize their work group energy and efforts in order to keep up with their competitors. The supervisors together with the various team leaders decide Job rotation before it is finalized. That is to say before decision as to who should work on a particular task is reached, it is first discussed at the team level. It goes to show that employee are given opportunity to decide within themselves who, when and how often their task should be rotated. Employees’ empowerment is also demonstrated in the area of re-arrangement of tools in the
workstation. Employees now understand that proper arrangement, storing and identification of their tools in the work area has saved time and made work much easier to perform. Now our employees have seen the idea behind 5S of how much it is easier to have control over their work area, tools and materials.

Although we had problems at the implementation stage because employees found it difficult to understand how it works, we are at the moment enjoying its benefits.

**Training**

All employees undergo two days VPS (Volvo Production System) training when newly employed and they all have extra training for the ones that become group leaders. They also have job rotation from the work force into their VPS office. Five office workers are made to work in the VPS office for one year and then changed with other five new ones.

**Motivation**

They always want to try out new ideas. For example if they have new ideas on how to standardized the assembly hall then they try to find the work group that is interested in trying out the new ideas and the idea is implemented in their work group. If it turns out well then they have that as example and the work group as witness on how the new idea has turned out. The work group becomes ambassadors for the new concept or new method of assembly. When this is finished they take a new idea and implement it in one single work group to try it out show that it is working and its efficient and then implement in the rest of the plant. In terms of reward "We follow what most Swedish companies do, a suggestion box is used for new ideas and if the idea is good, the worker that came up with the suggestion is rewarded on some percent of the savings his idea has brought the company. However this method is not much in use as such but instead the whole work groups together are empowered by seminar twice a year. It is important for our survivor that we continuously improve ourselves so that the haulers will have higher quality and good enough price and be better than the competitors”

**Communication**

Communication is evident in Volvo CE because management and workers in the assembly lines must interact and between employees within the same work group. Communication facilitates the discussion and forms a vital tool for understanding during meetings held daily to tackle the previous day performance issues. The cross-functional team guiding each of the
corner stones in VPS cannot be effective without exchange of information amongst themselves and with management. Ideas/suggestions from employees cannot be heard talk less of implementing them if employees cannot reach out to their team leader who is suppose to pass it to management for approval in the case of ideas that require higher approval. Here in Volvo CE we see communication very important as it serves as base for continuous improvement to be carried out which requires a back and forth flow of information.

**Standardized task**

In general they try to have different worker work in a standardized way. For example if one worker assembles the gear box, the work is done exactly in the same way irrespective of who does it or on which shift it is been done. They also try to incorporate white collar employees for example he said “his immediate employees working in the material control, have standardized task for half of their working hours in respective of who is doing it. That is to say they perform their task in the same way no matter who does it. Standardized task are the foundation for continuous improvement and employees empowerment. All work is standardized step by step.

**Visual Control**

Every day they have meetings regarding the result of yesterday’s productions and prognosis of today’s production. These meetings are held not in conference rooms but in the actual assembly halls where they stand in front of a white board and the key KPI’s visual in front of them while they have these meetings and they report their status at the end. This is the main proof of visualization according to him. If they have any disturbances they also have a deviances meetings of how to handle the disturbances out where the actual problem is for example if they have quality problem on one of the parts in the haulers the managers meet outside the assembly hall where the parts is suppose to be use in the haulers. Axel stated that through visual control problems are easily exposed. Each work group has their own board where different measurements and tasks are visualized. Through visual management, all leaders are encouraged to visit the assembly line regularly to thoroughly understand the situation. Meetings and discussion are held on the work floor on regular basis.

**Continuous improvement**

They have quite a fixed process for managing continuous improvement. All the assembly line is stopped every Tuesday for 54 minutes which is one takt time and instead of producing one
hauler that 54 minutes they have improvement meetings and all the work groups are discussing on how to improve their working environment, standardized work and quality and so on which is the formalized meetings. Then between the meetings different workers have different responsibility; so the quality guide in that work group might be to do some adjustment in the check list of quality so that it can be easier to read or clearer in some ways before the next meetings in the next week.

For the different adjustments we have to do, different instructions is made available for each team and it is the team leader’s responsibility to take out the information from the system and presents it to the work group with regards to yesterday’s production; final inspection shows the faults found and they have to use their continuous improvement time to improve the problem. Axel said “we build a culture of stopping to fix problems, to get the quality right the first time through management guiding principles that we follow”

**Competence matrix**

The competence matrix is combined with the job rotation plan. Each worker has blank competence matrix is presented at the start and is filled step-by-step as work progresses after learning in the different work area. Based on this supervisor and team leaders are better disposed to decide who perform a particular task. In Volvo CE Braås the competence matrix board is used to determine the abilities of the assembly line workers and it also shows who did what and when it was done as can be seen in the figure below.

**Kompetensmatris Ankomstgruppen**

<table>
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<td>Ulf</td>
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<td>Ordinarie</td>
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</tbody>
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**Definitioner**

Ordinarie: Normalt det jobb man gör
Ersättare är personen på raden under den ordinarie
MMM-ÅÅ: Senaste gången repetition eller upplärning genomfördes

Figure 4.7 Competence matrix of Volvo CE Braås
4.2.4 Performance Management Systems in Volvo CE

Vision and mission
Volvo CE has as its vision to be valued as the world’s leading supplier of commercial transport solutions. They aspire to be number one in image and customers satisfaction, achieve a sustainable profitability that is above average. For their mission as they strive to create value for their customers as well as their shareholders.

Key success factors
Volvo CE key success factors that have made them the third in terms of market shares in the producers of construction equipment includes:

- Quality
- Safety
- Environmental care
- To work towards profitable growth with energy, passion and respect for the individual.

Organizational structure
The organizational structure of Volvo CE Braås is both centralized and decentralized. From the structure as shown in figure 4.5 above little changes can be made within the management team in place, while organizational policies comes directly from the CEO. The effect of this kind of structure is that management decisions are sometimes delayed; this is due to the flow of information from the top down to the shop floor employees in the assembly lines and vice visa.

Strategies and plans
They developed the VPS to enable them measure and improve the production process by satisfying its customers through continuously improving their product based on quality and deliveries made just in time.

Key performance measures
There are some 93 key performance indicators in Volvo CE amongst them are quality, delivery, cost. In terms of quality, Volvo CE has a final inspection process where faults detected are corrected through the continuous improvement meetings held. They have a culture of stopping to fix problems so as to get the quality right the first time. From the performance measures in
place, they are able to get statistics on how many adjustments are done on the average on each hauler on weekly and monthly basis. Delivery precision is measured by the actual deliveries of the hauler to finished stock with the production schedule. They also have a statistics on how many was early or late and so on. The cost is assessed from their financial system based on the calculated cost for each haulers and it is compared with the actual cost that include the cost of raw materials, salaries, heating of the plant and everything else.

**Target setting**
Setting of deliveries targets by ensuring that actual deliveries are matched with production schedules. Quality targets are set to know the numbers of adjustments made on the haulers weekly and monthly.

**Performance evaluation**
The competence matrix is used to evaluate performance in Volvo CE. Through the competence matrix how well an employees can function is known, that way management are better able to evaluate who perform which task. Through visual control for each work group, management is able to see how well a particular group is performing and areas that require attention are discussed in meetings held regularly both at work group and management levels respectively.

**Reward systems**
They have reward system in place that rewards everyone in the work group alike irrespective of who came up with the improvement suggestion. Apart from the financial reward, the work group is also sponsored to seminars twice a year.

**Information flows, systems and networks**
There is no formal information system in place that is currently used by Volvo CE to facilitate the flow of information. Information is passed through other means such as the visual control board displayed for everyone to see how things are done both at the work group level and the overall production level.

**PM systems use**
Based on their visual control board and competence matrix the information retrieved is acted upon at group level and at management level too. At the work group level they have daily
meetings where they discuss the performance of the previous day’s production to find ways of solving issues that came up and also try to predict the current day production. At the management level, issues that cannot be resolved within the group are resolved here. All these discussions are based on the information retrieved from the performance management systems.

**PM system change**

Since they believe strongly in continuous improvement, processes are constantly reviewed to eliminate non value-adding activities or come up with suggestions for improvement. There performance management system is designed in such a way that changes made are reflected in the overall organization.

**Strength and coherence**

In Volvo CE the performance management systems can be said to be imbalance because they do not have a formal information system in place which facilitates the flow of information. Other than that it appears to be well conceived as there is consistencies between key objectives, the structure of the organization and the culture.

### 4.3 Case company III: HammarPlast AB

#### 4.3.1 General information

Hammarplast consists of two independent plastics processing companies: Hammarplast Consumer AB and Hammarplast Medical AB. Each company has its own specialist competencies. Our wide range of products, continuous product development and a highly developed quality assurance system give the group a unique strength. Hammarplast Consumer AB has around 160 employees and a turnover of approximately SEK 300 million. Hammarplast Consumer has its own sales companies in the Nordic countries. In the rest of Europe we work directly with major customers, and through agents and distributors. We are represented in the North American market through our associate company, Snapware Corp., which has a turnover of approximately USD 42 million. Hammarplast Consumer AB is a company in the Hammarplast group with a total turnover of about 38 M€. Majority owners are the families Hermansson and Bergendahl together with Industrifonden, a Swedish
investment fund. The business is divided into two-business unit, Consumer and Medical. Hammarplast Medical AB is also part of the group. Their products are manufactured in highly automated factories that are located in Sweden. Scandinavia is their home market and forms a strong platform for further expansion into Europe. Hammarplast Consumer AB has been certified in accordance with quality standard ISO 9000 since 1997 and environmental standard ISO 14 000 since 2002 which means that they must, within the framework of what is technically and financially feasible, contribute to an ecologically sustainable society (http://www.hammarplast.com, accessed 30/06/2010).

![Figure 4.8 Organizational structure of Hammarplast AB (Tingsryd)](image)

The following information was extracted from the interview conducted with Jonas Johansson (Production manager) on 30/06/2010.

### 4.3.2 The types of Production Waste

The following are the types of waste experienced at Hammarplast Consumer AB

- Over-production waste
- Transportation waste
- Over-processing waste
- Inventory waste
- Defect waste

**Over-production waste** in Hammarplast AB is tackled through a production process where
orders are made to stock based on forecasts and production based on ordered quantity and minimum order quantities. A combination of both of these production techniques gives them the opportunity to produce only orders that have been placed and thereby reducing waste associated with over-production.

*Transportation waste* in Hammaplast involves the unnecessary movement of products that do not add value to the activity. This type of waste will cause delays and thus slow down the production process. As a way of reducing this waste they are trying out different location for their equipment to find out the best place that would amount to less unnecessary transportation.

*Over-processing waste* in Hammarplast AB is reduced through product development and maintenance of machines. For product development they ensure that products created are with new or different characteristics so that it can offer new or additional benefits to their customers. It could be in altering the shape or entirely coming up with new products.

*Inventory waste* in Hammarplast AB is handled through the making of accurate forecasts that requires proper record of inventory. Where proper inventory records of components, work-in-progress, finished product that are not been processed are kept, unnecessary waste of inventory is reduced.

*Defect waste* in Hammarplast AB is as a result of waste due to scrap value. In order to ascertain the waste that results due to scrap, the scrap value (per shift), production value (per shift), OEE (per week) and scrap value per mould and machine (per month) is measured. They tackle defects waste through product instructions that serves as guide for operators to use in the production process. Maintenance is also carried out regularly on all equipments to reduce machine mal-functions. Where errors are detected the causes are documented and are discussed during follow up meetings.

### 4.3.3 Lean Principles in Hammarplast Consumer AB

*Employee empowerment*

Simple suggestions from employees are welcomed but someone has to ascertain whether it will be feasible or not. Sometimes ideas from employees could go contrary to some other decisions
already in place. So with the continuous improvement suggestions board we have in place, ideas from employees could be looked into and yes or no decisions are made. “We would like more suggestions on how to make small changes to get the production better, however suggestions regarding how the moulds should be made is not quite easy for employees to make because it requires understanding of how plastics flows through the moulds”. Continuous improvement is very vital to us because through it our employees are involved in the daily decision making process by little ideas they come up with.

Employees’ empowerment also entail that they are made responsible for the machines operated by them. On the instructions board the specific ways this should be carried out is stated, for example how a machine should look like before it is being used and how it should be look like after work is finished.

**Training**

For new employees we have introduction week or so to say where they are trained on different steps so that they can be able to manage their work. There are also special employees’ for some departments that require more training, the more specialized you are the longer times you have to do the introduction to the work. Employees’ working with highly sophisticated robots would require more training as compared with those working on simple and everyday machines. We have areas that are considered in such training for example there are discussions with employees concerning the issue of quality. Training is done two times a year but sometimes when they have new equipments operators are given additional training on how to operate it. It is not very easy to have training on every machines because they have so many products and it will be costly to train operators on every of these machines. We have a production instructor who tells the operators how to stick it on the palette and so on.

**Motivation**

It is always difficult because we have a kind of bonus system where everyone gets the same bonus where they do a good work from the managing director to the operators on the job floor. However Jonas said, “we believe money is not always the best way to motivate our employees”. According to him, employees have to like the work they are doing otherwise they will not be able to put in their best. Continuous improvement has allowed employees to come up with suggestions by getting them involved in the daily work. “We try to listen to every idea brought to the table by employees”
Communication

“Normally we have a pretty fast decision making process. Since we do not have a long chain of different management, communication between management and employees are transferred fast”. When there is critical decision that needs to be made the time it requires for management to act depends on the kind of the decision. Some decision relating to attitude takes shorter time because it is easier to make, unlike serious decision that requires longer time. There is also communication between shifts chief during meetings held daily, weekly and monthly as the case may be.

Continuous Improvement

Continuous improvement was the next step we implemented and we have follow up every four working days to gathering all the improvement suggestions and have a board to go through all the process of improvement. We give some money back to the group for any good improvement suggestions. One hundred Swedish kronor is given for every good suggestions and two hundred if the suggestions is followed up and yield results. It is like a reward system for in these cases it given to the group working on the shift and not to individual employees. Continuous improvement is seen in every aspect of Hammarplast AB production process because it forms one of the core principles of their management process. They have a continuous improvement board where all decisions regarding suggestions for improvement is displayed and reviewed.

Kanban

We have kanban on some articles here in the stock, when the sheets is going down to the last article or at least ten of them, then we take the card to the employees to order new articles. We have only few articles that have Kanban system. Normally we have a total system, ERP system and material requirement system counting out the total of how much of the articles we need.

Single Minute Exchange of Dies (SMED)

This is what we use when we have problems with the moulds. A mould is the pigments in which the plastics products are formed on, you have two halves that are pressed together when after it is filled with the melted plastics. We try to see how we can contribute to improve the whole production cell or moulds and so on. They have not come up with a meaning for it and it
has not yet fully been implemented into the production process it however has helped reduced the set up times in the machines. Presently the tool is not been used and the reason was not immediately disclosed to me but according to Jonas “We will start using it sometime around the autumn, we have tested it and it worked well so far”.

**Job rotation**

There is change every four hours because operators work on shift and change their machines and take on some other machines. The reason for doing this is because sometimes an operator works on heavy machines and on his next shift he will be on another machine. They also have a “PRAO SYSTEM” where the operators are allowed one or two days to do a PRAO day. It is about working and testing system where an operator is allowed to call in and go and see how some other operator does his work usually someone who has worked before or after you in the process you have worked.

**4.3.4 Performance Management Systems in Hammarplast Consumer AB**

**Vision and mission**

Hammarplast Consumer AB has as its vision to be a world leader in Storage concepts, with its SmartStore brand, and a market leader in the Nordic region in Home and Garden, with its Hammarplast brand. Then for its mission, Hammarplast Consumer will bring order and structure to everyday life, with concern for the environment and smart quality concepts.

**Key success factors**

The key success factors that have made Hammarplast Consumer AB to stand out in their industries are: *Reliability, Eco-friendly, Innovativeness, and Quality.*

**Organizational structure**

The structure at Hammarplast Consumer AB is more like a centralized one because they do not have many managers thus decision is made by the CEO.

**Strategies and plans**

Its strategies are developed around being a fully integrated business, controlling its entire
process chain from development to the end user with its in-house control system. With a long-term perspective they have established a lasting relationship with both customers and suppliers.

**Key performance measures**

Their key performance measures rest on quality, flexibility and deliveries. The quality issue is checked with the in-house control system while for flexibility they operate a job schedule that allows employees to be assigned different tasks and for deliveries, products are delivered to customers as at when requested.

**Target setting**

They have as target to have less than two percent scrap value for every month. This limit is based on the agreement reached by the shift and production manager.

**Performance evaluation**

There is a follow up performed every 4 days and the purpose of this follow up is to gather improvement suggestions, displayed on the board, reviewed and decisions are made.

**Reward systems**

In the case of reward system Hammarplast consumer AB has both financial and non-financial reward system in place.

**Information flows, systems and networks**

Information in Hammarplast Consumer AB is very important that is why they have a formal information system in place. They make use of the total system, EPR and material requirement planning system.

**PM system use**

Department heads make use of the Information retrieved from their continuous improvement board for decision-making. Apart from the information retrieved from the continuous improvement board, the ERP and MRP system in place are also important source of information which management rely on to make certain managerial decisions.

**PM system change**

Hammarplast Consumer AB relies so much on the principle of continuous improvement to
effect the desired change in their organization.

**Strength and coherence**

Hammarplast AB only makes use of the lean principles that fit its particular process. This way, they are better able to consistently relate with the lean principles.
Chapter 5 Analysis

In this chapter, the empirical evidence collected from three case companies will be analyzed. To begin with I will use the within case method to highlight the unique features of each case company separately. Thereafter I will employ the cross-case analysis method to highlight areas of similarities and differences observed between the cases.

The following Figure 5.1 illustrates the way the analysis will be conducted. Firstly, within case analysis is indicated with arrows pointing from each case company to the three different main areas in connection with the research questions as shown in the model below. Thereafter a cross case analysis indicated by the up-down arrow between the case companies; highlight areas of similarities and differences among the cases. The purpose of which would assist in answering both research questions.

Figure 5.1 Analysis model
5.1 Within case analysis

5.1.1 Electrolux Laundry Systems (EPS)

5.1.1.1 Types of production waste
EPS experience the seven types of waste as described by Kippenberger (1997) and Martins (2010). They have taken steps to reduce these wastes in the following ways:

- **Over-production waste** is reduced through the adoption of the pull system by producing only when needed thus they have a production capacity of 185 units per day. In accordance to one of the five lean principles “pull system” Emiliani (1998), their goal is meet customers satisfaction by producing to meet their specific demand.

- **Waiting waste** was as a result of lack of proper storage of materials and keeping of tools. It has however been taken care of through the new assembly lines built and maintaining well-balanced lines.

- **Transportation waste** has been reduced through the new lines built as they were made shorter, also tools and materials that were not properly kept is now possible thanks to 5S (Chen and Meng, 2008) they are now using that has helped in proper storage. Milk run is another method they have adopted in reducing transportation waste. EPS relies so much on the use of 5S to eliminate production waste (Liker, 2004).

- **Over-processing waste** is not of focus here because EPS adopts a policy to produce according to specification of their customers. This way they do not add features and functions not wanted by customers which is in relation to the principles of lean production (Emiliani, 1998). According to the author, identifying the value stream concerns itself with the identification of the process in the production of a product; so doing unnecessary features and functions that do not add value and amounts to waste will be eliminated.

- **Inventory waste** that plagued them due to storage of materials and tools not needed for the production process in the assembly line was reduced through pushing their inventory from the assembly line to the supermarket. Although their aim is to push it all the way to their external supplier.
Motion waste is reduced through the shorter assembly lines they built because movements that were made that amounted to non-value adding are no longer made. Tools are located close to the operators so they do not have to leave their work area unnecessarily. Reducing motion waste would sort of create flow as pointed out by Julien and Tjahjono (2009) that value should continuously flow. Eliminating unnecessary motion would certainly create a continuous flow in the production process.

Defects waste has been reduced to a large extent because working standards are put up in all workstations so employees see instructions of how work should be done. They also have Poka-yoke in place to reduce human errors. With the Poka-yoke in place they will perfect every process thereby focusing on only those activities that create value.

5.1.1.2 Lean Principles

Teamwork empowerment

Through teamwork empowerment, employees in EPS are together able to identify ways through which the production process can be improved so as to meet their customers’ expectations (Julien and Tjahjono, 2009); hence they have daily meetings where they discuss any issue that would have come up the previous day and find a way of making the situation better. Reducing production waste entails a continuous improvement process as according to Emiliani (1998), thus EPS employees through teamwork effort come up with suggestions (Ian, 1999) to improve their daily activities by reducing the process time and the cost associated with such process.

Training

Empirical evidence suggests that EPS ensures employees receive adequate training which they believe is an essential to function effectively. Henderson and Larco (2003) recommendation of cross training, EPS ensures its employees are all trained to perform all jobs in the assembly line. Job rotation is highly encouraged in EPS because they believe in employees being multi-skilled (Henderson and Larco, 2003). Teamwork empowerment is also reflected here as decision sometimes to train employees on the line is necessitated out of fact that more understanding is gained and time is saved. This is evident in their visit of another of Electrolux branch that has implemented some of the lean principles to actually have a feel of how things work.
Motivation

Employees’ working independently in EPS is a form of intrinsic motivation as asserted by Kohn (1999); having the room to come up with suggestions of how to improve their work area gives them a sense of self satisfaction which corresponds to Kohn (1999) three C’s of motivation.

Communication

Communication in EPS is experienced in different aspect. Through their visual management board displayed in their assembly line, everyone easily obtains information. Robbins (2005) stresses effective communication for work to be done efficiently; in EPS crucial suggestions for improvement from employees is passed on to top management through middle management and decision reached is feedback to employees for implementation. They also utilize verbal communication (Robbins, 2005) through daily group meetings held. Communication also forms a control mechanism as it is through it management policies are handed down to employees; in terms of motivation communication enables employees to know their responsibilities, how to go about it.

Standardized work

Standardized work in EPS allowed them to work more effectively as work before its implementation was not performed accordingly to how it should. Through the repetitive process (Henderson and Larco, 2003) employees have become familiar with their job function and thus are able to see areas where waste can be reduced in their production process. Standardizing work in EPS has reduced work variation (Martin, 2010) because employees in the assembly area notice such variation and are quickly corrected due to the charts pasted in every workstation. Reducing work variation eliminates over-production, processing and defects waste. Standardizing work spells out no one can begin the next machine before the whole line is finished, this entails everyone is always at the same pace at all times. Defects waste which is a result of errors is avoided because employees have the work standard pasted close so mistakes are quickly detected.

Visual management

Visual management in EPS according to Henderson and Larco (2003) is seen as management by sight. Through visual management, employees in EPS are able to see and understand how
everything works I the assembly line. On their visual management board that is displayed employees, supervisors, team leaders and managers alike know exactly the current situation of the production process. In Henderson and Larco (2003) opinion is that employee empowerment (Emiliani, 1998) is not possible without available information which is the foundation for continuous improvement. EPS production process is centred on continuously improving its process thus it needs information to be available for employees alike to utilize in performing their functions effectively. Through the displays on the visual management board in EPS, everyone easily obtains information they need from the board; thus production manager can easily get the information his department needs; team leader knows how well its group is performing and ways to improve it if they are not performing well can be discussed in their next group meetings.

**PDCA (Plan, Do, Check, Act)**

In EPS the SPQLE technique used to solve problems in their PDCA makes use of the continuous improvement process, thus it is deeply rooted and evident in all their process. Through everyone contributions in form of the cross-functional heads that represents employees from every department they are able to meet to solves problems using the PDCA. It is a continuous improvement process (Oakland, 1999) as highlighted problems are first of all identified, decisions are reached on how to solve these problems after which check is carried out to ensure that the decisions to correct the identified problems are in place and lastly is the implementation of the decisions reached into the current process (Bergmann et al, 2001).

**Competence matrix**

Through the competence matrix management in EPS are able to ascertain individual performance as it is displayed on the competence matrix board. With the aid of this matrix team leaders are able to select the best man for a particular task because it shows what employees in the assembly line is capable of doing and which task they perform the most. Matching the best man for a particular task would reduce cycle time because the process is completed effectively. Based on the matrix board, the employees that posse four pies can be used as training supervisors thus save cost of hiring the service of an external trainer. Further it would serve as motivation for such employees as they feel their expertise is being utilized and appreciated by management.
Layered audit

Through the layered audit, management in EPS have been able to ascertain how well the production process is functioning. Through it management ensures employees comply with the standardized work because it is done on a daily basis.

5.1.1.3 Performance management systems in EPS

For EPS to achieve its vision and mission of being the world’s leader in the provision of laundry systems for its customers, it is mandatory that the right key success factors are developed to assist in the actualization of the dream of their vision and mission. In connection they have established a culture of engaging its employees in contributing to the improvement process that forms the focus of their principles. The environment is another key factor that is considered as their operations must be such that it impact on the environment is minimized. Quality terms, EPS ensures their products exceed customers requirement at all times. In delivery performance, EPS delivers on time to its customers by optimizing the entire supply chain.

The decentralized organizational structure evident in EPS makes it possible for employees to make suggestions that lead to improvement of their production process. If employees are to be engaged they must be given room to make decisions in the continuous improvement process. In relation to Ferreira and Otley (2009) assertion that there should be a link between organizational structure and key success factors, EPS decentralized organizational structure allows a culture where everyone contributes to the continuous improvement process.

Having vision and mission defined and supported through the organizational structure that would enable these key success factors developed to be achieved; it is important to strategies and plans in place through which the key success factors developed can be achieved. Employees empowerment as a strategy matches with people engagement as a key success factor (Ferreira and Otley, 2009). EPS has developed strategies of performing regular audit on employees in the assembly line ensuring that the key success factors like safety, environment concern, quality, delivery performance are achieved at all times.

The layered audit is one of the key performance measures of EPS, because it shows how well the assembly lines are functioning. Management uses information gathered by the layered audit
for decision-making and improvement purpose. From the layered audit it becomes easy to know individual performance; based on the areas that need improvement are shown and decisions can be made. Also daily safety measurement is another key performance measure to ensure that all employees in the assembly area always observe safety.

For EPS to be able to evaluate that the measures are working targets are set. Amongst the target set is to ensure that the stop-time per day is not exceeded and that quality is achieved the first time through. Performance evaluation of these set targets is ascertained through the layered audit performed on daily basis on every aspect of the assembly line.

Based on the performance evaluation of the set targets, EPS has a reward system in place that rewards teamwork at the completion a project. This reward system is non-financial and its management way of showing appreciation.

EPS rely on information retrieved from the visual management board, to fix problems which is done in real-time; this way they are able to see how the line is functioning and thus take better and quicker decisions. Although they do not have a formalized information system in place they are still able to use their visual management board, competence matrix, layered audit, PDCA as a means of control and ensuring that the assembly line is constantly improved through suggestions from employees.

The use of information retrieved from the different sources are utilized to improve the production process and for decision purposes. At group level information retrieved from the competence matrix allows group leaders and supervisor to assign employees to specific task while at management level information retrieved from the visual management board enables management to take managerial decisions (Neely et al, 2000; Bhasin, 2008).

For changes to be made to the performance management systems of EPS, it has be designed in such a way to accommodate these changes. As continuous improvement is all about process increment on daily basis, it is important for the performance management system to be flexible.
Looking at the performance management systems of EPS in comparison with the model it is evident that it complies with the design and usage as prescribed by Ferreira and Otley (2009).

Figure 5.2 EPS PMSs  (An enlarged figure is shown in appendix 1)

5.1.2 Volvo CE Braås

5.1.2.1 Types of production waste

*Over-production waste* is evident because they produce to stock due to the high demand of their products. As this method has not been able to reduce over-production waste for them, they have however adopted another approach know as the pull system where production is the outcome of customers demand based on orders they have placed (Julien and Tjahjono, 2009; Emiliani, 1998). This system checks over production because products are not produced without being demanded for by consumers; this way inventory is reduced and work in progress
does not exceed the demand that has been placed. The reduction in inventory would indirectly affect the need for raw materials as it is equal to the quantity of the product that is demanded.

*Waiting waste* in Volvo CE is due to human errors as a result of employees forgetting to place orders when the inventory is low. As I understand other reason for stops is due to stoppages to fix problems as they occur or routine machine maintenance. In my opinion having a narrow transportation routes could also amount to delays as only one forklift driver can access the lanes at a time.

*Transportation waste* is one of their major problems because of the size of their products and parts that is used in production. To overcome this waste there is emphasis on finding possibilities of using other transport equipments that is in compliance with the fifth lean principle “perfection” (Emiliani, 1998). In other to reduce transportation waste in their production process they are looking for other means of transportation that would reduce the value adding activity; this in the view of Karlsson and Ahlstrom (1996) is very important transportation within the assembly line most at times is a non-value adding activity.

*Over-processing waste* is not evident in Volvo CE at present.

*Inventory waste* in Volvo CE is connected to the ability to be able to check the waste of over-production because production is based on matching available capacity to actual demand. That way there would not be wastage of materials that would have been used up for anticipated production. The adoption of the pull system to reduce over-production waste also helps in reducing inventory waste because it reduces inventory waste as raw materials are not demanded for anticipated demand. The principle of creating flow asserts that there should be continuous flow thus where demand is pulled through the production process; activities are not delayed unnecessary so as to meet customers on time (Julien and Tjahjono, 2009; Emiliani, 1998).

*Motion waste* is reduced by continuously improving the assembly lines through coming up with ideas to locate the machines as close as possible to each other to shorten any unnecessary motion that amounts to waste. Where machines are located as close as possible because of the size of their products and parts it becomes difficult to be involved in unnecessary movement (Hines and Rich, 1997) which causes them to be tired. Hence Volvo CE had to come up with
best possible location for their machines in their assembly lines so as to perform work efficiently in other to reduce high cycle times and cost (Kippenberger, 1997).

Defects waste is not experienced at Volvo CE at the moment.

5.1.2.2 Lean Principles in Volvo CE

Employee empowerment
Regular daily and weekly meetings held at Volvo CE correspond to Henderson and Larco (2003) recommendation of between five to ten minutes for daily and about thirty minutes weekly respectively. The purpose of these meetings is to continuously improve their production process because employees are able to collectively discuss ways of improving the process by taking responsibility. Also through 5S steps (Chen and Meng, 2008) Volvo employees are better able to organize their working environment accordingly. This has given them the sense of responsibility knowing you are in charge of your work area.

Training
Volvo CE understands that without given employees quality training it becomes difficult for employees empowerment because they need to have knowledge of their working environment. Volvo CE employees are trained in every aspect to allow room for flexibility in assignment of task. Through job rotation (Henderson and Larco, 2003) employees gain experience from different task, even office employees are also trained in VPS for one year that shows how much they believe in cross training.

Motivation
The idea of trying out new suggestions from employees first in a particular work group might have its downside. The psychological effect of a new suggestions not turning out well might hinder the work group from being used as an example. Also the group leader might make the group members over-work themselves to ensure the idea pulls through forgetting it would lead to fatigue; which could indirectly affect the outcome.

Communication
As established that communication plays an important role in managerial performance (Robbins and Coulter, 2007), Volvo ensures that the suggestions from employees are
channelled through team leaders up to top management for decision to be taken. Decision from top management in form of information is passed down to employees in form of feedback. Apart from employee/management information flow, communication is also a necessity during the daily group meeting held. Without which it becomes impossible to continuously improve the production process that requires a continued progression.

**Standardized work**
With employee empowerment evident in Volvo CE, it is vital to standardize work which allows employees to work on with little or no supervision. Through job rotation it becomes possible to assign any employee to perform a particular task and be assured it will be done in the same way if the same task is assigned to a different person based on repeated routine (Martin, 2010).

**Visual control**
Seeing visual control as management by sight (Henderson and Larco, 2003), Volvo CE schedules its meetings in the actual assembly line to have a better understanding of the problem at hand. Apart from having meetings in area where problems are experienced in the assembly line, work group also have individual group visual control board. This group board allows its members to see areas they are not performing well thereby improve in those areas. Through visual control it becomes possible to go to problems root cause in their continuous improvement process.

**Continuous improvement**
Continuous improvement in Volvo CE is to improve its process which according to Emiliani (1998) entails incremental improvement of products, process or service. This is achieved through the stopping of their assembly line for almost one hour; time that would have been used to produce one hauler. Stopping of the assembly line is done in such a way that all work groups together have improvement meetings in which they discuss how their working environment is improved in a problem solving way (Ahlstrom, 1998). This problem solving approach according to Emiliani (1998) allows problems root source to be discovered with the assistance of visual control.

**Competence matrix**
Through the competence matrix it becomes possible to determine who perform a particular job in Volvo CE. Again the importance of visual control is evident here because the board displays
the employee’s abilities in different work environment. Thus it is possible to ascertain different employee capability.

5.1.2.3 Performance Management Systems in Volvo CE

Volvo CE accomplishes its vision and mission through well established key success factors developed by them. The key success factors described in (4.3.4.2 “key success factors”) must be met for the vision and mission are to be achieved. Thus to be the world’s leader in supplier of commercial transport solutions and create value for its customers as well as shareholders, Volvo CE ensures that the quality of its products are always top. In terms of environmental care, Volvo strives that its products meets environmental standards.

The organizational structure in Volvo CE is both decentralized and centralized making decisions to be delayed sometimes because of the different levels of management that it advocates. Within different managerial levels, decisions are made as long as it within the responsibility and accountability of department head. The overall structure of Volvo CE is a part of a wider organization which has impact upon its control arrangements (Ferriera and Otley, 2009).

Volvo CE developed the Volvo Production System “VPS” with the sole aim of to improve its production process whereby customers specific needs are met based on the key success factors such as ensuring quality products, making sure deliveries are made just and as when customers need them.

Volvo CE 93 key performance measures contradict Ferreira and Otley (2009) recommendation of a maximum 25 measures claiming that the use of too many measures reduces managers impact. Target setting ensures that the haulers that are actually delivered correspond to what is produced; this way over-production and inventory waste are checked. Thus fulfilling the key performance measure in terms of quality, Volvo CE set targets allows them to know the numbers of adjustments that were made weekly and monthly. To keep this number at its barest minimum they adopted the approach of stopping to fix problems relating to quality rather than leaving it. This way they ensure quality is gotten right the first try.

The reward system in Volvo CE of rewards everyone in the work group irrespective of who came up with the improvement suggestion is in line with Ferreira and Otley (2009) proposition
of team-based incentive schemes. Another type is that of reward system in use in Volvo CE is that of non-financial where groups are sponsored to seminars.

Information flows, systems and networks in Volvo CE rely on information’s derived from their visual control board and continuous improvement. Through the meetings held there is feedback and forward of information and decisions are made based on it. However as stated, Ferreira and Otley (2009) stresses the importance of a formalized information system which is lacking in Volvo CE at the moment. Information retrieved from the performance management system in Volvo CE is actually used for what is was intended for that is to control the production process and make more efficient by continuous improving its process. Looking at the performance management systems in Volvo CE, changes can easily be made to the different lean principles they make use of.

Although information is still made available through other means Volvo CE lacks a formalized information system. From my examination of the performance management systems of Volvo CE in comparison with the performance management systems model it is obvious that all the different stages are tightly connected as suggested by Ferreira and Otley (2009).
5.1.3 Hammarplast Consumer AB

5.1.3.1 Types of production waste

Over-production waste in Hammarplast Consumer AB is handled in two ways. Firstly they adopt the make to stock production strategy which rely heavily on past demand forecast, secondly they also employ the strategy of make to order whose strength relies on the amount of quantity ordered and the minimum order quantities.

Transportation waste is tackled as Hammarplast Consumer AB finds out the best possible location for its heavy automated equipment, as these machines cannot be moved randomly. These machines also need to be located such that the time and distance materials would be
transported is reduced. In fact being a process industry most of this transportation waste is already reduced as they do not have assembly lines.

**Over-processing waste** is one of the production waste Hammarplast Consumer AB faces and has tackled it through development of products and regular maintenance on their machines. In product development they ensure that modifications done to already existing products are done in such away that customers would get additional value from it; while for machines maintenance they ensure that their machines are regularly maintained. Maintenance would require the machines performing as it should so that quality, throughput and efficiency is achieved. With the kind of products they produce that requires high temperature, pressure and density, flow rate, moisture level etc machines need to be in perfect working condition to perform well.

**Inventory waste** in Hammerplast AB is handled through forecast, facing in and out of products as good as possible, and tracking inventory. Keeping of accurate record of past inventory makes forecast to be made easily and close to accuracy not to amount to waste.

**Defects waste** is another very important waste in Hammarplast Consumer AB as this waste is as a result of errors. Hammarplast Consumer AB handles this waste through product instructions, maintenance, measuring scrap value per shift, production value (per shift), OEE (per week), Scrap value per mould and machine (per month), and follow up meetings. Where there are detailed instructions on how the machines should be programmed are followed by operators less errors made, thus Hammarplast Consumer AB ensures that instructions materials are made available to their employees and that they receive adequate training to effectively function. As have been said before, maintenance is important if the machines must perform optimally otherwise suboptimal performance would result to low quality and efficiency.

**5.1.3.2 Lean Principles in Hammarplast AB**

**Employee empowerment**

Hammarplast AB employees empowerment is limited to some extent in the following ways; firstly in as much as employees are given room to come up with suggestions, it is someone responsibility to make sure that the suggestions can be implemented. Secondly, the fact they do not have assembly lines and that they are more process based working with automated
machines although there are instructions board that indicates the machines must be operated in specified way “standardization” (Henderson and Larco, 2003). Thirdly, with little knowledge of moulds it becomes difficult for employees to make suggestions and there is no empowerment if they do not have some form of control in their work environment.

**Training**
Hammarplast AB ensures employees are adequately trained to operate the machines they work with. In the area of motivation, the inability to have control over their work environment reduces their self-esteem because they are working with automated machines therefore the possibility of coming up with improvement ideas is close to nothing as these machines are programmed to work in a specific way. Cross training of employees as suggested by Henderson and Larco (2003) to operate all machines is not feasible because of their many differentiated products and the cost involved.

**Motivation**
It is obvious that employees do not have room to make suggestions because of their type of production process and the fact that it is someone’s responsibility to check workability of such suggestions, having their improvement suggestions screened out would not doubt frustrate their efforts. This would definitely lead to employees not deriving satisfaction in their job and when they are not satisfied it becomes difficult to put in their best. Listening to their ideas is not enough but it becomes fruitful when these ideas are implemented.

**Communication**
Having a fast decision making process is an indication that communication is effective. This is so because they do not have a decentralized type of organizational structure that sometimes prolongs the decision making process. With a formal information system in place it becomes possible for anyone to retrieve the required information from the system. Their ERP and MRP system available aids the flow of information which a form of Communication (Robbins, 2005). If there is no communication, the meetings held between shift chiefs “lateral communication” and management “downstream” (Robbins, 2005) would be impossible because it plays an essentials role in decision-making that is a effective tool for managerial performance.

**Continuous improvement**
Continuous improvement was the second lean principle that was implemented in Hammarplast AB. For them the continuous improvement in place is to gather all improvement suggestions and have a board evaluate these suggestions and reward any found to be good. Although the board reviewing these suggestions complies to Farris et al, (2009) view of having a cross functional team in these board on one hand, it however does not fulfil the requirement of accomplishing defined objectives in an accelerated timeframe. Rewarding employees improvement suggestions financially reflects management appreciation of employees contribution and employees are motivated to put in their best knowing that their little contribution does not go unrecognized.

**Kanban**

Through their Kanban system in place although not fully implemented makes it possible to place orders for new stock based on the barest minimum without running out of supplies; is a pull system according to Kumar and Panneerselvam (2006). Having this type of system would reduce the waste of inventory if properly utilized because then inventory will only be ordered for when their stock is low.

**Single Minute Exchange of Dies (S.M.E.D)**

Hammarplast AB uses the S.M.E.D to solve problems with regards to their moulds. With many differentiated products in Hammarplast AB it is important to be able to change production process in shorter time thereby reducing setup time. Although they had a test run, they attest it assisted in the reduction of machines set up times. Thus they really speed up its implementation in their production process.

**Job rotation**

The PRAO system in Hammarplast AB is a form of motivation for employees as it makes them develop interest in their job. Apart from been motivation for employees it also enables them to be cross trained gives them an opportunity to have control of their work environment (Henderson and Larco, 2003), although requires less control over the machines being a process based industry.
5.1.3.3 Performance Management Systems in Hammarplast AB

Going through the twelve stages in the Ferreira and Otley (2009) performance management systems in comparison with Hammarplast AB performance management the following can be concluded.

For Hammarplast AB to accomplish its vision and mission to be the world’s leader in storage concepts and bring order to everyday life with a consideration of the environment it is important that some key success factors as described in (4.3.4.2 “key success factors”) must be met to actualize this. Thus to achieve its vision and mission Hamarplast AB must strive to be a reliable supplier with high demands on their service level, flexibility and deliveries, working determinately to reduce their impact on the environment by complying to environmental performance standards as stated in their ISO 14001 certification. In terms of quality they ensure they deliver products that comply with regulatory requirements as well as customer’s requirements and expectations.

In terms of organizational structure, as was pointed Hammarplast AB organizational structure is such that would allow decisions to be quickly made since it is more of a centralized structure. Ferriera and Otley (2009) argued that organizational structure is linked to key success factors and strategic decisions which was previously seen different by Donaldson (1987) cited in Ferriera and Otley (2009) that structure precedes strategy to the extent that limits managers authority and scope to develop strategies.

Looking at Hammrplast AB strategies and plans it is in line with its key success factors “reliability, eco-friendliness, innovativeness and quality” as suggested in Ferreira and Otley (2009) that it is important for organization to build up the strengths that equates its key success factors. Thus for Hammarplast AB to be reliable, eco-friendly, innovative and produce quality products it has developed strategies of controlling its entire process chain through its in-house control system they have in place; that way its strengths is matched with its key success factors.

Hammarplast AB performance evaluation is geared towards ensuring that the target set are such that it is achievable based on the key performance measures. Hammarplast AB evaluates its performance based on quality by making sure that its scrap value for every month does not exceed two percent through their in-house control system. The result of performance evaluation attracts both positive and negative rewards as suggested by Simons (1995) in Ferreira and Otley
(2009). In Hammarplast AB it is observed that they have both financial and non-financial rewards in place. Rewarding groups financially according to Ferreira and Otley (2009) is two-faced; some studies are in support of it while others oppose it. That there is a positive relationship between reward and motivation is evident in Hammarplast AB as employees see their little contribution in the big picture of the organization.

Information flows, systems and networks in Hammarplast AB is well structured in my opinion. With the presence of an ERP system the flow of information becomes well coordinated; as stated in Ferreira and Otley (2009) that information flows, systems and network forms the connecting rod that hold together the whole system. Other forms of information utilized in Hammarplast AB is the continuous improvement principle through which employees suggestions are reviewed and selected suggestions are implemented. As pointed out by Neely et al, (2000); Bhasin (2008) the information retrieved from their systems enables Hammarplast AB to manage the performance of its production process to reduce production waste thereby improving the process. To be able to adjust to changes in its organization, Hammarplast AB performance management system is designed in a way that accommodates changes made.

Thus looking at Hammarplast AB performance management system through the lens of the performance management system model there is a red line that runs through all the twelve stages. That is to say there is a connection between all the stages as proposed by Ferreira and Otley (2009); Bititci et al (1997) and in line with De Toni and Tonchia (1996); Cheng (2006, p 765); claim that all activities must be linked together.
5.2 Cross-case analysis

5.2.1 Types of production wastes

Both EPS and Volvo are assembly oriented industries whereas Hammarplast AB is more a process oriented one; more so they have different products which have to a large extent determined the approach of how the production wastes has been handled.

Over-production waste in EPS is reduced as employees cannot begin a fresh production process unless the previous one is finished. Through the adoption of one of the five lean
principles “specifying value” (Emiliani, 1998) they have been able to reduce this waste by producing to meet customers specification. Another way they have reduced this waste is by setting a limit for quantity produced per day and it is set at 185. Although this upper quota is lifted when demand from customers’ increases. Instead of this kind of restriction where no one is allowed to begin a fresh production process without first completing an ongoing one, Volvo CE adopts the pull system (Julien and Tjahjono, 2009; Emiliani, 1998) where demand is pulled through the assembly line. With the use of Kanban system they able to monitor what is produced.

Then for Hammarplast AB, over-production is dealt with through a combination of both “make to stock” and make to order”. The fact that EPS increase their production quota of 185 units per day if demand changes might lead to over-production waste in the long run because of fluctuations in demand on the part of customers. Switching to the pull system basically allows room for increase/decrease in changes in demand. For Hammarplast AB implementing the pull system would reduce the cost associated with making to stock and rely more on make to orders. Their make to stock is based on forecast which in my opinion might not be accurate. Production based on previous demand could result to over-production waste but adopting the pull system will to a large extent reduce and possibly eliminate over-production waste for both companies.

**Waiting waste** in EPS was a major problem for them as materials and tools were not properly stored. They have however been able to reduce this waste through the new lines they have in place which are shorter thus reducing the waiting time for transportation of materials to the assembly lines. The implementation of 5S also played a significant role here because proper keeping of tools and materials reduced time (Sekine, 1998) that would have otherwise been spent looking for the right tools or materials to work that was the case in the old lines. Waiting waste was also reduced as a result of well-balanced lines because at a glance the whole assembly line can be seen and reason for delays are noted and corrected.

In contrast, waiting waste in Volvo CE is due to operators forgetting to place orders is reduced by ensuring that orders for materials are place immediately. However is not seen as waste per se because it occurs due to maintenance of machines or stopping to fix problems when they occur. Rather waiting is seen as value adding activity for them. Since the wait as a result of employees forgetting to place orders does not occur frequently, it is not considered a serious issue at Volvo CE.
In Volvo CE it takes about 85 minutes for the big line and 123 minutes for the small line to assemble one hauler. In comparison, EPS assembles 185 units per day, which goes to show there is a staggering difference between their capacities. Although it should be pointed out here that they different products. For the case of Hammarplast AB, they do not have assembly lines plus they make use of automated machines and computerized robots.

Transportation waste in EPS is tackled first and foremost through shorter assembly lines built. Another way transportation waste has been handled is the milk run method EPS adopted for replenishing inventory, this way they do not have to transport materials back and forth whenever needed as such unnecessary movement adds no value to the product (Karlsson anf Ahlström, 1996).

In the case of Volvo CE transportation waste is a big obstacle because they are involved in the production of heavy machines with large parts and as such distance becomes a very challenging problem for them. In dealing with waste of transportation they are finding out the possibilities of using other transport equipments other than folklifts. This they think would reduce or if possible eliminate this waste. With their external storage facility located in Vaxjo, they incur costly transportation whenever materials are transferred from the storage location to the production plant where it is needed. One-way of reducing this waste would be to adopt the milk run system of replenishing of materials as done by EPS. This will reduce the cost in transportation but this will only be feasible if Volvo CE could find a storage company in Braås. For Hammarplast AB, they try out different location for their machines to find the best possible location that would amount to less transportation. As they are process based there is a significant substitution of mechanical, electrical, or computerized action for human effort and intelligence. Thus it requires a systematic location of these robotic machines in the production process to reduce the unnecessary transportation that amounts to waste.

Both EPS and Volvo CE makes use of 5S in the assembly line which has eliminated waste (Chen and Meng, 2008) and saved them a lot of time that would have been used up which amounts to transportation waste. In the case of EPS, 5S has reduced transportation waste because now the necessary tools needed by employees to do their work are always kept in the right place. This is not the case for Hammarplast AB as they do not have assembly lines.

Over-processing waste in EPS is not evident as such because unnecessary features and functions are not included in their product as customers to a large extent determines what is
produced according to the lean principle “specifying value” (Emiliani, 1998).

Hammarplast AB on one hand has reduced the waste of over-processing through product development and maintenance of machines. Where a pre-existing product is re-designed or coming up with an entirely new product reduces the possibility of over-processing because unnecessary add-on to an existing product that does not result to additional value for the customer is avoided. It should however be noted that over-processing waste is not a big issue in Hammarplast AB because their process is automated and computerized.

**Inventory waste** is another waste evident in EPS and they dealt with it first and foremost with the new assembly lines they built; as inventory stored on the old assembly lines led to inaccurate stock leading to inventory waste but with the new lines has helped to reduce this waste. In the case of Volvo CE, they have reduced this waste by making use of the pull system. Specifically they are using Kanban system (Kumar and Panneerselvam, 2006) to ensure that there is just enough material on hand to make what is needed. Secondly, EPS has pushed their inventory waste all the way to their internal supplier, with the external supplier being the final stop. Hammarplast AB handled it differently by relying heavily on forecast in dealing with the waste of inventory. Keeping of accurate records with regards to raw material, work-in-progress, and finished goods inventories goes a long way in reducing this waste.

The use of the milk run technique by EPS has also helped in reducing the inventory waste as materials are now delivered just as when needed instead of being stored in the assembly area.

Taking into account that Hammarplast AB does not have assembly lines and that they deal with a high degree of differentiated products; and most importantly use automated machines any of these techniques used either by EPS or Volvo CE is not applicable.

**Motion waste** in EPS is handled through the shorter lines that they built locating machines at fixed position which was the opposite in their old lines as machines were moved from one point to another; instead of building shorter line, Volvo CE resolved to locate their machines by finding the possible best location for machines due to the large nature of their product and the parts used. In terms of product size, EPS and Volvo CE products are significantly different thus the same approach might not work. EPS has a 2cm by 2cm work area where tools and materials needed by the operators to complete their task are delivered as close as possible to them to work with. But for Volvo CE this cannot be achieved because of the distance problem as a result of their large product and parts.
The use of 5S is evident in both EPS and Volvo CE. For EPS locating of tools as close as possible reduces unnecessary movement which sometimes results to wasteful activities (Hines and Rich, 1997); while for Volvo CE, they try to locate their machines as close as possible by understanding the different process involved in performing the task (Martin, 2010) and find ways of eliminating process that do not add value (Emiliani, 1998).

Hammarplast AB does not experience this type of waste. They are more into process based and thus use automated machines in their production process and do not have assembly lines.

**Defects waste** in EPS is reduced by the standardized work pasted in every work area so errors made are easily detected and corrected, whereas for Hammarplast AB they have instead of standardized work what is known as product instruction guide that serves as guide for operators working in the production process to follow. Although it means different names but its purpose in both case is the same.

Other steps taking to reduce defects waste by EPS is the audit carried out in the assembly lines several times a week ensures everyone understands the process and follows the standardized work. The touch pan built into the task system allows workers to see what they are doing; thereby reducing the waste as a result of defects. Poka-yoke in place reduces defects by eliminating, preventing, correcting, or drawing attention to human error as it occurred. For Hammarplast AB they cannot have this Poka-yoke in place as they are more process based and as such human errors likelihood is low. As most of their processes are performed by robots and computerized machines it is not feasible to adopt these steps that EPS has adopted to assist in reducing and possibly eliminating the waste of defects.

The defects waste is not evident in Volvo CE, so focus is not on it at the moment. Hammarplast AB carries out regular maintenance on their machines that reduces the rate of mal-function leading to waste of defects.

Figure 5.5 shows the summary of cross-case analysis of the different types of waste experienced and how they have reduced or eliminated it.
### 5.2.2 Lean Principles

**Teamwork empowerment**

Teamwork in EPS is considered very important as employees must all work together if they must find out ways to continuously improve their processes. Thus teamwork empowerment gives room to employees to come up with ideas that would bring about changes in the production process and daily working environment. They have five minutes meetings held on daily basis, during meetings questions about the previous day’s work is put on the table and team effort is pulled together in finding a lasting solutions to such problems. In Volvo CE teamwork empowerment is known as employee’s empowerment. Although the name is slightly different between these companies, it has the same meaning. For Volvo CE employees are also

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<th>Types of production wastes</th>
<th>Case Companies</th>
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<td>EPS</td>
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<tr>
<td></td>
<td>Ways they have reduced/eliminate it</td>
</tr>
<tr>
<td>Over production</td>
<td>✓ Pull system</td>
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<tr>
<td></td>
<td>✓ Limit for qty produced/day</td>
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<tr>
<td>Waiting</td>
<td>✓ Shorter lead time</td>
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<tr>
<td></td>
<td>✓ 5S</td>
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<tr>
<td>Transportation</td>
<td>✓ Shorter lines</td>
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<tr>
<td></td>
<td>✓ Milk run</td>
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<tr>
<td>Over-processing</td>
<td>✓ Produce according to customer order</td>
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<tr>
<td>Inventory</td>
<td>✓ Shorter lines</td>
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<td>Motion</td>
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<tr>
<td>Defects</td>
<td>✓ Regular audit</td>
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<td></td>
<td>✓ Poka yoke</td>
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Figure 5.5 Types of production wastes and ways it has been reduced or eliminated
allowed to come up with ideas that are discussed at meetings held at team level. Apart from the daily, weekly meetings held, twice a year each manager gathers his immediate work force and talk with them for one day about their strategy and strength of their competitors and together they come up with ideas on how to mobilize their work group energy and efforts in order to keep up with their competitors. For Hammarplast AB it is also known as employees’ empowerment. In their own case suggestions from employees are welcomed but someone is responsible to review whether it is feasible or not which is not in the case in the other two companies is. One difference that should be noted here is that where EPS and Volvo CE allows employees to suggest ways the production process could be improved; Hammarplast AB being a process based industry is restricted to a large extent as they mainly use automated machines. Area ideas are made in EPS and Volvo CE ranges from tools arrangement “where 5S plays a very important role” to ways production process could be improved. But in the case of Hammarplast AB this is not possible because they do not have assembly lines. Instead they have machines that are programmed to work in a specific process of which altering them could lead to changing the whole process which might be costly. Employees’ empowerment in terms of coming up with ideas in Hammarplast AB is not as high as compared with EPS and Volvo CE; because it requires understanding about how plastics flow through the moulds.

**Training**

All three companies consider training as a vital aspect of their lean principles because in order for a company’s employee to function effectively; they should be properly trained and should be done regularly. There was no mention about a special training for newly employed in EPS, however their employees’ are sometimes trained on every task in the assembly line so on as it reduces time and has more effect because employees actually have better understanding of the production process and the assembly line. For Volvo CE this is done differently, in their case all new employees undergo a two days of Volvo Production training. In this two days training, a complete understanding of the VPS is carried out. In relation to Volvo CE, new employees in Hammarplast AB have introduction for a whole week. In the week long introduction they are trained on how to operate the different machines.

Both EPS and Volvo CE ensure every employee working in the assembly area is trained in every possible task so that there is room for flexibility in terms of job rotation. Where they are trained on every workstation it becomes easy to assign who should work on which task and
ease with which substitutes can be made whenever there is emergency such as illness. Volvo
CE goes a step further to train five employees from its work force on VPS for one year after
which they changed with another five.
For both Volvo CE and Hammarplast AB, more training is required for some employees in
some department and positions. In the case of Volvo CE, those newly employed that would
work as group leaders requires more training while for Hammarplast AB more training is
required for those that would be working with highly sophisticated robots. Hammarplast AB
being a process-based company, production is mainly with automated machines; this is in
contrast with EPS and Volvo CE which have assembly lines.
Also since Hammarplast AB have highly differentiated products, a high cost is associated with
training employees to operate all the machines, thus they perform training just twice a year
although in exceptional cases when they acquire new machines employees are trained on how
to operate the new ones.

Motivation
Motivation for all three case companies is handled differently; on one hand EPS they do not
believe in financial reward for motivating employees but reply more on non-financial reward
system for motivating its employees. On the other hand Volvo CE believes in financial reward
for motivating employees although not much in use. Rather than reward only the employee that
came up with the suggestions, the whole group is rewarded on some percent of the savings his
idea has brought the company. Almost similar to Volvo CE reward system, Hammarplast AB
rewards all group members from whom the suggestion was generated by giving them 100 SEK
for any good improvement suggestions and 200 SEK if the suggestions are followed up and
yield results. It is important to mention here that everyone gets the same bonus from the
managing director to the operators on the job floor for a good work.
Common amongst all three case companies is that they all see the need to allow employee some
room to come up with ideas as continuous improvement is all about finding out ways for
constant improvement (Henderson and Larco, 2003). For EPS, apart from giving employees
room to come up with ideas to enable them function effectively they are allowed to work
independently although in strict compliance with the standardized work in place. For Volvo CE
new idea is first tried out in an interested work group and if it is successful; it is then
implemented in the rest of the assembly line making the work group that was used as “escape
goat” the ambassadors for the new concept/idea. The negative side of this looking at it from
another perspective is that no group would want to be used as an example to try out a new idea. This is however slightly different in Hammarplast AB because they do not have assembly lines to begin with so employees cannot come up with suggestions for improvement; plus they are process oriented and use robots and computerized machines in their production process. Nevertheless there are other areas employees’ ideas/suggestions are welcomed and are encouraged by getting them involved in the daily activities. This way there is the feeling of belonging as employee little contribution in terms of suggestions is well taking by management.

**Communication**

All three case companies see communication as a very vital principle. For all of them communication function cannot be over-emphasized because it aids in the flow of information which employees need to be on the same pace with management. For EPS and Volvo CE, the use of visual management is believed to make information available to everyone that needs it. Feedback from suggestions from employees and other performance management systems would not be transferred if no proper communication process were in place. Communication is possible through the visual management board whose function is an information centre through which all employees are informed. Communication is facilitated between management, supervisors, group leaders, and employees alike. For Hammarplast AB communication is handled differently. With their EPR system in place, information dissemination is more formal as compared to EPS and Volvo CE that do not have any formal information system in place. The decision making process is pretty fast in the case of Hammarplast AB because they do not have a long chain of different management. The C.E.O has the sole responsibility of making very important managerial decision unlike the other companies this is not the case. EPS and Volvo CE have a more complex organizational structure thus requires a longer decision making process as different heads meet to make such important managerial decision. This plays down to the long chain information has to flow through before it gets to the employees on the assembly line for implementation.

**Standardized work**

For standardized work not all tree case companies make use of it. Hammarplast AB does not use this lean principle because they do not have assembly line where people assembles product rather use robots and computerized machines and that they are process based. The other two are
similar in this aspect because they both make use of it. For EPS it is one of their main lean principles that have helped them organize work around the assembly line that was not the case before its implementation. While for Volvo CE it is done in quite a different way, they try to also incorporate white-collar employees into following a standardized way of doing work. Standardizing work has enabled them to reduce over-processing and defects waste; this is so because their employees have gotten used to a particular routine (Henderson and Larco, 2003) in performing their job thus their attention is quickly drawn to any variation in the process according to Martin (2010). The ability to perform a task regularly makes employees understand their job and thus come up with the best possible ways that same task can be done in lesser time. This gives empowerment employees to work independently but must do so according to the standardized work in place.

Standardization of work as a lean principle enables management to monitor processes in the assembly line; this is to ensure that work is done properly and accordingly.

Visual management

Both EPS and Volvo CE make use of visual management. For Volvo CE it is known as visual control. There cannot be standardized work without applying the visual management concept as it is all about management by sight; that is seeing everything as it is done to be able to ascertain its performance, problems and opportunities for improvement according to Henderson and Larco (2003). So if employees must follow a standardized way of performing their task it has to be such that everyone can see, understand what needs to be done and how it should be done. For EPS visual management is very important as they have a philosophy of everyone being on the same pace and employee’s empowerment. This can only be achieved where there are laid down instructions as regards what, how and who should do what. While for Volvo CE it is almost the same way, the only difference is that although they have a general board, each work group also has their group board where different measurements and tasks are displayed. So apart from workers knowing what is happening in other groups, they also see how they are performing based on what is displayed on their individual group board.

The visual management board is a source of information flow between work groups in the assembly line for both EPS and Volvo CE. In the case of EPS having the information displayed on the board gives cross-functional team insight into how to tackle arising problems and come up with ways of solving them so as to improving the production process. While for Volvo CE meetings held everyday is to discuss the previous day’s production performance and prognosis.
of today’s production. Information gathered from the visual management board is used for this purpose, because everyone has access to the board they actually prepare before the meetings and they have more like a brainstorming sessions during meetings. These meetings are held in the actual assembly area so as to have a feel of the situation. Availability of information empowers employees; there cannot be empowerment if there is no available information derived from visual management technique (Henderson and Larco, 2003).

Hammarplast Consumer AB does not make use of this lean principle simply because it does not relate to their style of production. Being a process based industry visual management is of little significance to them hence they do not make use of it.

**Continuous improvement**

Continuous improvement seems to be important to all three companies in different ways. To begin with, EPS applies continuous improvement in every aspect in their production process. Employees constantly find out ways to improve their processes by coming up with suggestions to re-arrange tools in their individual work area; meetings held by team leaders, production leaders, and managers is aimed at improving their working condition achieved through decisions they come up with based on feedback from assembly line workers. Continuous improvement in Volvo CE is used differently; they have improvement meetings ones every week allowing the various work groups to discuss ways on how to improve their working environment, standardized work, quality etc. For Hammarplast Consumer AB there are meetings every four days to gather all improvement suggestions. Unlike Volvo CE where the different work groups meet to discuss ways of improving their processes, Hammarplast Consumer AB delegates a board that goes through the process of improvement. There is some sort of financial reward attached to suggestions that are made. Continuous improvement is one the main lean principles used in Hammarplast; this goes to show why improvement suggestions are taking seriously as it forms the corner stone on which continuous improvement is built (Henderson and Larco, 2003). In their case, there is a continuous improvement board just as the visual management board that displays improvement suggestions that have been reviewed by the board.

From the communication angle, information in form of improvement suggestions are transferred to management and feedback from management is sent through middle management to employees on the work floor for implementation. The information flow process in all three companies is a value adding activity because information received if acted upon leads to
improvement. All three companies rely on the flow of information for improvement decisions to be made.

Rotating work is a form of motivation and it leads to improvement because when employees find their work interesting, then they want to find out the best possible ways things could be done either to reduce time and/or the process involved and improve the products through their suggestions. In the case of job rotation, all three companies strongly believe in rotating employee’s task.

**PDCA**

This lean principle is only used by EPS and they use it along side with continuous improvement. With their takt system in place that stores problems encountered during the production process, once a particular problem occurs more than ones it is transferred to their PDCA. In the PDCA cross-functional heads meet to tackle problems encountered in the production process. This forms a continuous improvement process as they fix problems and feedback to supervisors and team leaders. It is a way of continuously improving the production process by constantly fine-tuning process that are not in line that way they can see how the line is doing and take better and quicker decisions. Volvo CE on the other hand does not use this lean principle in solving problems. They adopt an approach of stopping to fix problems when it occurs. It is important to note here that both EPS and Volvo makes sure they get it right the first time through which in actual sense reduce the waste of defects.

Hammarplast Consumer AB just like Volvo CE does not make use of PDCA because it is not important to them. They on the other hand make use of the SMED (single minute exchange of dies) know in their own terms as FMEA which they use to solve problems with the moulds (*pigment on which plastics products are formed on*). For them set up time has been reduced through this process.

**Competence Matrix**

Both EPS and Volvo CE make use of competence matrix as one of their lean principles. Although their goal is the same to know employees capability at any point in time they however go about it in different ways. For EPS their competence matrix comprise of four pies representing different capabilities and competencies.

This is approached in a different way in Volvo CE. Instead of dividing theirs in pies with each representing employee’s capability and competence, they rather combine competence matrix
with job rotation plan where workers in the assembly line are made to fill out a blank competence matrix card that shows the step-by-step progress they have made learning different task at different work area. Based on this decision as to who fits a particular task can be ascertained. At the end of the day it is obvious that despite the fact they have adopted the same lean principle; they have however applied different approach achieving the same result which is to get the best man for a particular task.

Hammarplast AB does not use this lean principle.

The figure 5.6 below summarizes the different lean principles used by all case companies.

<table>
<thead>
<tr>
<th>Lean Principles</th>
<th>Case Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EPS</td>
</tr>
<tr>
<td>Teamwork empowerment</td>
<td>✓</td>
</tr>
<tr>
<td>Training</td>
<td>✓</td>
</tr>
<tr>
<td>Motivation</td>
<td>✓</td>
</tr>
<tr>
<td>Communication</td>
<td>✓</td>
</tr>
<tr>
<td>Visual management</td>
<td>✓</td>
</tr>
<tr>
<td>Continuous improvement</td>
<td>✓</td>
</tr>
<tr>
<td>PDCA</td>
<td>✓</td>
</tr>
<tr>
<td>Competence matrix</td>
<td>✓</td>
</tr>
<tr>
<td>Layered audit</td>
<td>✓</td>
</tr>
<tr>
<td>Kanban</td>
<td>*</td>
</tr>
<tr>
<td>SMED</td>
<td>*</td>
</tr>
<tr>
<td>Job rotation</td>
<td>✓</td>
</tr>
</tbody>
</table>

✓ Indicates Yes  * Indicates No

Figure 5.6 Lean Principles used at case companies
5.2.3 Performance Management Systems

5.2.3.1 How are they currently managing performance in their lean production process?
The case companies as discussed in each of the different case and the cross case has been summoned up in the figure 5.7 below. It shows the similarities and differences allowing the essence of a cross case analysis “pattern searching”. The first part of the second research questions is presented in the table below showing the performance management systems on the left and the current situation in the different case companies on the right.
<table>
<thead>
<tr>
<th>Case Companies</th>
<th>EPS</th>
<th>Volvo CE</th>
<th>Hammarplast AB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vision and Mission</strong></td>
<td>To be world leader providing best total solutions for their laundry needs.</td>
<td>To be the world’s leader in supplier of commercial transport solutions.</td>
<td>To be the world’s leader in storage concepts.</td>
</tr>
<tr>
<td><strong>Key Success factors</strong></td>
<td>People engagement, Safety, Environment, Quality, Efficiency, Delivery performance</td>
<td>Quality, Safety, Environmental care, profitable growth with energy, passion and respect for the individual.</td>
<td>Reliability, Eco-friendly, Innovativeness, Quality</td>
</tr>
<tr>
<td><strong>Organizational structure</strong></td>
<td>Decentralized Structure</td>
<td>Centralized and decentralized structure</td>
<td>Centralized structure</td>
</tr>
<tr>
<td><strong>Strategies and plans</strong></td>
<td>Product meets customers satisfaction always, carries out audit</td>
<td>Volvo production system</td>
<td>Being a fully integrated business, controlling its entire process chain, in-house control system</td>
</tr>
<tr>
<td><strong>Key performance measures</strong></td>
<td>Regular audit in all production process</td>
<td>93 key performance indicators</td>
<td>Quality, flexibility and deliveries</td>
</tr>
<tr>
<td><strong>Target setting</strong></td>
<td>Ensure stop time of 26 minutes is met</td>
<td>Those actual deliveries are matched with production schedules. Quality targets ensure to reduce numbers of adjustments made weekly and monthly</td>
<td>Target is to have less than two percent scrap value for every month</td>
</tr>
<tr>
<td><strong>Performance evaluation</strong></td>
<td>Daily layered audit</td>
<td>The competence matrix, visual control for each work group</td>
<td>Based on quality-scrap level</td>
</tr>
<tr>
<td><strong>Reward systems</strong></td>
<td>Reward teamwork at the end of a project through seminars and training</td>
<td>Financial reward system in place</td>
<td>Both financial and non financial reward system in place</td>
</tr>
<tr>
<td><strong>Information flows, systems and networks</strong></td>
<td>Visual management, competence matrix, layered audit, meetings</td>
<td>Visual control board, continuous improvement, meetings</td>
<td>ERP, MRP, continuous improvement meetings</td>
</tr>
<tr>
<td><strong>PMSs use</strong></td>
<td>Control, improvement purpose and decision making</td>
<td>Control, improvement purpose and decision making</td>
<td>Control, improvement purpose and decision making</td>
</tr>
<tr>
<td><strong>PMSs change</strong></td>
<td>Flexible</td>
<td>Flexible</td>
<td>Flexible</td>
</tr>
<tr>
<td><strong>Strength and coherence</strong></td>
<td>Connection between all stages</td>
<td>Connection between all stages</td>
<td>Connection between all stages</td>
</tr>
</tbody>
</table>

Figure 5.7 Case similarities and differences of Performance management systems
5.2.3.2 How are they currently managing performance in their lean production process?

**Vision and mission**

All three cases have as their vision and mission to be world leader in the various sectors. As suggested by Ferreira and Otley (2009) that performance begins with purposes and objectives. Performance cannot be managed if the organizations do not have their purpose and objectives clearly stated. Thus all case companies have a clearly stated purpose and objectives in their vision and mission. All three companies experience production waste and to achieve their different vision and mission, they have adopted similar lean principles in some cases and different in other cases to deal these waste. Having a clearly stated vision and mission enables these case companies to decide what should and shouldn’t be changed and thus lead to effectively managing its performance.

**Key success factors (KSF)**

For all case companies there are different activities, competences and capabilities that make them stand out in their various focus area and these act as essential ingredients for them to achieve their various vision and mission (Ferreira and Otley, 2009). Thus for EPS to be world leader in providing total solutions for its customers laundry needs, they have adopted KSF of engaging its employees, takes quality and environmental issue seriously, efficiency and delivery performance ensures that production meets customers specification “specifying value” (Julien and Tjahjono, 2009). For Volvo CE to achieve their vision and mission of world’s leader in supplier of commercial transport solutions, they have as their KSF quality, safety, care for the environment etc in place. And lastly for Hammarplast AB, their vision and mission is to be world’s leader in storage concepts and to achieve this they have as their KSF to be reliable in its supplies and flexibility; produce environmental friendly products; etc.

Peculiar amongst all the case companies KSF are those of quality and environmental care; meaning the success of these organizations to some extent rest on the issue of quality and care for the environment. That is producing quality product is a prerequisite and the effect these products have on the environment is taking also as important as the quality.

**Organizational structure**

There are differences in the style of organizational structure each of these companies adapts. Where EPS adapts a decentralized kind of structure, Volvo CE has a mix of both structure and Hammarplast AB adapts a centralized structure.
Strategies and plans

Based on the key success factors and organizational structure, the strategies and plans adopted by the case companies vary according to Ferriera and Otley (2009). Looking at the strategies of the different case companies it is obvious that they have adopted different strategies to support in achieving their vision and mission statement. Thus, for there to be a match between the organization strengths and its KSF as suggested by research (Ferriera and Otley, 2009) leads to higher performance. In the case of EPS they produce to meets customers specification thereby satisfying their needs; for Volvo CE, they developed Volvo production systems just as “TPS” to enable them measure and improve the production process and satisfy its customer through quality products and on time delivery. For Hammarplast AB, they have developed a fully integrated business so as to control its entire chain through their in-house system. This way the issue of reliability, quality and producing products that are eco-friendly that would propel them to be world’s leader of storage solution is achieved.

Having clearly stated vision and mission and KSF alone is not sufficient as research has shown (Ferriera and Otley, 2009) but requires the necessary action that would assist in achieving these goals. Thus strategies and plans play an important role as we can see in the different case companies; that without these in place it becomes difficult for management to achieve its goals.

Key performance measures (KPI)

There is also difference in their key performance measures used in the different case companies. Looking at EPS, its KPIs are derived from its KSF and strategies as suggested by research (Ferriera and Otley, 2009). Carrying out regular audit in all production process ensures that the KSF (quality, people engagement, safety, environment, efficiency, delivery performance) is in accordance to what is stated. Producing products that meets customer satisfaction always requires close control and that is ensured through the daily audit of the assembly lines; that way areas that are not in compliance are easily detected as measures expose areas that would have otherwise not been seen. For Volvo CE, there are ninety-three KPIs including quality, safety, profitability etc. It is evident that their KPIs is driven form its KSF as study suggest, Volvo CE ninety-three KPIs contradicts what research holds that the maximum number should be twenty-five. Further argument stresses that too many measures sometimes limits the managers’ impact. Hammarplast AB has amongst its KPIs: quality, flexibility and deliveries meaning it’s in according to what research suggest, that organization’s KPIs should be derived from its KSF.
Target setting
Setting of target forms a critical aspect of performance management as suggested by (Ittner and Larcker, 2001; Otley, 1999; Stringer, 2007 cited in Ferriera and Otley, 2009). EPS has as one of its set target to measure daily stop by ensuring that the stop time of twenty-six minutes per day is not exceeded. Having a cutoff point of stop times per day would reduce delays and ensure efficiency in the assembly lines. Therefore through the daily audit performed the stop time for each day is monitored and deviations are checked and control ensures that the causes are corrected. In the case of Volvo CE matching of actual deliveries against production schedule is one of the ways target is set. Quality target is set by ascertaining the number of adjustments made weekly and monthly that way it becomes possible to actually see areas that requires changes to be made. And lastly for Hammarplast AB, one of the area target is set is in the scrap value level for each month which is set at less than two percent. Meaning if they must meet their KSF of quality it is important to reduce the scrap level and the only way of measuring monthly performance is to have a target. Based on this performance can be controlled.

Performance evaluation
Performance evaluation in all case companies is handled differently. Firstly EPS through its layered audit report management is able to evaluate individuals and group performance either on daily or weekly as the case may be. For Volvo CE evaluation is based on the information retrieved from the competence matrix and visual control boards either in-group level or the general board for the whole assembly lines. Hammarplast AB performance evaluation is based on the quality-scrap level on monthly basis.

Reward systems
Looking the all three case companies, it is obvious they all have different ways of rewarding performance of employees which could be financial and/or non-financial.
As stated that rewards are the result of performance evaluation (Ferriera and Otley, 2009), EPS only has non-financial reward system in place which rewards teamwork at the end of projects by sponsoring employees to seminars. The idea of group reward creates corporation and team spirit (Henderson and Larco, 2003), which has positive impact resulting to success of such team. In the case of Volvo CE, they have financial reward system in place that rewards employees contributions in terms of improvement suggestion and those that are actually implemented and are successful is also rewarded. This motivates employees because they see
themselves as part of the organization through their little contributions. Hammarplast AB makes use of a combination of both financial and non-financial reward system. Research shows a relationship between rewards, motivation and performance (Ferriera and Otley, 2009). From all case companies it is obvious that the different reward systems in place motivates employees allowing them to align their individual effort with that of the company (Robbins, k2005) in different ways whether it is financial and/or non-financial. The outcome research holds sometimes does not always transcend to performance (Jenkins et al. (1998) as cited in Ferriea and Otley, (2009).

**Information flows, systems and networks**

The information flows, systems and networks shows that all three companies rely on their continuous improvement process to get information. Since information flows functions as a binding agent keeping the whole system together (Ferreira and Otley, 2009) it is important to have a formalized system in place to aid the flow of information. From observation it is that only Hammarplast AB has a formalized information system in place.

**PM system use**

The purpose of all case companies performance management systems is to control, improve and for decision-making.

**PM system change**

The performance management systems of all case companies have been designed to adjust to changes from the improvement meetings.

**Strength and coherence**

Conclusively looking at the strength and coherence of the performance management systems of all case companies, it can be said they there is connection between all the stages in the system.
Chapter 6 Conclusions

In this concluding chapter, I will specifically respond to my research questions which has being my guide in the course of this thesis, thereafter theoretical contributions from my point of view will, following is the generalizations of the results and lastly some suggestions for future research areas.

6.1 Answers of research questions

6.1.1 “What are the types of production waste that exist in the production process and with which lean principles are these waste reduced or eliminated in the case companies?”
Looking at all three case companies it is obvious they all case companies experience some or all of the production waste due to one reason or the other. In reducing or eliminating these wastes they also have adopted different lean principles.

1. Over-production waste *(Exist in all three companies)*
2. Waiting waste *(Exist in all three companies)*
3. Transportation waste *(Exist in all three companies)*
4. Over-processing waste *(Exist in all three companies)*
5. Inventory waste *(Exist in all three companies)*
6. Motion waste *(Only in EPS and Volvo CE)*
7. Defects waste *(Only in EPS and Hammarplast Consumer AB)*

The second part of the question focus on how the identified production wastes are reduced or eliminated can be seen as shown in figure 5.5 above.

6.1.2 How are they currently managing performance in lean production process in comparison with performance management model.

*Vision and mission* (All three companies want to be a world leader in their different product area)

*Key success factors* (Common amongst them are quality and environmental issues)

*Organizational structure* (they all different organizational structure, which means that it is the key success factors set out to achieve by the vision and mission that determines the suitability
of the structure. The organizational structure is connected to their individual key success factors and the strategy adopted).

**Strategies and plans** (they all have adopted different strategies based on their key success factors)

**Key performance measures** (they all have different performance measures in place)

**Target setting** (they all have different targets)

**Performance evaluation** (they all evaluate performance differently)

**Reward system** (Volvo CE and Hammarplast AB both have financial and non-financial reward, EPS only makes use of non-financial reward)

**Information flows, systems and networks** (they all have a form through information is transmitted but only one “Hammarplast AB” actually has a formal system in place)

**PM system use** (they all use information retrieved for improvement purposes and decision making)

**PM system change** (they all have a system that accommodates changes in their performance management. They all work towards continuously improving their processes).

Using the PMSs as proposed by Ferreira and Otley (2009) makes it possible to see the interconnections between the different aspect and how it assist in the performance management in lean production in all case studied.

Conclusively, performance management of all three case companies through the lens of Ferriera and Otlay (2009) performance management system assert the view of Bititci et al, (1997, p. 524) that performance management is a closed loop system where policy and strategies are set out and from the feedback obtained the organization manages the performance of its business. Based on the above it is obvious that through the lens of the PMSs all the management activities in the different case companies are linked together in having a unified goal.

When it comes to managing performance in lean production it is clear that each of the case company performance management systems is similar although they have adopted different approach.

### 6.2 Theoretical contributions

Theoretical contribution could either be theory generation, extension and refinement. Generation is a means of discovering new concepts, detecting theoretical constructs, or even developing a mid-range theory drawn from existing theoretical perspectives. Theory extension
is to expand pre-existing theoretical or conceptual formulations to other groups or aggregations, to other bounded contexts or places, or to other socio-cultural domains. Theory refinement is the modification of existing and emerging theoretical perspectives through extension or through the close inspection of a proposition with new case material.

The main findings and contribution of this thesis to the existing theory of seven types of production waste is that not all times the seven types of production wastes is evident in a company’s production process. For the studied case companies, two of them only experience five of the seven types of production waste. The reason for this is largely dependent on the nature of products they produce. For process oriented industries most common production waste are inventory, waiting and defects wastes while for industries with assembly lines the most common are over-production, transportation and motion waste.

Below are areas that are in conflict with existing theories about lean production and its performance management. The areas in conflict are highlighted in italics.

The concept of lean production according to Womack et al, (1990) argues that it changes how work is done, thus results to increased productivity but does not have much effect on how people think (Boyer, 1996).

The empirical evidence collected from the studied case companies shares a contrasting light about the theory that lean production does not have much effect on how people think. Employee empowerment gives employees the room to work independently within their job specification. Getting use to the routine allows them to see their task different which enables them to come up with ideas to improve the process in some ways. The previous assertion that lean production does not have much effect on how people think could be refined as the whole concept of employee empowerment is geared towards allowing them to think individually or as a group. From all case companies’ evidence shows that management strongly encourage employees to come up with ideas to improve the production process. This some companies have financial reward for good suggestions while others reward is non-financial.

In Parker and Slaughter (1994) opinion, lean production is regarded as “management by
stress”. According to them lean production enhances the close monitoring of workers performance because the production process is structured in such a way that deviations from the main process are easily detected.

The opinion that lean production is management my stress and that it closely monitors workers performance to detect deviations from the main process should not be regarded as a negative aspect of lean production. Monitoring workers performance to detect deviation is a continuous improvement approach which goal is to improve the process and avoiding such deviations. Target setting goes hand in hand with reward, consequently monitoring workers performance could stem from that fact it could be used for rewarding employee’s performance.

6.3 Generalization of results

This research consists of three Production Companies that have just implemented lean production barely two years. Looking at the theoretical framework used, most of the empirical evidence is in support with a slight deviation. Findings of this study can therefore be generalized to companies in the production sector either process based or those with assembly lines.

6.4 Suggestions for future research

The focus of this thesis was on production companies producing products ranging from laundry equipments, dishwashers, dryers, to all sorts of plastics products used at home and in the hospitals. It would be interesting to undergo a similar research in the service sector to see if the findings arrived would be the same or if it will lead to contradictory results.

Additionally, since the main focus was on performance in within the studied case companies, it would be interesting to see the outcome of how performance management between these companies and their external suppliers would turn out.
Appendix 1

EPS Performance Management Systems (PMSs)

- Contextual Factors
- Culture

EPS PMSs
Appendix 2

Volvo CE PMSs
Hammarplast AB PMSs
Appendix 4

Interview guide

The following questions were used for all interview meetings conducted with the different personnel at the various case companies.

Questions 1 Types of Production Waste and Lean Principles

1.1 Which lean principles are you using in your production processes at the moment?
1.2 How does your company handle the seven types of waste as identified by the Toyota production System (TPS)?
   i. Transportation (moving products that are not actually required to perform the processing)
   ii. Overproduction (production ahead of demand)
   iii. Waiting (waiting for the next production step)
   iv. Motion (movement of products that is not required to perform the processing)
   v. Over-processing (due to poor tool or product design)
   vi. Inventory (all components, work-in-progress, and finished product not being processed)
   vii Defects (the effort involved in inspecting for and fixing defects with associated rework and scrap)
1.3 How is waste eliminated and/or reduced in your production process?

Questions 2 Performance management

2.1 What performance management systems are you currently using in managing performance in your production process? How the measurement data are collected and how often is it collected; how are the measures analyzed?
2.2 How do you make use and take action based on the information received?
2.3 Are there any formalized way? Give some examples in this regard? How are the measures communicated to the employees?
2.4 What do you think is good and what can be improved with the current performance measures? Do you think it is meaningful and relevant to have those measures? What could be done differently?
2.5 Do operating managers have access to accurate information to measure performance? If yes how, if not how is performance measured?
2.6 Do the employees think of the possibility to marginally change the design of the products
that would simplify the production process?

2.7 Do you work with job rotation? How? How do you support it? Any formalized way and measures regarding this?

2.8 Do you or your teams spend too much time in status meetings or management reviews? If yes how is it handled and if no state why?

2.9 Are your employee's involved in your company’s lean manufacturing processes?

2.10 Amongst the various performances management techniques in lean your company make use of which will you consider the most important? Why?
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